THE UNIVERSITY OF MANITOBA

AN EMPIRICAL ANALYSIS OF THE CANADIAN MINING INDUSTRY LABOR MARKET

by

DENNIS O'BRIEN

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

WINNIPEG, MANITOBA

December, 1974

AN EMPIRICAL ANALYSIS OF THE

CANADIAN MINING INDUSTRY

LABOR MARKET

by

DENNIS O'BRIEN

A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

ACKNOWLEDGEMENT

The critical reviewing by Dr. J.A. MacMillan (my major advisor) of Chapter I of this thesis in the early stages and the consequent redrafting of that chapter was extremely worthwhile to me. It provided a well established course on which to follow through with the analysis.

The extensive comments of Dr. MacMillan on the various drafts of each chapter and the suggestions of both he and Dr. E.W. Tyrchniewicz, at times throughout the analysis when I required it, is greatly appreciated.

Dr. J. Gray was most helpful with his comments of the later drafts.

A special thank you to the members of my thesis committee is also due, for the haste with which they returned their comments to me. Without the completeness of their comments each time and the haste with which they provided them, this thesis could not have been completed on schedule.

Mrs. Cynthia Herman has been most helpful throughout the entire course of my Master's program. Her precise attention to detail, thorough knowledge of format in professional writing and excellent typing, both with respect to this thesis and course term papers, is most appreciated.

The role of my wife, Gail, throughout the course of my studies has been very special. It is to her, that I dedicate this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The Canadian mineral mining industry has expanded rapidly in the post war period. The total quantity of metal and non-metal ores mined in Canada expanded over the period from 65.1 million tons in 1948 to 420.6 million tons in 1971 (an annual average rate of increase of 8.7 percent).[1] The total net capital stock in mineral mining is estimated to have increased to more than ten times[2] the 1948 level over the twenty-five years to 1973. The total labor input, in terms of total weekly man-hours worked, by comparison did not increase as substantially. Annual average rate of increase was 1.5 percent for the period from 2.3 million man-hours per week in 1948 to 3.3 million in 1971. The number of workers employed in the metal and non-metal mining sectors was 81,117 in 1971 compared to 51,494 in 1948.

Over the period the industry has been characterized by large cyclical fluctuations in both mineral prices and output. These have led to substantial cyclical variations in the labor requirements of the industry and resulted in large lay-offs (hires) of workers during recessions (expansions). In 1972 International Nickel Company instituted a ten percent cut back in production and laid off 4,007 employees.[3] In

---

[1] Statistics Canada, General Review of the Mineral Industries, Catalogue No. 26-201.

[2] Appendix A.

[3] International Nickel Company, Annual Report, 1972, p. 21.

the past summer of 1974, massive shortages of labor existed in this company and job openings could not be filled. The turn-around in two years clearly indicates the instability in mining manpower demand caused by mineral price fluctuations and the cyclical nature of mineral production. The purpose of this study is to quantify the relationships between the demand for minerals and the derived demand for labor and estimate the lags in adjustment to cyclical changes in the demand for minerals.

Problem Statement

A need exists to establish an empirical framework of the mineral industry labor market, consistent with the theoretical principles that determine the level of labor demanded by the industry and the supply of labor to the sector.

It is well recognized by industry personnel that the fluctuations in industry labor requirements, due mainly to changes in mineral prices and production and the difficulty in finding workers, have a high cost to the industry as well as to workers and mining communities. This study does not propose to measure these costs but intends to establish the empirical significance of factors affecting the supply of and demand for labor by the Canadian mineral mining industry and the rate of response to cyclical factors.

Overview of the Mining Industry Labor Market

An overview of the mining industry labor market (Figure 1) shows the flow of workers through the mining industry labor market and demonstrates the interrelations within the market. It is one industry subdivision of the national labor market, with each industry having a labor

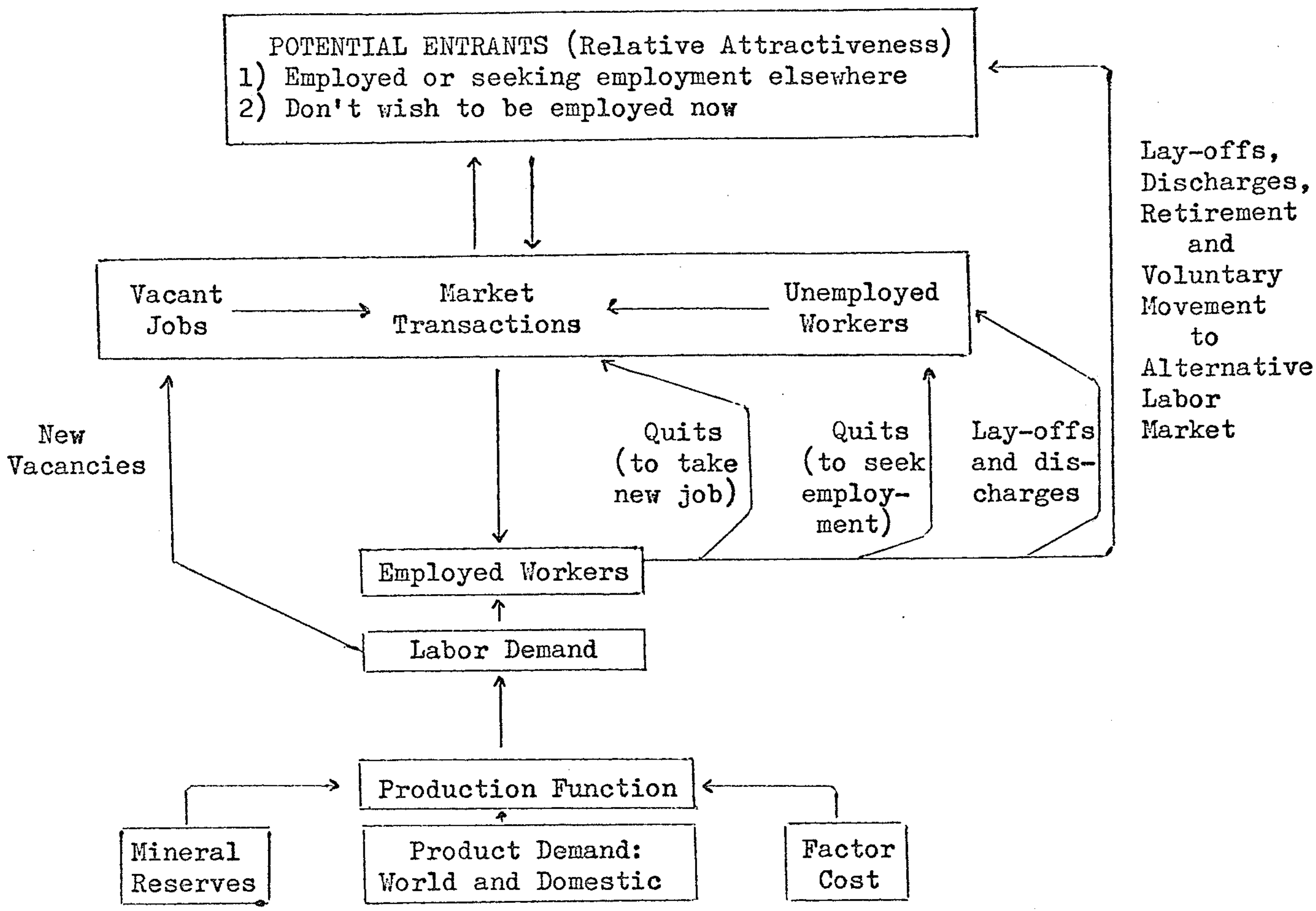

Figure 1. Mining Industry Labor Market

market structure similar to that shown. The flow of workers between markets and into and out of the total labor force is indicated by the arrows between the top rectangle (Potential Entrants) and the rectangle below it (Market Transactions).

A range of factors influence the demand for labor. Changes in industry structural factors in terms of both fluctuations and general trends in product demand and prices, technological change, capital and labor substitution and factor costs determine the demand for labor over time; both the quantity and type of labor demanded are effected. These industry structural factors also effect the general conditions of employment within the industry which are compared by the worker to employment conditions elsewhere, along with considerations of relocation costs, labor market conditions and the probability of finding employment, in his decision to migrate. These factors determine the number of workers drawn into the industry labor force from the potential labor supply[4] and the movement of workers out of the mining industry labor force.

The overview of the mining industry labor market provides a very general context for the study. Not all the variables discussed above will be analyzed in detail due to data and time limitations.

Study Objectives

A simultaneous supply and demand equation system will be estimated. This will determine the significance of the factors outlined briefly in Figure 1 and discussed in detail later in the theoretical review of Chapter III. The following aspects are of major concern in this analysis for their effect on the supply of and demand for labor in the Canadian mineral mining industry.

i. The fluctuations in industry production and mineral prices are known to lead to substantial lay-offs in recession periods and shortages of workers in expansion periods. The importance of these two product demand factors will be analyzed to establish their importance in the determination of labor demand.

ii. The level of capital investment and the effect of technological change will also be investigated for their net effect on labor

---

[4]The potential labor supply being the total number of workers suited to the type of employment and the hours of work they are able to provide. The potential labor supply is the total hours of work sought by workers as distinct from the hours of work actually provided or being done.

demand.

iii. A major problem in the industry is the rate of adjustment to changing conditions. Incorporation of Nerlove distributed lags into the model will provide estimates of the time for both the industry demand and supply to adjust. Estimates of the long-run and short-run elasticities of demand and supply to factors affecting the labor market will also be possible by incorporation of this lag.

iv. The effect of wages and salaries in the industry on the demand for and supply of labor will be determined. Wages and salaries elsewhere in the economy will also be investigated for its effect on labor supply to the mineral mining sector

v. The mineral mining industry is investigated on the basis of the two sectors within it - the metal and non-metal mining sectors. The labor market for hourly-paid (production) and salaried (management) workers to each sector is also investigated. It is hypothesized that the two sectors compete for workers and that the two types of workers complement each other. This interdependence between catagories of workers and mineral mining sectors is tested in the model formulation.

The thesis results will be of value to the industry and government by:

i) providing empirical information on the factors underlying the wide fluctuations in industry employment and thereby facilitate improvement of contra-seasonal and contra-cyclical employment programs specific to the mining sector,

ii) enabling mining companies to more accurately determine labor's response to changing conditions and to plan appropriately, and

iii) establishing the structure and interrelationships of the industry labor market, a basis will have been formed to which more specific studies of the mining industry labor market can be related.

OUTLINE OF THE STUDY

The study is divided into six chapters. Following this introduction, Chapter II presents a review of the Canadian mineral mining industry with particular reference to the role of agriculture. The relevant economic theory is reviewed in Chapter III. In Chapter IV variables to be analysed are specified and hypotheses about expected results are presented; a review of previous studies is given; and the form of the econometric model, its limitations and problems associated with its estimation are discussed. The results, limitations and implications of the study are discussed in Chapter V. In Chapter VI the conclusions and suggestions for possible further studies are presented.

CHAPTER II

A REVIEW OF THE CANADIAN MINING INDUSTRY WITH PARTICULAR REFERENCE TO THE LABOR MARKET

Production of the Canadian Mineral Mining Industry

The total quantity of metals and non-metals mined in Canada has expanded rapidly in the post-war period from 65 million tons in 1948 to 421 million tons in 1971[1] (Table I and Figure 2). The total quantity of metals and non-metals mined in Canada has shown a steady increase of 9.0 percent per year in the post-war period with only two declines in production being recorded in 1958 and 1969. The average annual rates of growth for metallic and non-metallic minerals were 9.2 percent and 9.3 percent respectively.

Provincially, mining production (excluding fuels) has expanded considerably in every province with the major producer (Quebec) showing the most marked increase.[2] The tonnage of ore mined and rock quarried in Quebec increased by 9.0 percent per year in the post-war period, from 24.5 million tons in 1948 to 163.9 million tons in 1971. The continuous expansion in output in Quebec likely creates a different pressure on

---

[1]The last year for which Statistics Canada data are available.

[2]The provincial fluctuations during the post-war period are illustrated by the changes in the tonnage of ore mined and rock quarried, as a provincial breakdown to metals and non-metals is not available (Table II and Figure 3).

TABLE I

ANNUAL TONNAGE OF MINERAL ORE MINED IN CANADA BY SECTORS, 1948-1971[a]

Year	Metal	Non-Metal	Total: Metal and Non-Metal
	. . . .	.1,000 tons	
1948	36,876.8	28,233.1	65,109.9
1949	43,331.7	26,690.9*	70,022.6
1950	45,915.9	35,740.4	81,656.3
1951	48,793.7	37,440.0	86,233.7
1952	52,343.7	37,512.1	89,855.8
1953	54,433.2	39,672.4	94,105.6
1954	59,014.4	53,726.9	112,741.3
1955	69,188.8	55,229.1	124,417.9
1956	77,391.7	63,576.9	140,968.6
1957	84,340.8	70,809.7	155,150.5
1958	78,755.4*	67,269.6*	146,025.0*
1959	99,080.8	79,690.7	178,771.5
1960	101,633.9	87,366.0	188,999.9
1961	99,417.6*	95,937.3	195,354.9
1962	113,263.4	101,757.9	215,021.3
1963	124,463.2	120,799.4	245,262.6
1964	141,251.0	134,781.7	276,032.7
1965	178,578.9	147,344.2	325,923.1
1966	162,266.8*	172,421.4	334,688.2
1967	186,536.6	178,203.1	364,739.7
1968	206,056.6	177,285.0*	383,341.6
1969	189,578.6*	183,338.7	372,917.3*
1970	234,868.7	182,482.5*	417,351.2
1971	233,108.1*	187,476.1	420,584.2

[a] The tonnage of metal and non-metal ores mined in Canada and does not include stone or rock quarried and fuel extracted.

*Indicates a decrease in annual production relative to the level of the preceding year.

Source:

Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201 (Ottawa: Information Canada, annual).

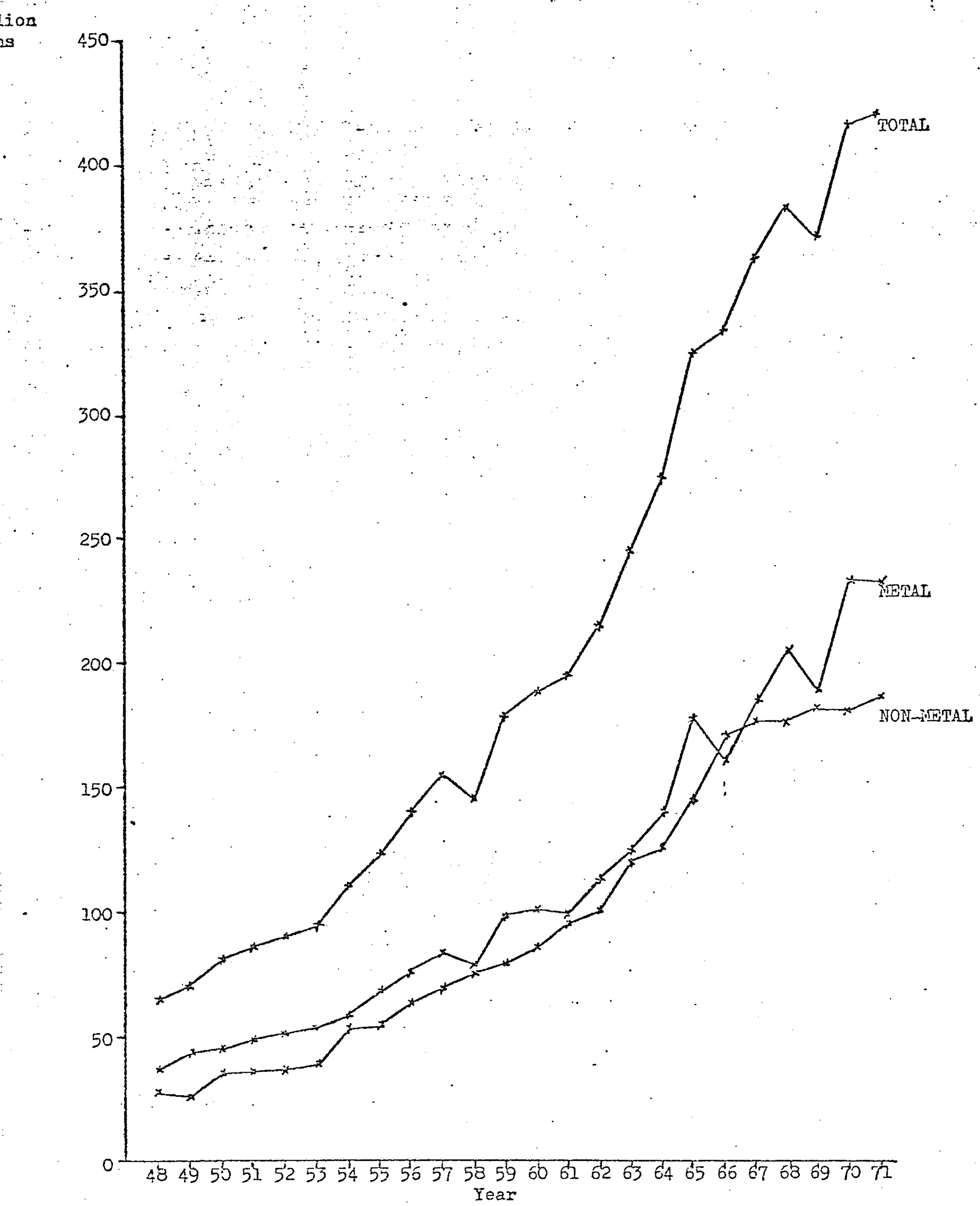

Figure 2

Annual Mineral Production of Canada by Sectors, 1948-1972

Table II

Annual Tonnage of Ore Mined and Rock Quarried[a] by Province, 1948-1971

Year	Newfoundland	Nova Scotia	New Brunswick	Prince Edward Island	Total Maritimes	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories	Total Yukon and Northwest Territories	Canada (excluding coal)
	......	......	......	......	......	......	......	Million Tons	......	......	......	......	......	......	......
1948[b]	..	3.3	0.3	..	3.6	24.5	30.3	1.7	2.0	0.3	7.6	—	0.2	0.3	70.4
1949	2.4	2.9*	0.4	..	5.6	24.4*	32.7	2.2	1.8*	0.4	8.9	—	0.3	0.3	76.2
1950	2.0*	3.5	3.2	..	8.8	29.8	35.0	2.7	1.5*	0.4	9.0	0.1	0.4	0.4	87.7
1951	2.7	3.7	1.0*	..	7.3*	32.1	38.8	2.7	1.6	0.4	9.1	0.1	0.4	0.5	92.6
1952	2.6*	3.6*	0.5*	..	6.7*	33.7	40.3	2.0*	1.5*	0.5	11.2	0.1	0.4	0.5	98.5
1953	3.7	3.7	1.3	..	8.8	35.0	41.3	2.3	1.1*	0.8	11.8	0.2	0.5	0.7	101.6
1954	5.4	13.7	1.0*	..	20.2	40.3	43.8	2.5	1.2	0.8	10.9*	0.2	0.6	0.8	120.5
1955	7.9	4.6*	1.5	..	14.1*	50.6	49.2	2.9	1.2	0.8	13.1	0.2	0.6	0.8	132.7
1956[c]	9.5	4.9	2.5	..	17.0	57.6	56.2	3.2	1.5	1.0	13.0*	0.2	0.7	0.9	150.4
1957	10.5	4.7*	2.0*	..	17.2	63.8	64.7	3.4	2.5	1.1	12.8*	0.2	0.7	0.9	166.5
1958	7.4*	3.8*	2.5	..	13.7*	63.3*	62.9*	2.9*	2.9	0.9*	9.5*	0.2	0.8	0.9	157.1*
1959	7.5	6.7	2.4*	1.7	18.3	76.2	76.2	2.9	3.2	1.4	10.5	0.2	0.8	1.0	169.8
1960	9.8	5.5*	2.2*	0.8*	18.3	84.1	77.2	3.1	2.6*	1.0*	12.0	0.2	0.8	1.1	193.4
1961	10.8	5.6	3.3	0.2*	20.0	92.1	72.1*	5.0	2.4*	1.0	12.4	0.2	0.8	1.1	206.1
1962	11.6	5.5*	3.7	0.2	21.0	112.7	69.8*	5.2	2.9	1.2	15.1	0.2	0.7*	0.9*	228.7
1963	20.7	5.9	5.3	0.2	32.1	124.4	68.6*	7.8	5.1	1.2	17.3	0.2	0.7	0.9	257.3
1964	25.3	6.1	4.9*	0.4	36.6	146.2	76.0	5.6*	5.1	1.2	17.2*	0.2	0.7	0.9	288.7
1965	43.3	5.9*	4.7*	0.2*	54.2	151.4	83.8	5.9	6.5	1.4	23.4	0.2	1.4	1.2	328.0
1966	46.9	6.2	6.5	0.2	59.8	160.9	81.2*	7.0	8.1	1.4	28.5	0.1*	2.7	2.8	349.8
1967	55.2	5.5*	6.8	0.7	68.1	167.3	88.4	7.0	10.2	1.4	36.6	0.7	2.6*	3.3	379.1
1968	61.8	6.2	5.9*	0.4*	74.3	150.1*	103.8	7.7	12.9	1.4	37.4	5.5	3.3	8.8	396.4
1969	48.2*	7.1	5.0*	—	60.2*	155.1	94.5*	7.3*	16.3	1.6	41.4	5.9	4.3	10.2	385.7*
1970	65.0	6.8*	5.6	—	77.3	156.4	109.7	8.9	15.3*	1.5*	49.6	8.9	4.7	13.6	432.2
1971	63.4*	7.9	6.1	—	77.4	163.9	109.7	10.3	16.5	1.7	49.0*	4.9*	4.6*	9.5*	437.9
Production Decreases	(5)	(10)	(10)	(4)	(5)	(3)	(6)	(4)	(7)	(3)	(6)	(2)	(3)	(2)	(2)

[a] Sand and gravel, sodium sulphate, etc., which are not actually mined or blasted, are not included. Does not include coal or other fuels.

[b] Newfoundland joined Confederation in March, 1949.

[c] Uranium ore included, but it was excluded prior to 1956.

.. Not available.

— Less than 0.05 million tons.

* Indicates a decrease in annual production relative to the level of the preceding year.

Source: Statistics Canada, <u>General Review of the Mineral Industries</u>, Cat. No. 26-201 (Ottawa: Information Canada, annual).

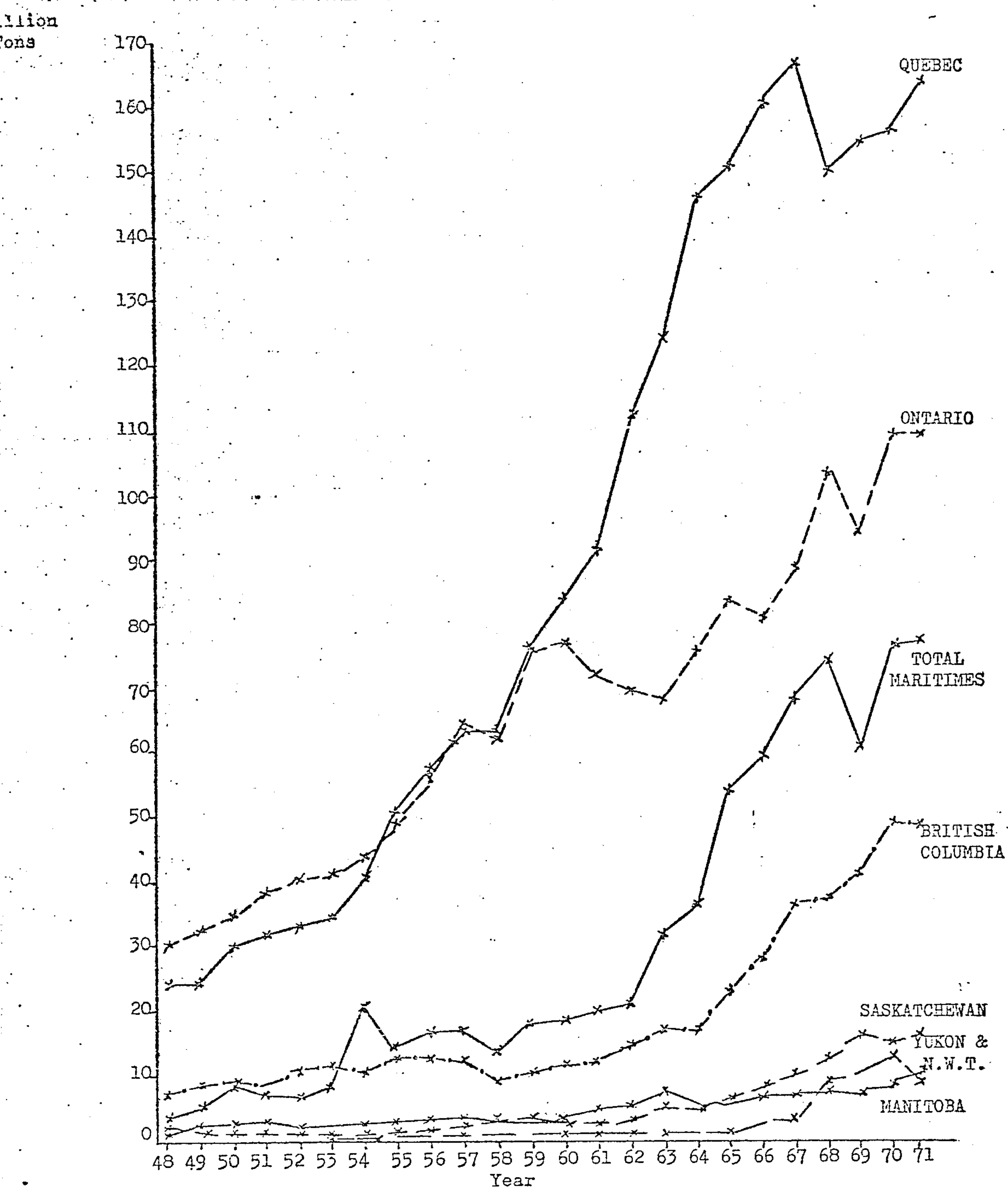

Figure 3

Annual Tonnage of Ore Mined and Rock Quarried
by Province, 1948-1971

turnover compared to other provinces in which erratic changes in output occur.

Production in Ontario expanded less rapidly with six reversals in annual production (average annual post-war rate of 6.1 percent), from 30.3 million tons in 1948 to 109.7 million tons in 1971. Ontario and Quebec have accounted for more than 50 percent of mineral output over the years.

In the Maritimes the tonnage of ore mined and rock quarried in the period 1948-1971 has increased at an average annual rate of 18.5 percent from 3.6 to 77.4 million tons, with the major part of the expansion due to increased mining in Newfoundland and Labrador. Production in Newfoundland increased at an average annual rate of 19.1 percent with five reversals in production levels. In contrast, New Brunswick had the largest number of production reversals (ten) in Canada.

British Columbia is the fourth major mining province. In 1971, 49.0 million tons of ore and rock were mined in that province. This compares with 12.4 million tons 10 years earlier and 7.6 million tons in 1948. Production in British Columbia represented 11.5 percent of the total national production for that year. The average annual rate of growth in British Columbia during the post-war period was 9.3 percent with six reversals in production.

In the Prairie Provinces, the tonnage of ore mined and rock quarried totaled 28.5 million tons in 1971, with 16.5 million tons of that being mined in Saskatchewan. Manitoba and Alberta accounted for 10.3 and 1.7 million tons respectively. Most of the increase in production on the Prairies has occurred in Manitoba and Saskatchewan over the last ten years. In the period 1961 to 1971 production in Manitoba increased at an average annual rate of 9.2 percent from 5.0 million tons to 10.3 million tons, while output in Saskatchewan rose at an average rate of 22.9 percent per year from 2.4 million tons in 1961 to 16.5 million tons in 1971. Manitoba, Saskatchewan and Alberta had four, seven and three production reversals respectively.

The tonnage of ore mined and rock quarried in the Yukon and Northwest Territories increased at an average annual rate of 21.7 percent during the post-war period from 0.3 million tons in 1948 to a high of 13.6 million tons in 1970 (production in 1971 declined to 9.5 million tons). The major part of the expansion has occurred over recent years with few production reversals. Production in the far North in 1971 accounted for 2.2 percent of the total national tonnage of ore mined and rock quarried.

Internationally, Canada is among the world's largest producers of some minerals. The total quantity of minerals produced from metal and non-metal ores mined in Canada was 76.1 million tons in 1971, 8.9 percent of the total world production of 852.2 million tons (Table III).

Information on the tonnage of ore mined by country is lacking. The United Nations Statistical Yearbook does not report the quantities of ores mined in different countries. It does however provide data on the tonnage of minerals produced in different countries from ores mined within that country or imported from others. To estimate the significance of the Canadian mineral mining industry in a world context, the production of minerals from ores mined in Canada, as well as the production of minerals within Canada, is compared to the total world production.

TABLE III

CANADIAN AND WORLD MINERAL PRODUCTION

	Mineral Production in Canada[1]			From Ores Mined in Canada[2]						World[1]		
Year	Metal	Non-metal	Total	Metal[3]	Metal[4]	Non-metal[3]	Non-metal[4]	Total[3]	Total[4]	Metal	Non-metal	Total
	'000 tons											
1963	19,184	7,465	26,649	30,853	30,858	7,227	18,488	38,080	49,346	356,852	190,270	547,12
1964	24,557	8,673	33,230	39,948	40,383	8,498	18,417	48,446	58,800	399,603	203,944	603,54
1965	25,795	10,166	35,961	41,863	42,252	9,977	20,750	51,840	63,002	435,120	224,556	659,67
1966	27,149	10,315	37,464	42,258	42,264	9,649	20,654	51,907	62,918	453,276	229,701	682,97
1967	28,499	12,108	40,607	44,635	44,642	11,922	21,441	56,557	66,083	457,913	242,398	700,31
1968	31,734	12,784	44,518	49,870	49,877	12,625	22,830	62,495	72,707	494,978	261,190	756,16
1969	27,096	13,471	40,567	42,400	42,408	13,410	24,042	55,810	66,450	523,126	271,861	794,98
1970	34,945	15,110	50,055	53,717	53,724	14,695	26,142	68,412	79,866	556,763	287,131	843,89
1971	32,678	14,752	47,430	50,051	50,056	14,944	26,051	64,995	76,107	577,390	274,795	852,18

[1] United Nations Statistical Yearbook, 1971, pp. 184-208.

[2] Statistics Canada, Catalogue Number 26-201, General Review of the Mineral Industries.

[3] Minerals surveyed in both the United Nations Statistical Yearbook and Catalogue Number 26-201 (that is, for comparison to world).

[4] Minerals surveyed in Catalogue Number 26-201 (that is, total for Canada).

Statistics Canada, Catalogue Number 26-201[3] provides data on the production of minerals from ores mined in Canada, some of which are smelted or refined outside Canada, while the United Nations Statistical Yearbook provides information on the mineral production within Canada. The minerals covered in the catalogue are not the same as those reported in the United Nations Statistical Yearbook. The Yearbook covers some metal minerals not mined in Canada or reported in catalogue number 26-201 (chromium, bauxite, manganese and uanadium) while it does not cover all metals reported in the catalogue (bismuth, cadmium, calcium, cobalt, columbium, platinum, selenium, tantalum, tellurium, thorium, indium and yttrium). For non-metals, the yearbook covers salt, asbestos, potash, phosphate and sulphur (also covered in the catalogue) as well as diamonds. The catalogue also covers many other non-metals that are mined in Canada but not reported in the yearbook.

Table III shows the production of minerals as reported in these sources for the years 1963 to 1971.

The production of minerals from ores mined in Canada has shown a general upward trend for both metals and non-metals but with some fluctuation. World production, by comparison, has shown a steady increase, with production of both metal and non-metal minerals increasing in every year shown.

The world mineral market is characterized by a large number of producing nations in each mineral and although Canada is among the top producers of many minerals, Canadian production does not dominate the

---

[3]Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201 (Ottawa: Information Canada, annual), Tables 1A, 1B and 1C.

world market. In total, Canadian production reported in Statistics Canada, Catalogue Number 26-201 at 76.1 million tons was 6.76 of the world's total mineral production of 852.2 million tons.[4] If only those minerals reported in the United Nations Statistical Yearbook are considered, the production of minerals from ores mined in Canada as derived from Statistics Canada, Catalogue Number 26-201, is 65.0 million tons, 7.6 percent of total world production. The production of minerals[5] within Canada (from ores mined both in and outside Canada) was 47.4 million tons in 1971, 5.6 percent of total world production in that year.

The United Nations Statistical Yearbook reports the production of minerals by country for the major minerals. In 1971, Canada produced 32.7 million tons (5.7 percent) of the world's metal production and 14.8 million tons (5.4 percent) of the non-metal production.[6] Canadian production of uranium accounted for 20.2 percent of total world production, second to the United States that produced 49.9 percent. Canada is the largest producer of nickel with production in 1971 accounting for 36.2 percent of world production. Canada was also the major producer of zinc (23.5 percent in 1971). Canadian production of molybdenum was the second largest in the world in 1971 and accounted for 13.3 percent of world production.

Of the non-metals, Canada is the world's major producer of asbestos (30.7 percent of world production in 1971) and accounted for 17.7

---

[4]United Nations Statistical Yearbook, 1971, pp. 184-208.

[5]Ibid.

[6]Ibid.

percent of world potash production and 15.2 percent of sulphur production and was the second and third largest producer respectively of these two minerals.

Value of Production

The value of Canadian mineral production has risen over the post-war period to reach $3.4 billion in 1971 ($0.11 million less than the record level of 1970). Table IV and Figure 4 show the growth in the value of the metal and non-metal sectors of the industry since 1948. Six reversals occurred for metals and two for non-metals. The reversal for 1958 was the largest value reversal for both metals and non-metals.

Mineral Prices

Statistics Canada only publishes annual metal prices for gold, silver, copper, lead and zinc,[7] however, it does publish the values and tonnages of minerals mined. Table V shows annual average metal and non-metal prices in current dollars since 1948, calculated by dividing the annual values by the tonnages mined.

Prices in both sectors have not shown any marked trend over the post-war period. Metal prices have increased at an average annual rate of 0.32 percent with eleven declines on the level of the preceding year over the twenty-three years since 1948. Non-metal prices increased at a slightly higher rate of 0.88 percent per year but showed the same number of declines over the period.

Price levels for minerals in constant 1948 dollars (Table VI)

---

[7]Statistics Canada, op. cit.

Table IV

Annual Values of Mineral Production of Canada by Sector, 1948-1971[a]

Year	Metal	Non-Metal	Total: Metals and Non-Metals	Annual Percent Change
	....	$'000	....	
1948	488,287.8	67,097.5	555,385.3	8.7
1949	538,967.3	64,585.2*	603,552.5	18.0
1950	617,238.3	94,721.6	711,959.9	21.0
1951	745,877.6	115,418.2	861,295.8	-1.0
1952	728,458.2*	124,493.3	852,951.5*	-2.1
1953	709,920.5*	124,999.6	834,920.1*	11.4
1954	802,401.4	128,038.5	930,439.9	23.9
1955	1,007,839.5	144,920.8	1,152,760.3	13.4
1956	1,146,349.6	160,341.6	1,306,691.2	1.7
1957	1,159,579.2	169,061.1	1,328,640.3	-3.6
1958	1,130,160.4*	150,354.8*	1,280,515.2*	21.0
1959	1,370,648.5	178,216.6	1,548,865.1	3.6
1960	1,406,558.1	197,505.8	1,604,063.9	-.4
1961	1,387,159.1*	210,467.8	1,597,626.9*	7.3
1962	1,496,434.0	217,453.0	1,713,887.0	2.9
1963	1,509,536.9	253,452.4	1,762,989.3	12.8
1964	1,701,648.5	287,497.0	1,989,145.5	12.4
1965	1,907,575.9	327,238.9	2,234,814.8	5.1
1966	1,984,672.6	363,387.7	2,348,060.3	14.6
1967	2,285,279.5	406,269.3	2,691,548.8	9.2
1968	2,492,599.6	446,922.2	2,939,521.8	-3.8
1969	2,377,523.4*	450,188.7	2,827,712.1*	25.7
1970	3,073,344.1	480,537.6	3,553,881.7	-3.2
1971	2,940,287.0*	500,826.8	3,441,113.8*	

[a]The production of the metals (copper, gold, lead, nickel, silver, zinc, etc.) is given as far as possible on the basis of the quantities of metals recovered in smelters, and the total quantities in each case are valued chiefly at the average market price of the refined metal in a recognized market. There are thus included in some cases the values that have accrued in the smelting or refining of metals outside of Canada.

*Indicates decrease in the value of production on the level of the preceding year.

Source: Statistics Canada, General Review of the Mineral Industries, Cat. No. 26-201 (Ottawa: Information Canada, annual).

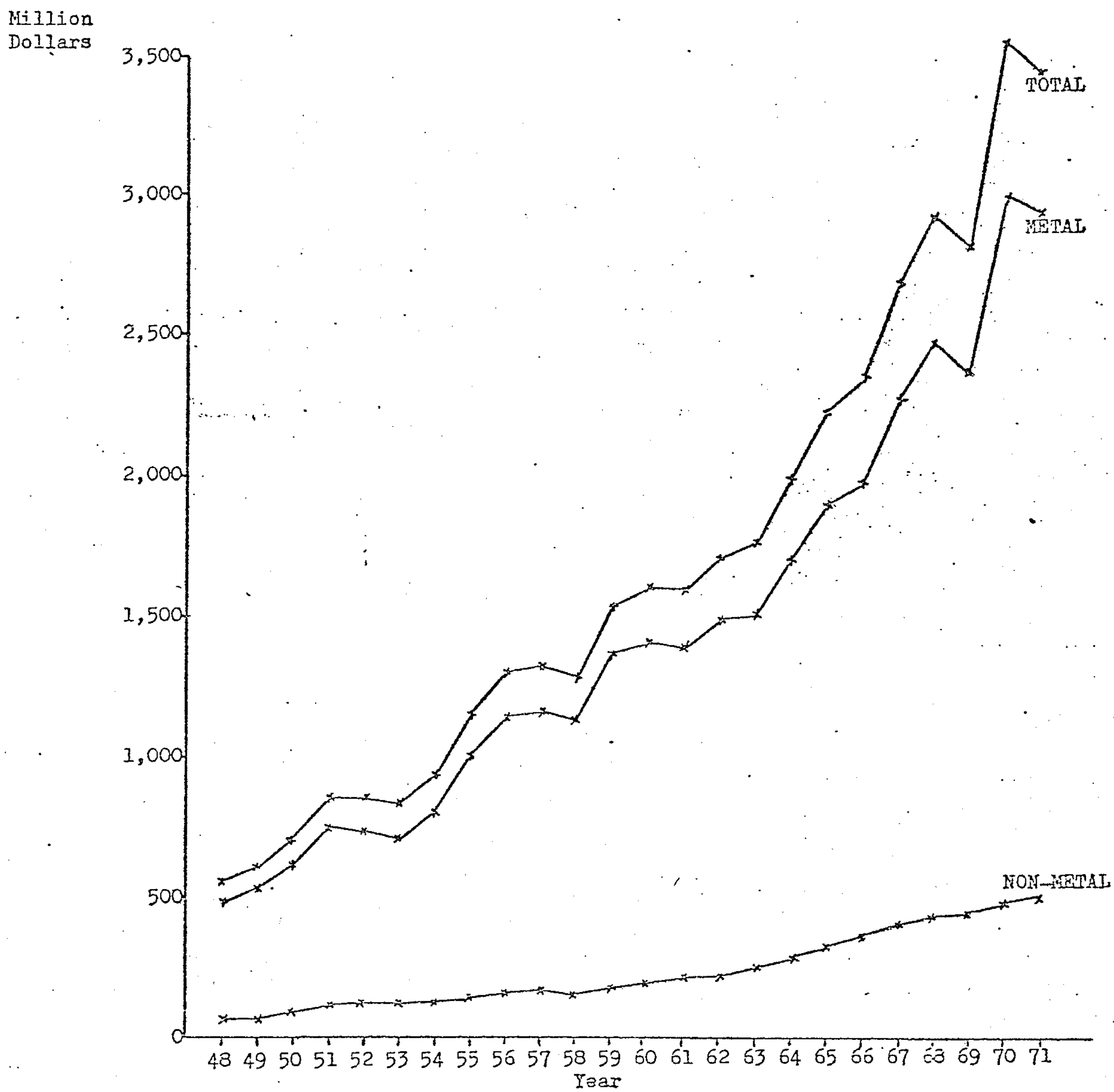

Figure 4

Annual Values of Mineral Production of Canada
by Sector, 1948–1971

TABLE V

ANNUAL AVERAGE METAL AND NON-METAL PRICES IN CANADA IN CURRENT DOLLARS[a]

Year	Metal	Non-Metal	Total: Metal and Non-Metal
	.... $ per ton		
1948	13.24	2.37	8.52
1949	12.43*	2.41	8.61
1950	13.44	2.65	8.71
1951	15.28	3.08	9.98
1952	13.91*	3.31	9.49*
1953	13.04*	3.15*	8.87*
1954	13.59	2.38*	8.25*
1955	14.56	2.62	9.26
1956	14.81	2.52*	9.26
1957	13.74*	2.38*	8.56*
1958	14.35	2.23*	8.76
1959	13.83*	2.23	8.66*
1960	13.83	2.26	8.48*
1961	13.95	2.19*	8.17*
1962	13.21*	2.13*	7.97*
1963	12.12*	2.09*	7.18*
1964	12.04*	2.13*	7.20
1965	10.68*	2.22	6.85*
1966	12.23	2.10*	7.01
1967	12.25	2.27	7.37
1968	12.09*	2.52	7.66
1969	12.54	2.45*	7.58*
1970	13.08	2.63	8.51
1971	12.61*	2.67	8.18*

[a]Calculated by dividing the annual values of mineral production by the tonnage of ore mined.

*Indicates a decrease in price relative to that of the preceding year.

Source:

Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201 (Ottawa: Information Canada, annual).

TABLE VI

ANNUAL AVERAGE METAL AND NON-METAL PRICES IN CANADA IN CONSTANT 1948 DOLLARS[a]

Year	Metal	Non-Metal	Total: Metal and Non-Metal
	. . . .$ per ton		
1948	13.24	2.37	8.52
1949	12.06*	2.30*	8.35*
1950	12.67	2.50	8.21*
1951	13.04	2.63	8.52
1952	11.58*	2.76	7.90*
1953	10.95*	2.64*	7.45*
1954	11.34	1.99*	6.89*
1955	12.13	2.18	7.72
1956	12.16	2.07*	7.60*
1957	10.93*	1.89*	6.81*
1958	11.12	1.73*	6.79*
1959	10.61	1.71*	6.64*
1960	10.48*	1.71	6.42*
1961	10.47*	1.64*	6.13*
1962	9.80*	1.58*	5.91*
1963	8.76*	1.51*	5.19*
1964	8.62*	1.53	5.16*
1965	7.46*	1.55	4.79*
1966	8.24	1.42*	4.72*
1967	7.97*	1.48	4.80
1968	7.56*	1.58	4.79*
1969	7.50*	1.47*	4.53*
1970	7.57	1.52	4.92
1971	7.10*	1.50	4.60*

[a]Calculated by deflating current prices by the consumer price index for Canada.

*Indicates a decrease in price relative to that of the preceding year.

Source:

Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201.

have shown considerable declines on the immediate post-war levels. Metal prices rose in only nine years while non-metal prices increased in eleven of the twenty-four years since 1948.

Capital Investment

Table VII and Figure 5 show the post-war growth in capital stock, annual production and total weekly man-hours of the mineral mining industry. The total net capital stock has increased steadily to more than ten times the 1948 level over the years to 1973.[8] This compares to the 44.2 percent increase in total weekly man-hours and the more than six fold increase in production over the same period.

Labor Input

Number of Workers

Table VIII shows the total number of management and production workers in the metal and non-metal mining industries. The total number of workers in the mineral mining industry increased from 51,494 in 1948 to 81,117 in 1971. The total number of production workers in 1971 was 63,180. The number of management employees was 17,937.

The total number of employees in the metal mining industry increased at an average annual rate of 2.08 percent since 1948 to reach 66,012 in 1971. Production workers in that sector increased from 37,705 in 1948 to 51,117 in 1971. Management staff, by comparison, increased from 4,420 to 14,895 over the same period (over three times the level of 1948).

---

[8] Refer to Appendix A for estimation procedure used to determine the capital stock flow for the mineral mining sector.

TABLE VII

CANADIAN MINERAL MINING INDUSTRY - CAPITAL, LABOR AND PRODUCTION

Year	Annual Mineral Production[a] '000 Tons	Index 1948=100	Total Weekly Man-Hours[b] '000	Index 1948=100	Total Net Capital Stock[c] $000,000	Constant 1948 dollars	Index 1948=10
1948	65,109.9	100.0	2,301.5	100.0	645	645	100.0
1949	70,022.6	107.6	2,473.6	107.5	667	647	103.4
1950	81,656.3	125.4	2,594.2	112.7	732	690	113.5
1951	86,233.7	132.4	2,793.3	121.4	839	716	130.1
1952	89,855.8	138.0	2,919.5	126.9	853	710	132.3
1953	94,105.6	144.5	2,771.0	120.4	868	729	134.6
1954	112,741.3	173.2	2,758.3	119.9	1,008	841	156.3
1955	124,417.9	191.1	2,860.9	124.3	1,203	1,003	186.5
1956	140,986.6	216.5	3,079.4	133.8	1,447	1,188	224.3
1957	155,150.6	238.3	3,149.4	136.8	1,667	1,326	258.5
1958	146,025.0	224.3	3,039.8	132.1	1,804	1,398	279.7
1959	178,771.5	274.6	3,117.8	135.5	2,099	1,610	325.4
1960	188,999.9	290.3	3,014.3	131.0	2,266	1,717	351.3
1961	195,404.8	300.0	2,901.3	126.1	2,269	1,703	351.8
1962	215,021.3	330.2	2,886.0	125.4	2,329	1,728	361.1
1963	245,242.6	376.7	2,849.7	123.8	2,478	1,792	384.2
1964	276,032.7	424.0	2,892.9	125.7	2,694	1,930	417.7
1965	325,923.1	500.6	3,063.5	133.1	2,874	2,008	445.6
1966	334,688.3	514.0	3,081.3	133.9	3,279	2,210	508.4
1967	364,739.7	560.2	3,099.6	134.7	3,719	2,420	576.6
1968	383,341.6	588.8	3,190.5	138.6	4,178	2,611	647.8
1969	372,917.3	572.8	3,064.5	133.2	4,643	2,777	719.8
1970	417,351.3	641.0	3,309.3	143.8	5,160	2,986	800.0
1971	420,584.2	646.0	3,319.6[f]	144.2[f]	5,601	3,152	868.4
1972					6,155[d]	3,306	954.3[d]
1973					6,921[e]		1,073.0[e]

[a]Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201 (Ottawa: Information Canada, annual). (Total metals and non-metals from Table III.)

[b]Statistics Canada, Review of Man-Hours and Hourly Earnings, Catalogue Number 72-202 (Ottawa: Information Canada, annual).

[c]Statistics Canada, Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926-1960: Methodology, Cat. No. 13-522 (Ottawa: Information Canada); and Statistics Canada, Private and Public Investment in Canada, Outlook and Regional Estimates, Cat. No. 61-205 (Ottawa: Information Canada).

[d]Preliminary actual.

[e]Expected.

[f]1971 average weekly hours worked are not available. Estimated by assuming the average weekly hours worked in 1971 is the average for the preceding three years.

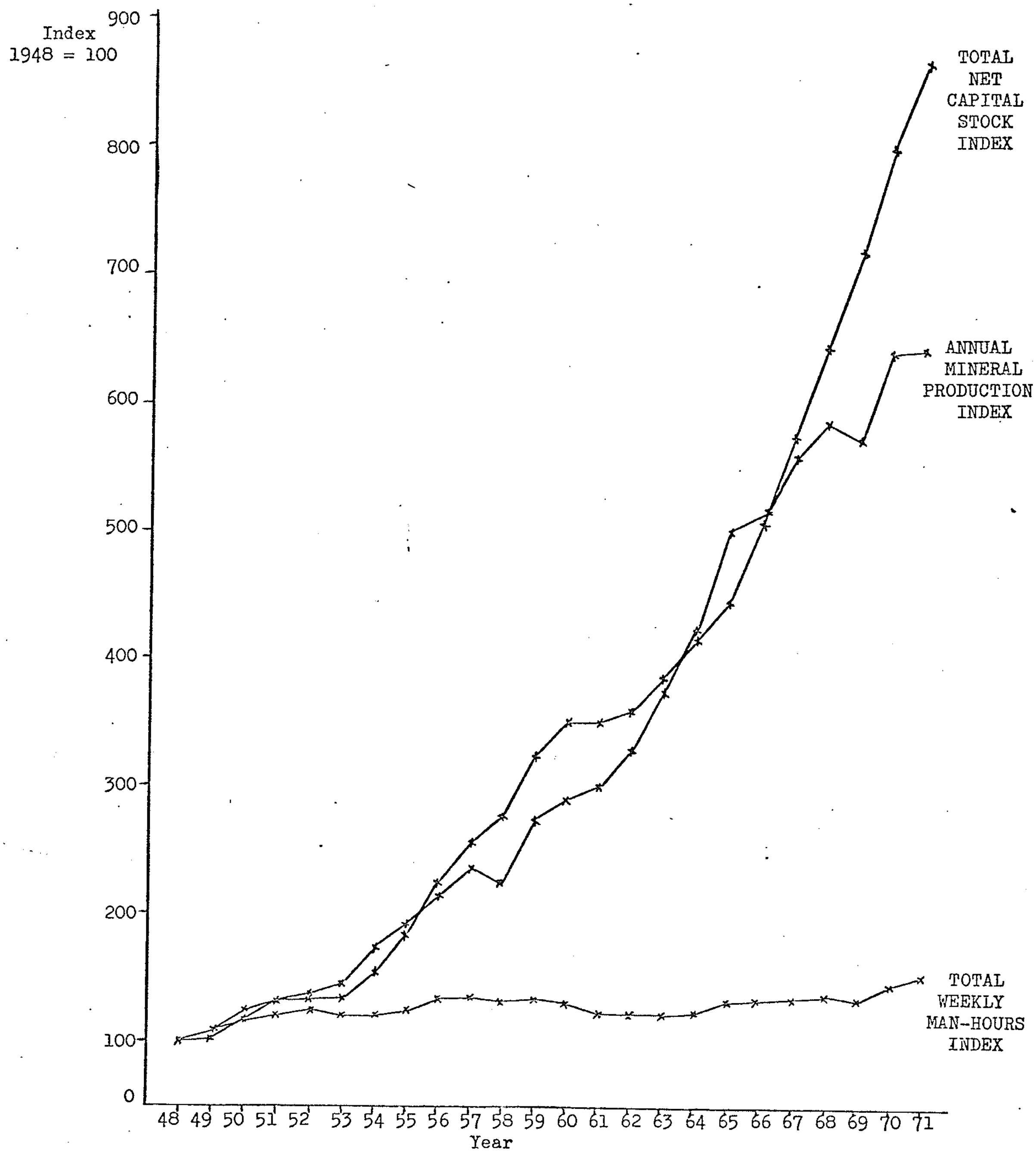

Figure 5

Canadian Mineral Mining Industry—Indices of Capital, Labor and Production, 1948–1971 (1948 Base Year)

TABLE VIII

NUMBER OF PRODUCTION AND MANAGEMENT EMPLOYEES IN THE CANADIAN MINERAL MINING INDUSTRY

	Metal Mining			Non-Metal Mining			Total Mineral Mining		
Year	Production	Management	Total	Production	Management	Total	Production	Management	Total
1948	37,705	4,185	41,890	8,647	957	9,604	46,352	5,142	51,494
1949	41,761	4,420	46,181	7,499	1,107	8,606	49,260	5,527	54,787
1950	42,944	4,753	47,697	9,023	1,093	10,116	51,967	5,846	57,813
1951	46,096	6,175	52,271	9,386	1,225	10,611	55,482	7,400	62,882
1952	49,273	6,065	55,338	9,754	1,292	11,046	59,027	7,357	66,384
1953	45,859	5,852	51,711	9,756	1,343	11,099	55,615	7,195	62,810
1954	45,680	5,919	51,599	9,493	1,399	10,892	55,173	7,318	62,491
1955	46,726	6,638	53,364	10,214	1,508	11,722	56,940	8,146	65,086
1956	50,009	7,555	57,564	10,895	1,653	12,548	60,904	9,208	70,112
1957	54,082	8,472	62,554	10,479	1,831	12,310	64,561	10,303	74,864
1958	52,855	9,144	61,999	9,913	1,747	11,660	62,768	10,891	73,659
1959	54,654	9,217	63,871	9,269	1,606	10,875	63,923	10,823	74,746
1960	52,975	8,907	61,882	9,238	1,770	11,008	62,213	10,677	72,890
1961	50,837	8,760	59,597	9,523	1,759	11,282	60,360	10,519	70,879
1962	49,660	9,657	59,317	9,743	1,778	11,521	59,403	11,435	70,838
1963	48,751	10,027	58,778	9,821	1,952	11,773	58,572	11,979	70,551
1964	47,445	10,203	57,648	9,331	2,396	11,727	56,776	12,599	69,375
1965	49,654	11,288	60,942	9,627	2,489	12,116	59,281	13,777	73,058
1966	49,808	11,862	61,670	9,858	2,564	12,422	59,666	14,426	74,092
1967	49,370	12,358	61,728	10,431	2,646	13,077	59,801	15,004	74,805
1968	50,028	13,341	63,369	10,806	2,867	13,673	60,834	16,208	77,042
1969	46,766	13,784	60,550	11,415	2,907	14,322	58,181	16,691	74,872
1970	52,218	14,372	66,590	12,232	3,083	15,315	64,450	17,455	81,905
1971	51,117	14,895	66,012	12,063	3,042	15,105	63,180	17,937	81,117

<u>Source</u>:

Statistics Canada, <u>General Review of the Mineral Industries</u>, Catalogue Number 26-201.

The total number of workers in the non-metal mining sector increased from 9,604 in 1948 to 15,105 in 1971. The number of production workers rose to 12,063 in 1971. The number of management employees rose from 957 in 1948 to 3,042 in 1971.

These figures compare with the similar increase of 59.2 percent in the total national level of employed workers, from 4.95 million in 1948 to 7.88 million in 1970 (Table IX).

Number of Man-Hours

The total number of weekly man-hours potentially available to the Canadian labor market is more than 50 percent higher than the 1948 level (Table X). The hours made available and the total weekly hours worked have also risen to over 50 percent of the levels in 1948.

Table XI shows the total weekly man-hours of salaried and hourly rated employees in the metal and non-metal mining industries.

The average hours worked per week by each hourly rated and salaried worker have shown a consistent downward trend in the post-war period.

The total labor input (total weekly man-hours) of the mineral mining industry increased from 2,278.4 million man-hours in 1948 to 3,271.1 million man-hours in 1971 (an average annual rate of increase of 1.71 percent). The labor input into non-metal mining rose at an average rate of 1.92 percent per year, from 417.2 million man-hours in 1948 to 621.6 million in 1971. The labor input into metal mining rose from 1,861.2 million man-hours in 1948 to reach 2,649.5 in 1971 (an average annual rate of increase for the period of 1.72 percent per year).

The total weekly man-hours of salaried workers rose at a considerably higher rate than that of hourly paid workers, in both the

TABLE IX

THE CANADIAN LABOR FORCE (NUMBER OF WORKERS)

Year	Civilian Population, 14 Years of Age And Over	Employed	Unemployed	Unemployment Rate	Total Labor Force	Not in Labor Force (14 years of Age or Over
	. . . .	'000		. percent. .	. . . . .	'000 . . . . .
1948	9,123	4,954	81	1.61	5,035	4,088
1949	9,254	4,991	101	1.98	5,092	4,162
1950[a]	9,610	5,056	142	2.73	5,198	4,412
1951	9,696	5,155	81	1.55	5,236	4,460
1952	9,933	5,239	105	1.96	5,344	4,589
1953	10,127	5,271	115	2.14	5,386	4,741
1954	10,362	5,255	221	4.04	5,476	4,886
1955	10,571	5,371	214	3.83	5,585	4,986
1956	10,807	5,585	197	3.41	5,782	5,025
1957	11,123	5,731	278	4.63	6,008	5,115
1958	11,388	5,706	432	7.04	6,137	5,250
1959	11,605	5,870	372	5.96	6,242	5,363
1960	11,831	5,965	446	6.96	6,411	5,420
1961	12,053	6,055	466	7.15	6,521	5,531
1962	12,280	6,225	390	5.90	6,615	5,665
1963	12,536	6,375	374	5.54	6,748	5,787
1964	12,817	6,609	324	4.67	6,933	5,884
1965	13,128	6,862	280	3.92	7,141	5,986
1966	13,475	7,152	267	3.60	7,420	6,055
1967	13,874	7,379	315	4.09	7,694	6,179
1968	14,264	7,537	382	4.82	7,919	6,344
1969	14,638	7,780	382	4.68	8,162	6,475
1970	15,016	7,879	495	5.91	8,374	6,642
1971	15,385	8,079	552	6.40	8,631	6,754

[a]Newfoundland included from 1950.

Source:

Canada Yearbook, various issues.

TABLE X

THE CANADIAN LABOR FORCE (NUMBER OF MAN-HOURS)

Year	Average Weekly Hours of Hourly Rated Wage Earners, All Manufacturing[b]	Total Weekly Hours Potentially Available[d]	Total Weekly Hours Available[e]	Total Weekly Hours Worked[f]
		. . . .	million[c].	
1948	42.3	384.90	212.98	209.55
1949	42.2	390.52	214.88	210.62
1950	42.3	406.50	219.88	213.87
1951	41.7	404.32	218.34	214.96
1952	41.5	412.22	221.78	217.42
1953	41.3	418.25	222.44	217.69
1954	40.7	421.73	222.87	213.88
1955	41.0	433.41	228.99	220.21
1956	41.0	443.09	237.06	228.99
1957	40.4	449.37	242.72	231.53
1958	40.2	457.80	246.71	229.38
1959	40.7	472.32	254.05	238.91
1960	40.4	477.97	259.00	240.99
1961	40.6	489.35	264.75	245.83
1962[a]	41.1	504.71	271.88	255.85
1963	41.5	520.24	280.04	264.56
1964	41.7	534.47	289.11	275.60
1965	41.8	548.75	298.49	286.83
1966	41.3	556.52	306.45	295.38
1967	40.9	567.45	314.68	301.80
1968	40.9	583.40	323.89	308.26
1969	40.6	594.30	331.38	315.87
1970	39.8	597.64	333.29	313.58
1971	38.9	598.48	335.74	314.27

[a]No data available for 1962. Average of the weekly hours in 1961 and 1962.

[b]A complete set of data on average hours of salaried and hourly rated wage earners in manufacturing is not available.

[c]Estimated by assuming the average hours worked by hourly rated employees in manufacturing is the same as that for all workers.

[d]Product of the total civilian population, 14 years of age or over, and the average weekly hours of hourly rated wage earners, all manufacturing.

[e]Product of the total labor force and the average weekly hours of hourly rated wage earners, all manufacturing.

[f]Product of the total number of employed and the average weekly hours of hourly rated wage earners, all manufacturing.

Source:

The data for the period 1948 to 1961 are taken from: Statistics Canada, Review of Man-Hours and Hourly Earnings, 1945-61, Catalogue Number 72-202.

The data for all years after 1961 are taken from: Statistics Canada, Earnings and Hours of Work in Manufacturing, Catalogue Number 72-204, various issues.

TABLE XI

TOTAL WEEKLY MAN-HOURS OF SALARIED AND HOURLY RATED EMPLOYEES IN THE CANADIAN MINERAL MINING INDUSTRY

Year	Average Weekly Hours of Hourly Rated Wage Earners[a]		Total Weekly Man-hours of Hourly Rated Wage Earners (million)			Average Weekly Hours Paid Salaried Worker	Total Weekly Man-hours of Salaried Workers (million)			Total Weekly Man-hours of all Employees (million)		
	Metal	Non-Metal	Metal[b]	Non-Metal[b]	Total	Manufacturing[e]	Metal[f]	Non-Metal[f]	Total	Metal	Non-Metal	Total
1948	44.9	43.8[c]	1693.0	378.7	2071.7	40.2[d]	168.2	38.5	206.7	1861.2	417.2	2278.4
1949	45.4	43.8[c]	1895.9	328.5	2224.4	40.1	177.2	44.4	221.6	2073.1	372.9	2446.0
1950	45.1	43.8[c]	1936.8	395.2	2332.0	40.0[d]	190.1	43.7	233.8	2126.9	438.9	2565.8
1951	44.1	46.0	2032.8	431.8	2464.6	39.9[d]	246.4	48.9	295.3	2279.2	480.7	2759.9
1952	44.1	42.6	2172.9	415.5	2588.4	39.4	239.0	50.9	289.9	2411.9	466.4	2878.3
1953	44.4	42.8	2036.1	417.6	2453.7	39.0	228.2	52.4	280.6	2264.3	470.0	2734.3
1954	44.4	42.9	2028.2	407.2	2435.4	39.0	230.8	54.6	285.4	2259.0	461.8	2720.8
1955	44.1	43.3	2060.7	442.3	2503.0	39.1	259.5	59.0	318.5	2320.2	501.3	2821.5
1956	44.1	43.1	2060.6	469.6	2530.2	38.9	293.9	64.3	358.2	2354.5	533.9	2888.4
1957	42.2	41.4	2232.3	433.8	2716.1	38.6	327.0	70.7	394.3	2609.3	504.5	3113.8
1958	41.3	41.1	2132.9	407.4	2590.3	38.5	352.0	67.3	419.3	2534.9	474.7	3009.6
1959	41.2	41.5	2251.7	384.7	2636.4	38.5	354.9	61.8	416.7	2606.6	446.5	3053.1
1960	41.4	41.1	2133.2	379.7	2572.6	38.5	342.9	68.1	411.0	2536.1	447.8	2983.9
1961	41.8	41.1	2125.0	391.4	2516.4	38.4[d]	336.4	67.5	403.9	2461.4	458.9	2920.3
1962	41.5	41.1	2060.9	400.4	2461.3	38.3[d]	369.9	68.1	438.0	2430.8	468.5	2899.3
1963	41.5	41.1	2023.2	403.6	2426.8	38.5	386.0	75.2	461.2	2409.2	478.8	2888.0
1964	41.7	41.7	1969.0	389.1	2358.1	38.6	393.8	92.5	486.3	2362.8	481.6	2844.4
1965	41.8	42.6	2075.5	410.1	2485.6	38.9	439.1	96.8	535.9	2172.3	506.9	2679.2
1966	41.5	42.0	2067.0	414.0	2481.0	38.4	455.5	98.5	554.0	2522.5	512.5	3035.0
1967	41.3	42.3	2039.0	441.2	2480.2	38.2	472.1	101.1	573.2	2511.1	542.3	3053.4
1968	41.2	42.4	2061.2	458.2	2519.4	38.1	508.3	109.2	617.5	2569.5	567.4	3136.9
1969	40.7	41.9	1903.4	478.3	2381.7	38.4	529.3	111.6	640.9	2432.7	589.9	3022.6
1970	40.3	41.3	2104.4	505.2	2609.6	38.3[d]	550.4	118.1	668.5	2654.8	623.3	3278.1
1971	40.7	41.9	2030.5	505.4	2585.9	38.2[d]	569.0	116.2	685.2	2649.5	621.6	3271.1

[a]Statistics Canada, Review of Man-hours and Hourly Earnings, Catalogue Number 72-202.

[b]The product of columns 1 and 2 of this table with columns 1 and 4 of Table IX.

[c]Average of the average weekly man-hours in 1951, 1952 and 1953.

[d]Estimated by assuming the change on the preceding year is 0.18 percent (the average rate of change in those years for which data were available.

[e]Statistics Canada, Earnings and Hours of Work in Manufacturing, Catalogue Number 72-204. Data on hours worked by salaried employees in mining are not available.

[f]The product of column 6 of this table with columns 2 and 5 of Table IX.

metal and non-metal mining sectors. The labor input of salaried workers into the metal and non-metal mining industries rose by 5.67 and 5.27 percent respectively per year over the period shown in Table XI. For hourly paid workers in the metal and non-metal mining sectors, the average annual rate of increase was 1.25 and 1.48 percent respectively.

Cost of Labor

Total Salaries and Wages

Table XII shows the total wage and salary bills for production and management staff in the metal and non-metal mining sectors.

The wage bill paid to production employees in the mineral mining industry increased more than four fold in the post-war period, with the labor cost of production employees in the non-metal mining sector increasing to more than five times the 1948 level (94,066 thousand dollars in 1971). The labor input of production employees in the metal mining sector increased by almost four times to 444,571 thousand dollars in 1971.

The level of salaries paid to management rose to 168.3 and 28.8 million dollars respectively in the metal and non-metal mining sectors. The increase in the metal mining sector was more than ten times the level of 1948. The total salaries in 1971 for the non-metal mining sector was over nine times that of 1948.

Average Salaries and Wages

The average annual salaries and wages of production and management employees in the metal and non-metal mining sectors is shown in Table XIII.

Wages and salaries in metal mining have tended to be higher than those in the non-metal mining sector. Salaries and wages in both

TABLE XII

TOTAL SALARIES AND WAGES OF PRODUCTION AND MANAGEMENT EMPLOYEES IN THE CANADIAN MINERAL MINING INDUSTRY IN CURRENT DOLLARS

	Metal Mining			Non-Metal Mining			Total Mineral Mining		
Year	Production	Management	Total	Production	Management	Total	Production	Management	Total
	. . . .				$'000.				
1948	100,168	14,985	115,153	18,655	2,642	21,297	118,823	17,627	136,450
1949	115,715	16,561	132,276	16,569	3,175	19,744	132,284	19,736	152,020
1950	123,353	18,677	142,030	21,848	3,586	25,434	145,201	22,263	167,464
1951	146,463	24,389	170,852	26,867	4,168	31,035	173,330	28,557	201,887
1952	170,153	27,530	197,683	30,859	5,143	36,002	201,012	32,673	233,685
1953	163,544	27,851	191,395	31,346	5,545	36,891	194,890	33,396	228,286
1954	167,225	27,972	195,197	32,045	5,833	37,878	199,270	33,805	233,075
1955	178,451	32,797	211,249	35,608	6,783	42,391	214,059	39,580	253,640
1956	204,896	38,051	242,947	39,068	8,060	47,128	243,964	46,111	290,075
1957	234,858	43,675	278,533	39,240	9,121	48,361	274,098	52,796	326,894
1958	239,286	50,344	289,630	37,593	9,302	46,895	276,879	59,646	336,525
1959	253,715	53,216	306,931	36,303	9,092	45,395	290,018	62,308	352,326
1960	254,370	53,672	308,043	38,849	9,760	48,610	293,219	63,432	356,653
1961	244,314	54,447	298,761	41,098	10,065	51,163	285,412	64,512	349,924
1962	250,899	59,332	310,231	42,850	10,540	53,391	293,749	69,872	363,622
1963	246,612	65,761	312,373	43,508	12,259	55,767	290,120	78,020	368,140
1964	249,896	71,710	321,605	45,727	15,222	60,950	295,623	86,932	382,555
1965	274,452	82,402	356,855	48,793	16,938	65,732	323,245	99,340	422,587
1966	294,416	90,726	385,143	52,849	18,092	70,941	347,265	108,818	456,084
1967	326,367	103,016	429,383	60,127	20,345	80,472	386,494	123,361	509,855
1968	356,985	117,787	474,772	68,630	24,038	92,667	425,615	141,825	567,439
1969	348,575	130,670	479,251	80,757	25,483	106,241	429,332	156,153	585,492
1970	432,896	147,650	580,546	89,534	27,848	117,382	522,430	175,498	697,928
1971	444,571	168,291	612,862	94,066	28,788	122,855	538,637	197,079	735,717

Source:

Statistics Canada, General Review of the Mineral Industries, Catalogue Number 26-201.

TABLE XIII

AVERAGE ANNUAL SALARIES AND WAGES OF PRODUCTION AND MANAGEMENT STAFF IN THE CANADIAN MINERAL MINING INDUSTRY IN CURRENT DOLLARS[a]

	Metal		Non-Metal	
Year	Production	Management	Production	Management
1948	2,657	3,581	2,157	2,761
1949	2,770	3,746	2,209	2,868
1950	2,872	3,929	2,421	3,280
1951	3,177	3,949	2,865	3,402
1952	3,453	4,539	3,163	3,980
1953	3,566	4,759	3,212	4,128
1954	3,550	4,725*	3,375	4,169
1955	3,819	4,940	3,486	4,498
1956	4,097	5,036	3,585	4,875
1957	4,342	5,155	3,744	4,981
1958	4,527	5,505	3,792	5,324
1959	4,642	5,773	3,916	5,661
1960	4,801	6,025	4,205	5,514*
1961	4,805	6,215	4,315	5,722
1962	5,052	6,143*	4,398	5,928
1963	5,058	6,558	4,430	6,280
1964	5,267	7,028	4,900	6,353
1965	5,527	7,299	5,068	6,805
1966	5,911	7,648	5,361	7,056
1967	6,610	8,335	5,764	7,688
1968	7,135	8,828	6,351	8,384
1969	7,453	9,479	7,074	8,766
1970	8,290	10,273	7,319	9,032
1971	8,697	11,298	7,797	9,463

[a]Obtained by dividing total salaries and wages (Table XII) by the number of workers (Table VIII).

*Indicates a decrease relative to that of the preceding year.

sectors have increased at rates of between five and six percent over the post-war period. Salaries of management employees in non-metal mining increased at an average annual rate of 5.58 percent since 1948 to $9,462 in 1971. Wages, in the same sector, increased at an average rate of 5.83 percent per year to $7,797 in 1971. In metal mining, salaries rose to $11,298 in 1971 (an average annual rate of increase of 5.18 percent since 1948). Wages, to production workers in the metal mining industry, increased at an average annual post-war rate of 5.33 percent to $8,697 in 1971.

Wages and salaries in the manufacturing sector,[9] have both been consistently higher than in the mineral mining industry (Table XV).

Table XVI shows the hourly wages and salaries of hourly paid and salaried workers in both sectors of the Canadian mineral mining industry and the manufacturing sector in constant 1948 dollars. Hourly wages and salaries have approximately doubled in all sectors, with the most substantial increase occuring for metal mining management staff.

[9]Representing the pattern for the total Canadian labor market.

TABLE XIV

AVERAGE ANNUAL SALARIES AND WAGES OF PRODUCTION AND MANAGEMENT STAFF IN THE CANADIAN MINERAL MINING INDUSTRY IN CONSTANT 1948 DOLLARS[a]

	Metal		Non-Metal	
Year	Production	Management	Production	Management
1948	2,657	3,581	2,157	2,761
1949	2,687	3,633	2,143	2,782
1950	2,707	3,703	2,282	3,091
1951	2,711	3,369	2,445	2,903
1952	2,875	3,779	2,634	3,314
1953	2,994	3,996	2,697	3,466
1954	3,055	3,944	2,817	3,480
1955	3,183	4,117	2,905	3,748
1956	3,364	4,135	2,943	4,002
1957	3,454	4,101	2,979	3,963
1958	3,509	4,267	2,940	4,127
1959	3,560	4,427	3,003	4,341
1960	3,637	4,564	3,186	4,177
1961	3,607	4,666	3,239	4,296
1962	3,748	4,557	3,263	4,398
1963	3,657	4,742	3,203	4,541
1964	3,773	5,034	3,510	4,551
1965	3,862	5,101	3,542	4,755
1966	3,983	5,154	3,613	4,755
1967	4,301	5,423	3,750	5,002
1968	4,459	5,518	3,969	5,240
1969	4,458	5,669	4,231	5,243
1970	4,797	5,945	4,236	5,227
1971	4,894	6,358	4,388	5,325

[a]Adjusted from Table XIII using the consumer price index.

TABLE XV

AVERAGE WAGES AND SALARIES IN MANUFACTURING IN
CURRENT AND CONSTANT 1948 DOLLARS, CANADA

	Average Annual Wages		Average Annual Salaries	
Year	Current Dollars	Constant 1948 Dollars	Current Dollars	Constant 1948 Dollars
1948	2,145	2,145	2,751	2,751
1949	2,216	2,149	2,852	2,766
1950	2,389	2,252	3,054	2,878
1951	2,669	2,277	3,431	2,928
1952	2,869	2,389	3,679	3,063
1953	2,951	2,478	3,841	3,225
1954	3,015	2,517	4,046	3,377
1955	3,148	2,623	4,190	3,492
1956	3,326	2,731	4,432	3,639
1957	3,396	2,702	4,676	3,720
1958	3,528	2,735	4,874	3,778
1959	3,710	2,845	5,049	3,872
1960	3,764	2,852	5,224	3,958
1961[a]	3,883	2,915	5,444	4,087
1962[a]	4,005	2,971	5,673	4,209
1963	4,202	3,038	5,787	4,184
1964	4,386	3,142	6,008	4,304
1965	4,645	3,246	6,254	4,370
1966	4,915	3,312	6,697	4,513
1967	5,214	3,392	7,078	4,605
1968	5,626	3,516	7,387	4,617
1969	6,038	3,611	8,118	4,855
1970[b]	6,754	3,909	8,667	5,016
1971[b]	6,214	3,497	9,253	5,207

[a]No survey taken in 1961 and 1962. The figures for these two years are estimated by assuming that the earnings increased at the average rate of the preceding five years.

[b]No data are available for salaried employees. Estimated by assuming that earnings increased at the average rate of the preceding five years.

Source:

Statistics Canada, Review of Man-Hours and Hourly Earnings, 1945-61, Catalogue Number 72-202; see also Statistics Canada, Earnings and Hours of Work in Manufacturing, Catalogue Number 72,204, various issues.

TABLE XVI

AVERAGE HOURLY SALARIES AND WAGES OF PRODUCTION AND MANAGEMENT STAFF IN THE CANADIAN MINERAL MINING INDUSTRY AND MANUFACTURING SECTOR IN CONSTANT 1948 DOLLARS[a]

	Metal		Non-Metal		Manufacturing	
Year	Production	Management	Production	Management	Production	Management
1948	1.14	1.71	0.95	1.32	0.98	1.32
1949	1.14	1.74	0.94	1.33	0.98	1.33
1950	1.15	1.78	1.00	1.49	1.02	1.38
1951	1.18	1.78	1.02	1.40	1.05	1.41
1952	1.25	1.84	1.19	1.62	1.11	1.49
1953	1.30	1.97	1.21	1.71	1.15	1.59
1954	1.32	1.94	1.26	1.72	1.19	1.67
1955	1.39	2.02	1.29	1.84	1.23	1.72
1956	1.47	2.04	1.31	1.98	1.28	1.80
1957	1.57	2.04	1.38	1.97	1.29	1.85
1958	1.63	2.13	1.38	2.06	1.31	1.89
1959	1.66	2.21	1.39	2.17	1.34	1.93
1960	1.69	2.28	1.49	2.09	1.36	1.98
1961	1.66	2.34	1.52	2.15	1.38	2.05
1962	1.73	2.29	1.53	2.21	1.39	2.11
1963	1.69	2.37	1.50	2.27	1.40	2.09
1964	1.74	2.51	1.62	2.27	1.44	2.14
1965	1.77	2.52	1.60	2.35	1.49	2.16
1966	1.85	2.58	1.65	2.38	1.54	2.26
1967	2.00	2.73	1.70	2.52	1.59	2.32
1968	2.08	2.79	1.80	2.64	1.65	2.33
1969	2.11	2.84	1.94	2.63	1.71	2.43
1970	2.29	2.99	1.97	2.62	1.90	2.52
1971	2.31	3.20	2.01	2.68	1.69	2.62

[a]Adjusted from Tables XIV and XV by dividing by the average number of hours worked through the year.

CHAPTER III

THEORETICAL BASIS OF THE DETERMINATION OF LABOR SUPPLY AND DEMAND CURVES

The supply of and demand for labor in the Canadian mineral mining industry are determined through the complex interaction of many factors as outlined in Figure 1 of Chapter I. These factors cause both intra-industry (intra-firm and inter-firm within the industry) and inter-industry movement of workers. This gross movement of workers consists of: i) replacement turnover, due to adjustments in the work force, independent of changes in industry structural factors but due to labor market imperfections, and ii) net turnover associated with changes in firm and industry structural factors relative to other places of employment.

This study does not propose to examine the intra-industry adjustment in labor to changes in individual firm structural factors, but examines the gross movement of workers into and out of the Canadian mineral mining industry.

MacMillan, Tulloch, O'Brien and Ahmad[1] have examined the effects of community, mine, work and personal characteristics on the level of labor turnover in metal and non-metal mining companies in Canada. The

[1]J.A. MacMillan, J.R. Tulloch, D. O'Brien and M. Ahmad, Determinants of Labor Turnover in Canadian Mining Communities, report prepared for the University of Manitoba, Centre for Settlement Studies under contract with the Canada Department of Energy, Mines and Resources (Department of Agricultural Economics, University of Manitoba, 1974).

micro-economic factors analysed in that study are not re-examined here, rather an analysis of the total industry labor demand and supply is carried out. Adjustment of the industry labor demand to changes in structural factors, such as world and domestic product demand, production relationships and technological advances, factor costs and the level of technically available reserves is analysed. The changes in the industry labor supply as these structural factors are translated into work preference conditions and compared by workers to conditions in other industries, are also analysed in this study.

I LABOR DEMAND

Product Demand

The total quantity of metals and non-metals mined in Canada has expanded rapidly (average rate of 8.7 percent per year) in the post-war period, from 65 million tons in 1948 to 421 million tons in 1971 (Table I and Figure 2). Internationally, Canada is among the World's largest producers of some minerals although total production of minerals from ores mined in Canada does not represent a substantial percentage of total World supply. In 1971 the production of minerals from ores mined in Canada was 76.1 million tons, 6.7 percent of the total World production of 852.2 million tons.[2] Of the major minerals, in 1971, Canada produced 5.65 percent of the World's metal production and 5.36 percent of the World's non-metal production.[3] For a more detailed discussion of the various minerals, refer to Chapter II.

---

[2]United Nations Statistical Yearbook, 1971, pp. 184-208.

[3]Ibid.

To determine the total demand for Canadian minerals on the World and domestic markets, it is necessary to aggregate the demand curves for each mineral on both markets.

Demand On The World Market

In the cases of such minerals as nickel and asbestos, where Canadian production is a significant part of the total World production (36.2 percent and 30.7 percent respectively in 1971), the demand on the World market for the Canadian product would be expected to be more elastic and for Canada to have a greater influence on World prices. If the World market is shared with a number of other major producers, as is the case with nickel and asbestos, the influence of Canada on the market would not be as pronounced and the demand for the Canadian mineral would tend to be less elastic than in the case of a mineral such as lead, where Canadian production is also a significant part of World production (11.7 percent in 1971) but where there is a large number of small producers competing for a share of the market. In the case of a large number of small producers competing on the market, the ability of one large producer to dominate the market over the independently operating small producers (each having no independent effect on price) is greater than in the case where two or more producers compete strongly, and jointly determine the market price.

In a situation that exists in a mineral, like magnesite, where there is a large number of producers and no single country dominates the market, the world price is almost independent of the action of any one producer.

Demand On The Domestic Market

A proportion of a country's production, besides going onto the international market will be sold on its own domestic market. Figure 6 illustrates the case in which a completely elastic world demand for the nations mineral production is assumed (i.e., the country is a small producer relative to total world production).

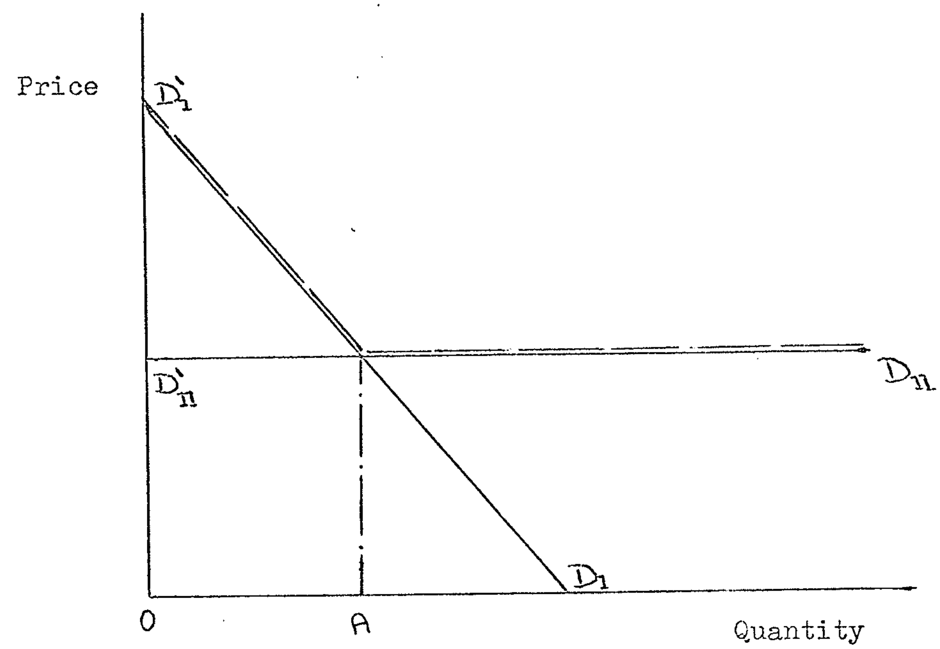

Figure 6. National Demand for Product Sold on Both the Domestic and Export Markets

D_1 D_1 domestic demand

D_{11} D_{11} export demand

D_1 D_{11} total demand (horizontal sum)

In a situation such as this, as the nation's supply curve shifts to the right, it will sell up to OA on the domestic market and the remainder on the world market.

The total demand curves for all metal and non-metal minerals mined in Canada is the horizontal sum of the individual domestic and export markets for each mineral. For most minerals mined in Canada, a large proportion is exported as ore to be refined or as the refined mineral.[4] and in the majority of cases, the world market is supplied by a large number of competitive producers[5] and Canada faces an elastic demand curve for its mineral products. In aggregate then (considering Canada produces only 6.7 of total world production) the demand curves for metals and non-metals mined in Canada could be expected to be relatively elastic.

Labor Demand-Derived From The Product Demand, Factor Costs And Production Function

The total amount of mineral sold is dependent on, i) the mineral supply function, as determined by the mineral reserves that are technically available, the production function of the industry and the factor costs relationships, and ii) the domestic and export demand for the product. The demand for labor depends on the demand for the product and the significance of labor as a product supply factor. This relationship is discussed now and illustrated in the flow chart of Figure 8, page 47.

Five principles[6] determine the elasticity of factor demand. The demand for labor is more inelastic:

---

[4]The Mining Association of Canada, "About 60 percent of Canada's total mineral production is shipped to foreign markets," Mining in Canada, Facts and Figures 1973 (Toronto, Ontario).

[5]United Nations Statistical Yearbook, 1971, op. cit.

[6]R.C. Fair, The Short-run Demand for Workers and Hours, Contributions to Economic Analysis (Amsterdam: North-Holland Publishing Company, 1969).

1. The more inelastic is the demand for the product.
2. The less important a fraction of total cost is the factor.
3. The less other factors can be technically substituted for this factor.
4. The more inelastic are the supplies of other factors.
5. The more inflexible is the administered price at which the firm continues to sell its product.

Items 1 and 5 relate to the demand curve for the product in terms of elasticity in the former and stability in the latter. Items 2, 3 and 4 refer to the production relationships between the factors of production determining the supply of the product. The product demand has already been discussed; it remains to relate the product demand function, through the production relationships specified in the production function, to the labor factor demand.

The Production Function

The demand for the industry's product acts through the production function to determine the derived labor demand. Three principles are of relevance to the analysis.

i. Level of Production -

Under conditions of perfect competition the marginal revenue product is determined solely by the shape of the production surface. However, under conditions of imperfect competition as is the case in the mineral mining industry, the elasticity of demand and the marginal product curve jointly to determine the marginal revenue received.

The profit maximizing level of production with respect to a factor of production occurs at the level where the marginal cost for one factor input equals the marginal revenue product gained from the addition of the extra unit of the factor. At equilibrium, the marginal revenue to labor is equal to the wage rate, and for capital is equal to the cost of invested capital. An increase in product demand will result in a shift out along the production possibilities curve. The consequent increase in the demand for the factors of production will depend on the shift and elasticity of the product demand function and the marginal productivity of the production function over the range for which the adjustment is occuring.

ii. Capital Labor Substitution -

For a given level of production, the optimum level of factor inputs is where the marginal rate of substitution equals the factor cost ratio.

iii. Effect of Technology -

The scale of the production function is altered by changes in technology. The effect is to move the production possibilities curve upwards thus increasing the product-factor ratio. Technological change may be either neutral, in which case the marginal rate of substitution remains unaltered and both capital and labor increase proportionally, or it may be non-neutral and lead to a change in the capital labor ratio with substitution of one factor for the other.

The interaction of factors, to determine the level and elasticity of factor demand is shown in Figure 7. The product demand curve determines the price level and the effect on marginal revenue as the producer increases production. The production function relates: 1) the product demand to the optimum level of production, and ii) the factor costs to the optimum level of factor inputs for any given level of production.

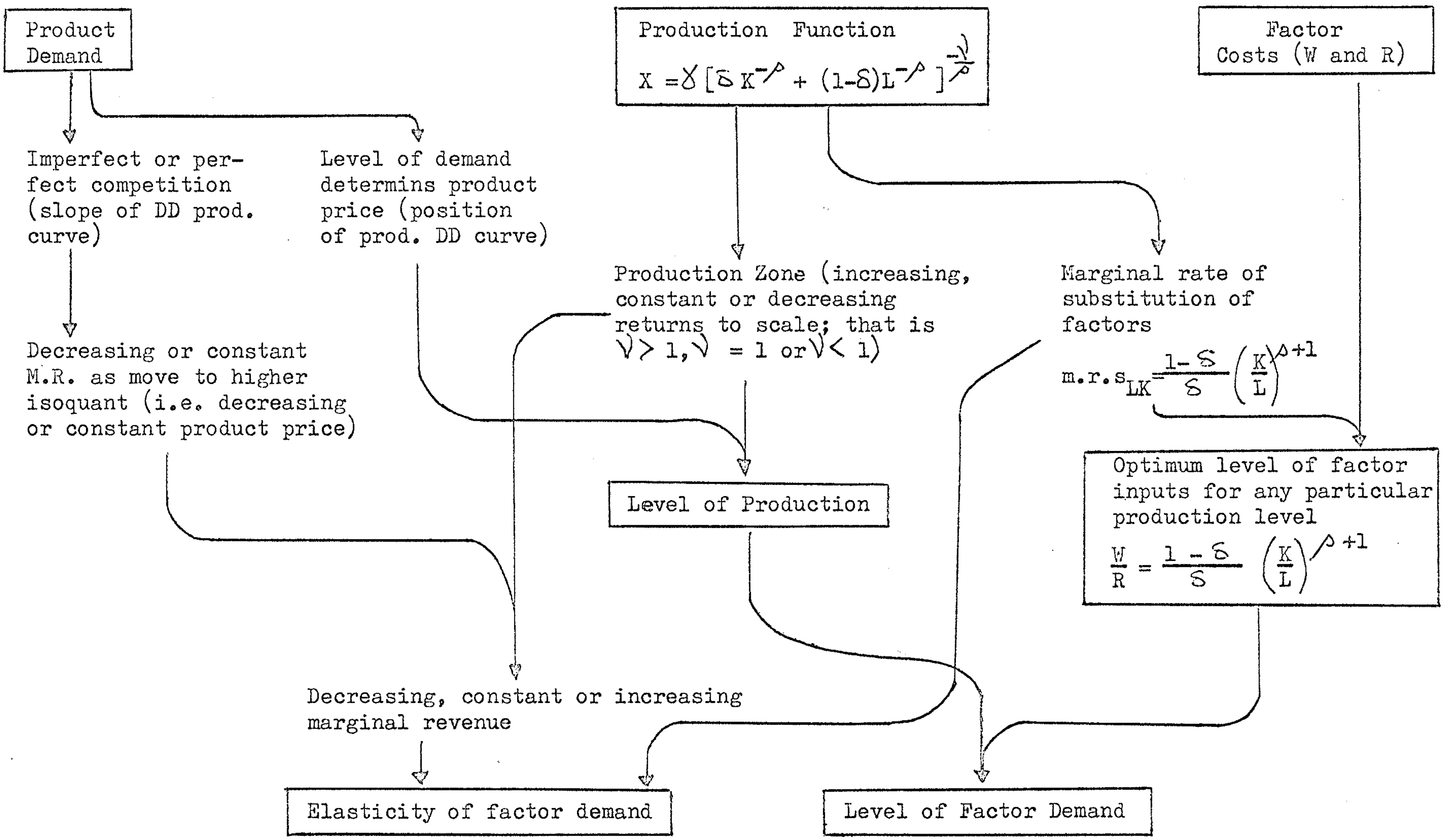

Figure 7. Determination of Factor Demand Curve from Product Demand, Production Function and Factor Costs.

II LABOR SUPPLY

The supply of any particular type[7] of labor to the Canadian mineral mining industry is dependent on the total man-hours of work of that type that is available to the total economy and the relative attractiveness in terms of wage and nonpecuniary benefits of employment in firms, industries or sectors of the economy competing for that labor. This interrelationship is shown in Figure 8.

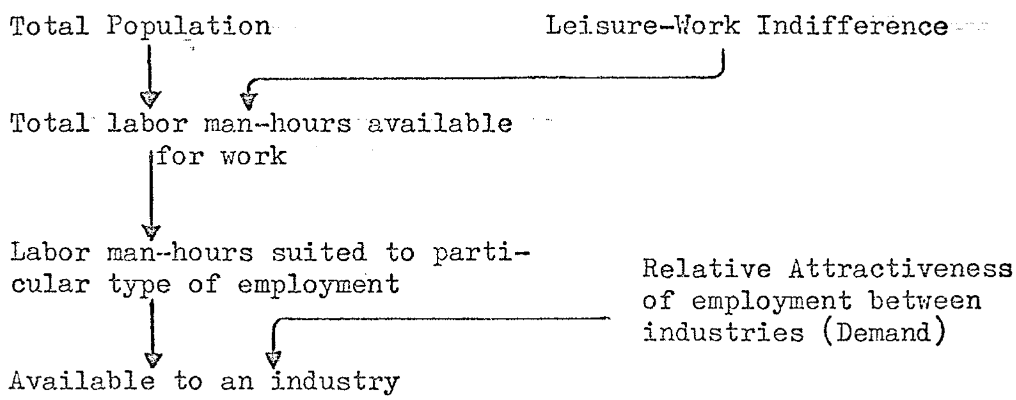

Figure 8. Determination of Industry Labor Supply.

The total labor man-hours available to the total economy depends on the number of people willing to work and the hours each is willing to provide. The total labor force available for employment depends on the population and participation rate. Since the last war, the civilian population, fourteen years of age and over, of Canada increased from 9.1 million in 1948 to 15.4 million in 1971. In the post-war period there

---

[7]Within a particular type of labor (e.g. welders) there is variation in the quantity and quality of effort and skill that workers provide, that effects the supply of labor.

have been three major changes in the labor force participation rate:[8]

1. increase in the female labor force participation rate,
2. reduction in the participation rate of young males because of a tendency to remain in school longer, and
3. reduction in the participation rate of the elderly.

As well as these changes there have also been changes in:

1. the hours of work (hours worked per day and the number of days worked per week), and
2. the length of vacations and holidays.

The Work-Leisure Decision

The total labor supply to the economy, in terms of the willingness of the population to work (number of hours worked per year) depends on the substitution and income effect as wages rise and the worker makes a decision to take more work or leisure.

As hourly wages rise the worker is tempted to work longer hours for the higher pay and substitute work for leisure, which in effect has become more expensive.[9] But, as well as this substitution effect there is an income effect. With the higher wage rate the worker is richer and can afford to buy more consumer goods and, of relevance to this discussion, can buy more leisure. That is, he can afford to work less hours.

The relative importance of the income and substitution effects will determine the shape of the labor supply curve. Generally though, it would be expected that until workers reach a level of income that they

---

[8] J.D. Owen, <u>The Price of Leisure</u> (Montreal: McGill-Queens University Press, 1970).

[9] The opportunity cost of leisure is the foregone income received if the worker had worked.

regard as "comfortable", the substitution effect will outweigh the income effect (S to C in Figure 9). Beyond this income level, the income effect will be more important and workers will forego the increased income for leisure (C to S in Figure 9).

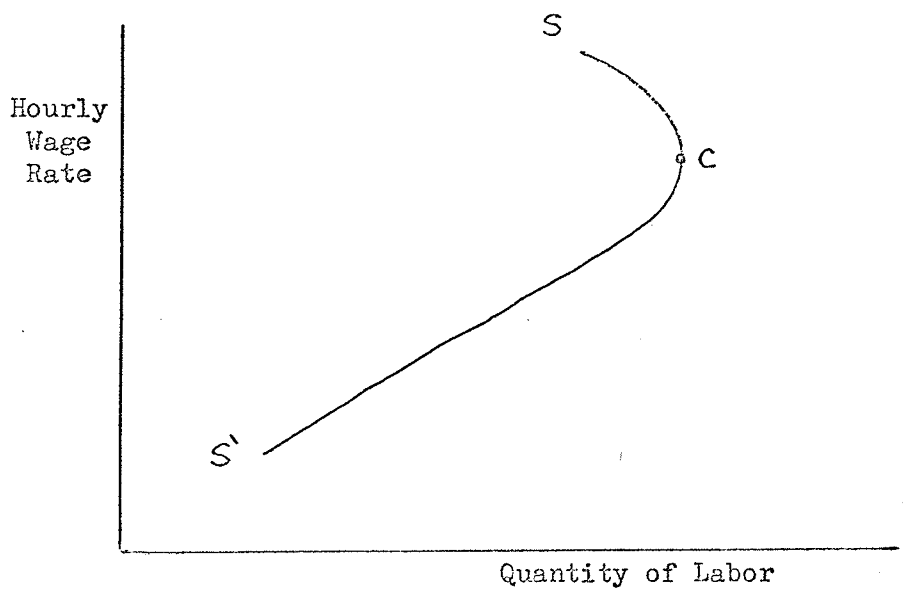

Figure 9. Backward-Bending Supply Curve for Labor.

Determination of Industry Labor Supply

Given a particular wage rate and set of working conditions for a type of work the labor supply to all firms or industries competing for that labor will depend on the number of workers with the skills required and the hours they are willing to work.

Determination of the supply of any particular type of worker to an industry or firm within the labor market will depend on the relative attractiveness of employment conditions (wage and non-pecuniary) between competing firms or industries.

If employment benefits are better in one industry, workers will tend to seek employment there, at a rate that depends on: i) their knowledge of the labor market, ii) the probability of gaining employment, iii) willingness to relocate, iv) the foregone benefits accumulated due to length of service in their present employment and other costs associated with relocation, v) the present value of their anticipated future income in the new employment, and vi) a range of sociological factors.

Higher wage rates alone will not result in a shift of workers between employers. The total benefits of employment are important and higher wage rates[10] in one industry may in part, be compensation for poorer working conditions. This is particularly relevant in the mining industry, where isolation from some community facilities and more difficult working conditions are characteristics of employment.

Employment, provides both remuneration for work done as well as the experience of working. This experience may or may not be pleasant, depending on the conditions of work.[11]

In a worker's decision to decide between employment with one or another firm or industry he will consider the total benefits associated with each. Figure 10 shows the relationship between benefits offered by

---

[10]Included in the wage rate are other pecuniary benefits, such as subsidized housing and meals. These other benefits, while they may be an important part of a worker's remuneration are not expected to vary greatly and therefore do not affect changes in the labor supply to the industry. They will, however, have the effect of inducing a generally higher level of labor supply to the industry, than would occur if they were not provided. Data on the provision of these benefits are not available and it is not proposed to include them in the analysis.

[11]Owen, op. cit., enlarges on this analysis of the effect of changing wage rate on the workers preference for work and leisure. Owen states that in a worker's decision to increase his work or leisure he will weigh the utility of an extra hour of leisure against the utility of an extra hour of work. That is the more pleasant the working conditions are, the more likely, ceteris paribus, that the hours of work will be longer.

employers, and workers' preference between wage rate and working conditions.

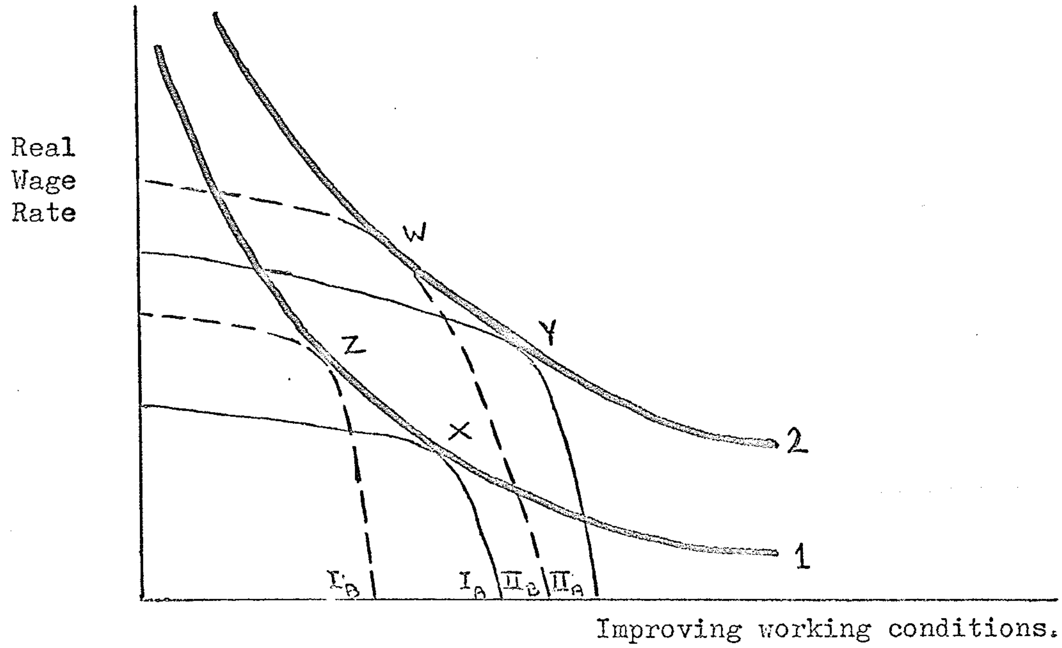

Figure 10. Employee Indifference and Employer Incentives.

Curves 1 and 2 represent two of the set of indifference curves of the employee, for wages and working conditions. Curves I_A and II_A and I_B and II_B represent two of the isocost curves for each of two employers (A and B).

Along indifference curve 1, workers are indifferent between employment with employer A or B. Although employer B offers a higher wage, the improved working conditions with employer A compensates for this, and employees are indifferent about which employer they work for. If employer A was to increase its wage rate to that of employer B (that is, move to a higher isocost curve, II_A) it would attract workers away from employer B because the employees would now be on a higher indifference curve and would be gaining a higher level of utility from their work than with employers A or B under the original conditions. The new equilibrium point would be at Y. To compete for workers with these preferences employer B would have to improve the benefits provided to at least the level shown by indifference curve 2. It would incur the cost designated by curve II_B if it just improved conditions to match those of employer A (that is to indifference curve 2). The equilibrium in this case, between employer A's cost of providing working incentives and the employee indifference, is at W.

The willingness of an employer to increase the benefits it provides in order to attract more workers (i.e. move to a higher isocost curve) is a demand for labor factor and has been discussed earlier in this chapter.

III LABOR SUPPLY AND DEMAND EQUILIBRIUM

Figure 1 of Chapter I shows the determination of labor supply at the top, the determination of labor demand in the lower part of the figure and the interaction within the labor market to establish the number of man-hours employed.

The number of workers employed in the industry and within sectors of the industry also depends on the efficiency of the labor market in relating the demand and supply factors. It is in a constant state of adjustment, associated with changing economic, political and technological conditions as well as adjustment associated with market imperfections, such as imperfect knowledge leading to dissatisfaction on behalf of both employers and employees.[12]

The Canadian mineral mining industry employment level (man-hours) varies seasonally within a year according to climatic conditions as well as annually according to a range of other factors, however, a general trend in labor employment has been observed since the last war.

The Canadian mining industry has been characterized by increasing capital intensity with a relatively constant labor input (in terms of total man-hours) and a rising wage rate.

Figure 11 shows the hypothesized general change in the industry labor demand and supply over the post-war period.

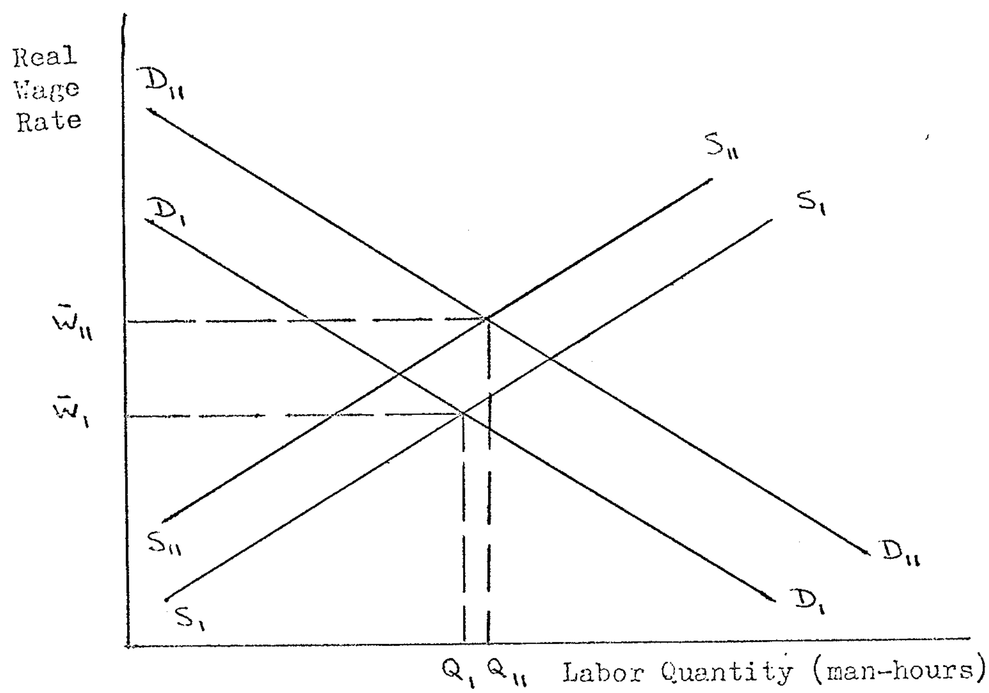

Figure 11. Post War, Long-term Shifts in the Labor Supply and Demand Curves in the Canadian Mineral Mining Industry.

---

[12]Chapter I discusses the gross turnover of workers and the net and replacement turnover.

The supply curve has shifted to the left. Workers are receiving a higher wage and have become less willing to work for the same wage they would have in the past. There has also been a decrease in the number of hours that each worker works.

The industry has been characterized by substantially increased production and capitalization with a relatively small increase in labor usage. The labor employed has tended to become more specialized and although the quantity employed has only increased slightly, its value in the productive process has increased due to its more specialized role in an increasingly capital intensive industry. This is reflected in the higher wage rate employers in the industry are prepared to pay.

This chapter has outlined the theoretical principles involved in the determination of labor supply and demand for a sector. It is the purpose of this study to specify those variables that are thought to best relate the economic forces in process, and to estimate the empirical relationships between these factors and the supply and demand for labor in the Canadian mineral mining industry.

CHAPTER IV

THE ECONOMETRIC MODEL

The purpose of this chapter is firstly, to specify the variables to be tested in the analysis and to discuss the hypothesized effects of these variables on the supply of and demand for labor in the Canadian mineral mining industry on the basis of the theoretical relationships established in the preceding chapter. Secondly, the econometric models tested in this study and alternative approaches used by other researchers in estimating supply and demand function for labor are specified and discussed. Finally, the identification problem is discussed and method of estimation established.

Specification of Variables and Hypothesized Relationships

Hypothesized relationships between the dependent and independent variables consistent with the theory discussed in the previous chapter are detailed below and summaried in Table XVII. The regression variables in many cases are tested in a number of different forms. Separate hypotheses are not made about each form of the same type of variable because the relationships should be the same except for statistical significance and the size of the regression coefficient.

The complete set of endogenous variables included in both the supply and demand equations is specified first. The wage rate and salary variables are also tested in both the supply and demand equations and,

TABLE XVII

HYPOTHESIZED RESULTS
FACTORS AFFECTING THE DEMAND FOR AND SUPPLY OF WORKERS IN THE CANADIAN MINERAL MINING SECTOR

	Salaried				Hourly-Paid			
	Demand		Supply		Demand		Supply	
	Metal	Non-Metal	Metal	Non-Metal	Metal	Non-Metal	Metal	Non-Metal
Demand Variables:								
Tons of metal ore mined	+				+			
Tons of non-metal ore mined		+				+		
Price per ton of metals	+				+			
Price per tone of non-metals		+				+		
Total net capital stock	+	+			-	-		
Trend variable	+	+			-	-		
Supply Variables:								
Unemployment rate			+	+			+	+
Available labor force			+	+			+	+
Employment Levels:								
Man-hours of salaried workers in metal mining			-	-	+			-
Man-hours of hourly-paid workers in metal mining	+							
Man-hours of salaried workers in non-metal mining							-	
Man-hours of hourly-paid workers in non-metal mining		+	+					
Man-hours of salaried workers in metal mining one year earlier	+						+	
Man-hours of hourly-paid workers in metal mining one year earlier				+	+			
Man-hours of salaried workers in non-metal mining one year earlier		+						+
Man-hours of hourly-paid workers in non-metal mining one year earlier						+		
Wage Rates and Salaries:								
Salaries in metal mining-present and one and two years earlier	-		+	-				
Wages in metal mining-present and one and two years earlier					-			-
Salaries in non-metal mining-present and one and two years earlier		-	-	+				
Wages in non-metal mining-present and one and two years earlier						-	-	+
Salaries in manufacturing	-	-	-	-				
Wages in manufacturing					-	-	-	-

dependent on the formulation of the model are either endogenous or exogenous to the system. They are also specified at this time.

Endogenous Demand Variables

Y_{MHD} Demand for hourly-paid workers in the metal mining industry in year t (total weekly man-hours).

Y_{NHD} Demand for hourly-paid workers in the non-metal mining industry in year t (total weekly man-hours).

Y_{1Mi} The hourly wage of hourly-paid workers in the metal mining industry in year t (current dollars).

Y_{1Mii} The hourly wage of hourly-paid workers in the metal mining industry in year t (constant 1948 dollars).

Y_{1Miii} Average annual wage of hourly-paid workers in the metal mining industry in year t (current dollars).

Y_{1Miv} Average annual wage of hourly-paid workers in the metal mining industry in year t (constant 1948 dollars).

Y_{1Ni} The hourly wage of hourly-paid workers in the non-metal mining industry in year t (current dollars).

Y_{1Nii} The hourly wage of hourly-paid workers in the non-metal mining industry in year t (constant 1948 dollars).

Y_{1Niii} Average annual wage of hourly-paid workers in the non-metal mining industry in year t (current dollars).

Y_{1Niv} Average annual wage of hourly-paid workers in the non-metal mining industry in year t (constant 1948 dollars).

Y_{MSDt} Demand for salaried workers in the metal mining industry in year t (total weekly man-hours).

Y_{NSDt} Demand for salaried workers in the non-metal mining industry in year t (total weekly man-hours).

Y_{2Mi} The hourly salary of salaried workers in the metal mining industry in year t (current dollars).

Y_{2Mii} The hourly salary of salaried workers in the metal mining industry in year t (constant 1948 dollars).

Y_{2Miii} Average annual salary of salaried workers in the metal mining industry in year t (current dollars).

Y_{2Miv} Average annual salary of salaried workers in the metal mining industry in year t (constant 1948 dollars).

Y_{2Ni} The hourly salary of salaried workers in the non-metal mining industry in year t (current dollars).

Y_{2Nii} The hourly salary of salaried workers in the non-metal mining industry in year t (constant 1948 dollars).

Y_{2Niii} Average annual salary of salaried workers in the non-metal mining industry in year t (current dollars).

Y_{2Niv} Average annual salary of salaried workers in the non-metal mining industry in year t (constant 1948 dollars)

Endogenous Supply Variables

Y_{MHS} Supply of hourly-paid workers in the metal mining industry in year t (total weekly man-hours).

Y_{NHS} Supply of hourly-paid workers in the non-metal mining industry in year t (total weekly man-hours).

Y_{1Mi} Previously defined.

Y_{1Mii} Previously defined.

Y_{1Miii} Previously defined.

Y_{1Miv} Previously defined.

Y_{1Ni} Previously defined.

Y_{1Nii} Previously defined.

Y_{1Niii} Previously defined.

Y_{1Niv} Previously defined.

Y_{MSS} Supply of salaried workers in the metal mining industry in year t (total weekly man-hours).

Y_{NSS} Supply of salaried workers in the non-metal mining industry in year t (total weekly man-hours).

Y_{2Mi} Previously defined.

Y_{2Mii} Previously defined.

Y_{2Miii} Previously defined.

Y_{2Miv} Previously defined.

Y_{2Ni} Previously defined.

Y_{2Nii} Previously defined.

Y_{2Niii} Previously defined.

Y_{2Niv} Previously defined.

Wage Rate Variables - Exogenous and Endogenous

The endogenous wage rate variables (Y_{1Mi} . . . . Y_{2Niv}) are also included in various supply and demand equations as exogenous variables. Lags of one and two years on each of these variables are also tested. Table XVIII shows the notation used for exogenous wage rate variables and the corresponding endogenous variables.

TABLE XVIII

EXOGENOUS AND ENDOGENOUS WAGE AND SALARY VARIABLES - SUBSCRIPT NOTATIONS

			Endogenous Variable Y at Time t		Exogenous Variable X at Time t		Exogenous Variable X at Time t-1		Exogenous Variable X at Time t-2	
			Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual
Metal	Hourly	Current	1Mi	1Miii	7Mi	7Miii	7Mi(t-1)	7Miii(t-1)	7Mi(t-2)	7Miii(t-2)
		Constant	1Mii	1Miv	7Mii	7Miv	7Mii(t-1)	7Miv(t-1)	7Mii(t-2)	7Miv(t-2)
	Salary	Current	2Mi	2Miii	8Mi	8Miii	8Mi(t-1)	8Miii(t-1)	8Mi(t-2)	8Miii(t-2)
		Constant	2Mii	2Miv	8Mii	8Miv	8Mii(t-1)	8Miv(t-1)	8Mii(t-2)	8Miv(t-2)
Non-Metal	Hourly	Current	1Ni	1Niii	7Ni	7Niii	7Ni(t-1)	7Niii(t-1)	7Ni(t-2)	7Niii(t-2)
		Constant	1Nii	1Niv	7Nii	7Niv	7Nii(t-1)	7Niv(t-1)	7Nii(t-2)	7Niv(t-2)
	Salary	Current	2Ni	2Niii	8Ni	8Niii	8Ni(t-1)	8Niii(t-1)	8Ni(t-2)	8Niii(t-2)
		Constant	2Nii	2Niv	8Nii	8Niv	8Nii(t-1)	8Niv(t-1)	8Nii(t-2)	8Niv(t-2)
Manu-fac-ture	Hourly	Current			7Mai	7Maiii	7Mai(t-1)	7Maiii(t-1)	7Mai(t-2)	7Maiii(t-2)
		Constant			7Maii	7Maiv	7Maii(t-1)	7Maiv(t-1)	7Maii(t-2)	7Maiv(t-2)
	Salary	Current			8Mai	8Maiii	8Mai(t-1)	8Maiii(t-1)	8Mai(t-2)	8Maiii(t-2)
		Constant			8Maii	8Maiv	8Maii(t-1)	8Maiv(t-1)	8Maii(t-2)	8Maiv(t-2)

X_{MH} The endogenous variable, Y_{MHDt} or Y_{MHSt}, in the hourly-paid labor market model as the corresponding exogenous variable in the salaried labor market model.

X_{NH} The endogenous variable, Y_{NHDt} or Y_{NHSt}, in the hourly-paid labor market model, as the corresponding exogenous variable in the salaried labor market model.

X_{MS} The endogenous variable, Y_{MSDt} or Y_{MSSt}, in the salaried labor market model, as the corresponding exogenous variable in the hourly-paid labor market model.

X_{NS} The endogenous variable, Y_{NSDt} or Y_{NSSt}, in the salaried labor market model, as the corresponding exogenous variable in the hourly-paid labor market model.

$X_{MH(t-1)}$ The observed employment level of hourly-paid workers in the metal mining industry, lagged one period ($Y_{MHD(t-1)}$ or $Y_{MHS(t-1)}$).

$X_{NH(t-1)}$ The observed employment level of hourly-paid workers in the non-metal mining industry, lagged one period ($Y_{NHD(t-1)}$ or $Y_{MSS(t-1)}$).

$X_{MS(t-1)}$ The observed employment level of salaried workers in the metal mining industry, lagged one period ($Y_{MSD(t-1)}$ or $Y_{MSS(t-1)}$).

$X_{NS(t-1)}$ The observed employment level of salaried workers in the non-metal mining industry, lagged one period ($Y_{NSD(t-1)}$ or $Y_{NSS(t-1)}$).

$X_{MH(t-1)}$ The observed employment level of hourly-paid workers in the metal mining industry, lagged two periods ($Y_{MHD(t-2)}$ or $Y_{MHS(t-2)}$).

$X_{NH(t-2)}$ The observed employment level of hourly-paid workers in the non-metal mining industry, lagged two periods ($Y_{NHD(t-2)}$ or $Y_{NHS(t-2)}$).

$X_{MS(t-2)}$ The observed employment level of salaried workers in the metal mining industry, lagged two periods ($Y_{MSD(t-2)}$ or $Y_{MSS(t-2)}$).

$X_{NS(t-2)}$ The observed employment level of salaried workers in the non-metal mining industry, lagged two periods ($Y_{NSD(t-2)}$ or $Y_{NSS(t-2)}$).

Demand Variables

The demand for labor is determined by the interaction of factors as discussed in Chapter III and shown in Figure 7. The following variables and their hypothesized relationships are formulated on the basis of the theoretical principles established in that chapter.

Exogeneous Demand Variables

X_1 Trend variable: Series of dummy variables from 1 to 24 for each of the years 1948 to 1971.

X_2 Net capital stock in the total mineral mining industry in year t in current dollars.

X_3 Net capital stock in the total mineral mining industry in year t in constant 1948 dollars.

X_{4M} Average annual price per ton of all metals mined in Canada in current dollars in year t.

X_{4N} Average annual price per ton of all non-metals mined in Canada in current dollars in year t.

X_{5M} Average annual price per ton of all metals mined in Canada in constant 1948 dollars in year t.

X_{5N} Average annual price per ton of all non-metals mined in Canada in constant 1948 dollars in year t.

X_{6M} Annual production of all metals mined in Canada in year t (tons).

X_{6N} Annual production of all non-metals mined in Canada in year t (tons).

Price of Labor

Wages and salaries are tested as both annual and hourly rates in current and constant 1948 dollars. Since the labor demand is measured in average weekly man-hours it is more appropriate to consider an hourly price of labor, however, both the annual and hourly rates are tested to establish which has the highest explanatory power. Current and constant dollar wages and salaries are also tested for the same purpose, however, it is anticipated that the constant dollar rate will prove to be the more explanatory variable. As the wage rate to a type of worker in a sector increases the demand for that type of labor in that sector is hypothesized to decline, ceteris parabus.

Number of workers and man-hours of the other type employed in the sector. As the man-hours of a type of worker employed in a sector increases, it is expected that the demand for the other type of workers in that sector would also rise. That is, as the number of salaried workers employed in a sector increases, the demand for hourly-paid workers is hypothesized to increase. Similarly, the demand for salaried workers is hypothesized to rise as the man-hours of hourly-paid workers employed increases. This direct relationship is hypothesized on the basis of the expected complementary nature of the two groups of hourly-paid and salaried workers.

Trend variable and capital intensity. Li[1] used a trend variable as a proxy for improved technology. Tyrchniewicz[2] includes Ruttan's index of technology to account for changing technology and treats it as both an exogenous and endogenous variable in alternative formulations of the model. In addition, he includes a time trend variable to allow for secular effects.

The mining industry has shown a definite upward trend in production in the post-war period with considerable technological change over that time. Associated with this growth in production and changing technology, there has been a considerable increase in capital use[3] with the number of man-hours employed increasing slightly over the period.

The trend variable will account for secular effects not included in the analysis, as well as the effect of technological change on the demand for hourly-paid and salaried workers. The effect of new technology is to shift the production function upwards so increased production can be achieved using the same level of productive inputs or the same level of production can be achieved using a lower level of

---

[1] Lew-king Li, "A Market Structure for Hired and Family Labor in Canadian Agriculture" (unpublished M.Sc. dissertation, University of Manitoba, 1965).

[2] E.W. Tyrchniewicz, An Econometric Study of the Agricultural Labor Market (unpublished Doctoral thesis, Department of Agricultural Economics, Purdue University, January, 1967).

[3] Statistics Canada provides data on the capital investment into the total mining industry (including fuels and structural materials). The estimates of net capital stock in the mineral mining industry, made in Appendix A, are based on the assumption that the ratio of the value of production to the level of capital investment are the same for the mineral mining and total mining industries. A further breakdown of net capital stock by assuming the ratios for the non-metal, metal and total mining are equal seems unrealistic. For this reason, estimates of net capital in the two separate sectors of the mineral mining industry are not provided.

productive factors. That is, the output-capital and output-labor ratios both increase.

Technological[4] change falls into two categories on the basis of the effect on the substitutuion of productive factors -

i. Neutral technological change, where the capital-labor ratio is not altered.

ii. Technological change that favors the substitution of one productive factor for another - in this case the capital-labor ratio is altered.

The Canadian mineral mining industry has been characterized by considerable technological advances in the post-war period accompanied by greatly increased levels of capital investment. It is hypothesized that the regression coefficients for this technology (trend) variable will be negative for productive or hourly-paid workers and positive for salaried workers in the demand functions for workers in the Canadian mineral mining industry. The negative coefficient for hourly-paid workers is hypothesized because of the expected substitution of capital for labor, associated with the type of technological changes occuring in the mineral mining industry. The positive coefficient hypothesized for salaried workers is put forward on the basis, that while technology may be labor saving, it requires more skilled employees and may for this reason cause an increase in the demand for management and technically trained salaried employees.

The influence of other factors, accounted for in this trend variable, may however distort the effect of technological change and

---

[4]K.G. Arrow, H.B. Chenery, B.S. Minhas and R.M. Solow, "Capital Labour Substitution and Economic Efficiency," Review of Economics and Statistics, Vol. XLIII, August, 1961.

lead to regression coefficients of different magnitude or effect than the negative and positive values respectively hypothesized for hourly-paid and salaried workers.

The relationship between the demand for hourly-paid and salaried labor and the level of capital investment incorporates the effect of technology on the substitution of productive factors but also involves other factors. Production of the mineral mining sector varies independently of technological change, in response to changing world prices, discoveries of new ore bodies of varying grades (for example, open pit mining of low grade copper) and government legislation. The level of capital and labor employed will vary accordingly, with labor perhaps showing the greater response in the short term. As well as the effect on the demand for labor of technological change and changes in production independent of technology, the relative costs of capital and labor will also effect the level of labor required by the industry.

The hypothesized effect of capital investment on the demand for labor is more difficult to establish because of the added complexity of these additional factors. It is hypothesized that the effect of technological change, and the associated substitution of capital for labor, is the major influence and that the relationship between the level of capital investment and the demand for hourly-paid workers will be inverse. For salaried workers the hypothesized relationship is positive because of the expected higher level of management required with increased capitalization.

The capital stock variable covers the total net capital stock of the mineral mining industry and is not broken down to the level of investment in the separate sectors. The metal mining sector is considerably larger than the non-metal mining sector (in 1971 the value of metal production in Canada was almost six times that of the non-metals - Table IV) and for this reason, the capital stock variable will be made up mainly of investment into that sector. It would seem likely for this reason, that this variable may prove to be statistically insignificant in the demand functions for workers by the non-metal mining sector.

Product price. The demand for labor is a derived demand. As prices for minerals rise on the world market, the level of Canadian production will increase and the demand for factor inputs will rise. In the long-run, increased production and changing technology has led to increased capital intensification, however, in the short-term (from year to year) fluctuations in price and consequent adjustments in the level of production is hypothesized to lead to corresponding increases and decreases in the use of the more mobile labor resource. Mineral prices are tested in current and constant dollar values.

Level of production. The level of industry production for a producer under near pure market conditions will be directly related to the price received. As prices rise or fall, production will increase or decrease and the demand for labor will follow. There is a lag between when the market price is realized and when the labor is actually employed and production increases. The correlation between the level of production and the mineral price is expected to result in multicollinearity in equations containing both these variables. On the basis of the measured correlation between these variables only the one with the highest statistical significance may be included in the final regression equations.

Number of workers and man-hours employed (lagged one year). Incorporation of Nerlove's distributed lags into the model[5] results in the observed employment level of the preceding year being included as an exogenous (predetermined) independent variable. The parameter estimated for the structural form equation (1-the adjustment coefficient) is hypothesized to lie between zero and one[6] because for stable equilibrium the adjustment coefficient is greater than zero but less than or equal to one.

The role of the adjustment coefficient and its derivation is discussed in greater detail later in the appendix. It is calculated from the regression coefficient for the employment level in the previous year. Essentially it enables estimation of the long-run demand and supply functions and indicates the rate of adjustment of these functions to changes in conditions in the labor market.

It is expected that the demand for hourly-paid workers will have a higher adjustment coefficient, that is will respond more rapidly than that for salaried employees. Hourly-paid workers are those directly involved in production and will therefore adjust more rapidly as conditions within the industry change. Salaried workers are more technically skilled and involved in management and the demand for their services is expected to be more long-run. Also, employers are more likely to layoff unskilled workers in periods of low demand because when they are required again replacements are more easily found.

---

[5]Marc Nerlove, "Distributed Lags and Estimation of Long-run Supply and Demand Elasticities: Theoretical Considerations," Journal of Farm Economics, Vol. 40 (May, 1958), pp. 301-311.

[6]That is the observed coefficient will be positive.

Supply Variables

The theoretical principles for the determination of the labor supply function was established in Chapter II. The following variables and their hypothesized relationships are formulated on the basis of these theoretical principles.

Exogenous Supply Variables

X_{7Mai} The hourly wage of hourly-paid workers in the manufacturing sector in current dollars in year t.

X_{7Maii} The average annual wage of hourly-paid workers in the manufacturing sector in current dollars in year t.

X_{7Maiii} The hourly wage of hourly-paid workers in the manufacturing sector in constant 1948 dollars in year t.

X_{7Maiv} The average annual wage of hourly-paid workers in the manufacturing sector in constant 1948 dollars in year t.

X_{8Mai} The average hourly salary of salaried workers in the manufacturing sector in current dollars in year t.

X_{8Maii} The average annual salary of salaried workers in the manufacturing sector in current dollars in year t.

X_{8Maiii} The hourly salary of salaried workers in the manufacturing sector in constant 1948 dollars in year t.

X_{8Maiv} The average annual salary of salaried workers in the manufacturing sector in constant 1948 dollars in year t.

X_9 Total national labor force of all workers (seeking or employed) in number of workers in year t.

X_{10} Total national labor force of all workers (seeking or employed) in man-hours in year t.

X_{11} Level of national unemployment in year t (percentage of those in the labor market).

$X_{MH(t-1)}$ Also included as an exogenous demand variable $(Y_{MHD(t-1)} = Y_{MHS(t-1)})$.

$X_{NH(t-1)}$ Also included as an exogenous demand variable $(Y_{NMHD(t-1)} = Y_{NMHS(t-1)})$.

$X_{MS(t-1)}$ Also included as an exogenous demand variable $(Y_{MSD(t-1)} = Y_{MSS(t-1)})$.

$X_{NS(t-1)}$ Also included as an exogenous demand variable $(Y_{NMSD(t-1)} = Y_{NMSS(t-1)})$.

$X_{MH(t-2)}$ Also included as an exogenous demand variable $(Y_{MHD(t-2)} = Y_{MHS(t-2)})$.

$X_{NH(t-2)}$ Also included as an exogenous demand variable $(Y_{NHD(t-2)} = Y_{NHS(t-2)})$.

$X_{MS(t-2)}$ Also included as an exogenous demand variable $(Y_{MSD(t-2)} = Y_{MSS(t-2)})$.

$X_{NS(t-2)}$ Also included as an exogenous demand variable $(Y_{NSD(t-2)} = Y_{NSS(t-2)})$.

Price of labor. As the wage rate to a type of worker in a sector increases, it is hypothesized that the supply of that type of worker to the particular sector will rise. As in the demand equations, the price of labor is included in current and constant dollars and on an hourly and annual basis.

Number of workers and man-hours of the same type employed in the other sector. As the man-hours of a type of worker employed in a sector increases, it is expected that the supply of that type of worker to the other sector will decrease. This relationship is hypothesized on the basis that if workers are drawn to one sector there will be less available for employment in the other sector.

Wage and salaries in the non-mining sector. Although the wage rate does not indicate completely[7] the benefits associated with employment within a particular sector, it is a major component and will indicate, in part, the attractiveness of employment within the mining industry relative to elsewhere. As wage rates rise in the manufacturing sector,[8] it is hypothesized that the supply of labor to the mineral mining industry will fall. Consistent with the wage and salary variables for the mineral mining industry sectors this variable is tested in current and constant dollars and on an hourly and annual basis.

Size of the civilian labor force. The size of the total population eligible to work[9] indicates the potential number of employees to the economy but does not indicate the number that are willing to work, the hours they are willing to work and their suitability to specific employment.

To convert from the total population eligible to work to the number of participants in the labor market (either employed or seeking employment) it is necessary to multiply the population of eligible

---

[7]Refer to discussion in Chapter III.

[8]Statistics Canada, Earnings and Hours of Work in Manufacturing, Catalogue No. 72-204 covers the complete range of manufacturing industries and should be representative of employment conditions generally outside the metal and non-metal mining industry.

[9]Canada Yearbook reports the number of people over fourteen years of age but not confined to a mental or criminal institution.

people by the participation rate. To estimate the total labor supply,[10] it is then necessary to multiply the number of workers in the labor market by the average number of hours each is willing to work under current conditions. To estimate the labor supply potentially available to specific employment within a sector[11] (e.g. production workers within the metal mining industry), it is necessary to breakdown the total labor supply into its skill components.

The supply of each of production and management workers potentially available to each sector of the mineral mining industry are the most meaningful variables but data is not available.[12] The total supply of man-hours to the Canadian labor market reflects the general conditions of the national labor market, including the wage rates being offered. The relative wage rates and other pecuniary and non-pecuniary benefits between sectors will determine the proportion of total suitable labor available, that is actually supplied to a particular sector. The hypothesized effect however, of the size of the available labor pool on the supply of labor to the mineral mining industry is positive.

Level of unemployment. The higher the level of unemployment, the easier it will be for any one sector to obtain the workers it requires.

---

[10]The total labor supply is the total man-hours available. No account is made for the effort given by each worker.

[11]This is the total man-hours available of workers with specific skills either employed within the sector, elsewhere or seeking employment and is distinct from the total man-hours of the specific type of labor that is employed within the sector. This is the actual supply.

[12]A breakdown according to skill categories is not available. Table IX of Chapter II shows the relevant information on the national labor supply that is published in the Canada Yearbook.

The hypothesized effect between the unemployment level and the short-run or observed supply of workers to the mineral mining sector is positive. Workers are more willing to take employment of a less favorable nature, under conditions of high unemployment when they realize their chances of obtaining work elsewhere is more limited than usual.

Number of workers and man-hours employed (lagged one year). Incorporation of distributed lags into the model results in the observed employment level in the previous year being included as an exogeneous variable in both the structural form demand and supply equations. The value of the estimated parameter (1-the adjustment coefficient) will be between zero and one.

The Adjustment Coefficient

The adjustment coefficient is derived from the regression coefficient for the employment level in the previous year. For the supply functions, it is expected that the response of hourly-paid workers will be faster than that for salaried employees and that the adjustment coefficient will consequently be larger. MacMillan et al have shown that hourly-paid mining workers are more likely to migrate than salaried employees.

Table XVII summarizes the hypothesized relationships between the supply and demand for labor and the variables to be tested in the analysis.

Review of Previous Studies on Labor Supply and Demand Estimation

Lew-King Li[13] examined the demand and supply factors for two categories of farm labor (hired and family) on a regional basis. Five regions across Canada were specified on the basis of existing production patterns and geographic delineation.

Li's model consisted of stochastic supply and demand functions for both types of labor in each region and non-stochastic Nerlove[14] adjustment functions for each supply and demand function.

Linear relationships were assumed and single-equation least-squares method was used to fit data for the period 1946 to 1962. The parameters estimated were the long-run elasticities of demand and supply and the coefficients of adjustment.[15]

The empirical results obtained in this study did not show a high level of significance between the independent and dependent variables although the hypothesized directions of influence were generally observed.

Tyrchniewicz[16] applied a similar model formulation to the determination of three categories of farm labor in the United States. He used a nine equation simultaneous system, to determine the elasticities of supply and demand for each of hired, operator and unpaid family labor.

The system used by Tyrchniewicz consisted of six stochastic

---

[13] Li, op. cit.

[14] Nerlove, op. cit.

[15] As defined by Nerlove, ibid., later in this chapter.

[16] Tyrchniewicz, op. cit.

functions for supply and demand for each category of labor and three market clearing identities. The first two identities specified total demand and supply as the respective sums of the separate labor demands and supplies and a third equated the total demand to the total supply. There were nine endogenous variables:

i. three supply variables for each category of labor,

ii. three demand variables for each category of labor,

iii. total labor demand and total labor supply, and

iv. a composite wage rate for all agricultural labor.

The Model Specification

The initial model was similar to that used by Tyrchniewicz.[17] Eleven equations were included in the system describing the demand for and supply of management and production employees in the metal and non-metal sectors of the mineral mining industry.[18] Fourteen endogenous variables were specified:

i. the price of both categories of labor in both sectors,

ii. the demand for both categories of labor in both sectors,

iii. the supply of both categories of labor in both sectors, and

iv. the total supply and total demand for all workers in the total mineral mining industry.

The equation system, with fourteen endogenous variables and only eleven equations was abandoned due to underidentification.

The initial specification of the model was made because of the

---

[17] Ibid.

[18] Refer to Appendix A.

expected inter-relationship between the demand and supply for each type of labor in each market.

The following model formulations are not as integrated, in terms of relating the supply and demand for each of hourly-paid and salaried employees in both sectors, within the equation systems, however they do overcome the initial identification problem by having the number of equations equal to the number of endogenous variables.

Three alternative model structures are tested. These are:

i. Two separate models for hourly-paid and salaried workers, each incorporating supply and demand factors for the metal and non-metal mining sectors.

ii. Two separate models for the metal and non-metal mining sectors, each incorporating supply and demand factors for hourly-paid and salaried workers.

iii. Four separate models for each of non-metal salaried workers; non-metal hourly-paid workers; metal salaried workers and metal hourly-paid workers.

The variables hypothesized to effect the demand for and supply of each type of labor in both mineral mining sectors have been discussed and specified earlier in this chapter. The general forms of the three model sets to be tested will now be established. For the sake of brevity, the complete set of exogenous variables in each equation are not included here. The variables are specified later in this chapter. The form of the equations is established at this stage. The complete specification of the equations, with all variables to be tested is given in Chapter V.

The models at this time are presented with one variable in each case, representing a set of exogenous variables. As well as the set of exogenous variables included in each equation, a number of other variables are either exogenous or endogenous to the system, depending on the specification of the model. They are:

In the demand equations -

i. The supply of the other category of worker to that sector of the mineral mining industry.

ii. The wage rate or salary for that category of worker in that sector of the mineral mining industry.

In the supply equations -

i. The supply of that category of worker to the other mineral mining sector.

ii. The wage rate or salary for that category of worker in the other mineral mining sector.

iii. The wage rate or salary for that category of worker in that sector of the mineral mining industry.

A lagged adjustment is also applied to enable estimation of the long-run supply and demand functions from the regressed equations. The application of a lagged adjustment requires inclusion of the previous period employment level of the category of worker under investigation. The theoretical basis and method of application of this lagged adjustment was established by Nerlove[19] and is reviewed in Appendix C.

In summary, the three model sets specified below show:

i. The set of exogenous variables for each equation, represented by a single variable,

---

[19]Nerlove, op. cit.

ii. Those variables that vary in their specification as either exogenous or endogenous specified as such, and

iii. Incorporation of a distributed lag, by including the employment level of the category of worker in the previous period.

The endogenous variables are designated by the letter Y. $\bar{Y}$ indicates the long-run equilibrium level of a particular endogenous variable as indicated by the subscript. In the regression functions, the supply and demand variables for salaried workers are lagged one period. Lagged endogenous variables are predetermined and are therefore exogenous to the system. For this reason they are designated with the symbol X in the regression equation.[20]

1. Hourly-paid and Salaried Workers in Two Separate Models

1.A. Labor market for salaried workers in the Canadian mineral mining industry.

Salaried Workers Demand

i. Metal Mining Industry

Long-run Demand Function for Salaried Workers

$$\bar{Y}_{MSDt} = a_1 + b_1 X_{iMSDt} + c_1 X_{MHSt} + d_1 Y_{MSPt} \qquad 4.1$$

Adjustment Function

---

[20]Endogeneous variables are designated with the letter Y and are those determined within the system defined by the econometric model. Exogeneous variables are predetermined variables and include lagged endogeneous variables.

$$Y_{MSDt} - Y_{MSD(t-1)} = \gamma_1 (\bar{Y}_{MSDt} - Y_{MSD(t-1)}) \qquad 4.2$$

Regression Equations with Observable Variables

$$Y_{MSDt} = a_1 \gamma_1 + b_1 \gamma_1 X_{iMSDt} + c_1 \gamma_1 X_{MHSt} + d_1 \gamma_1 Y_{MSPt} + (1 - \gamma_1) Y_{MSD(t-1)} \qquad 4.3$$

$$Y_{MSDt} = A_1 + B_1 X_{iMSDt} + C_1 X_{MHSt} + D_1 Y_{MSPt} + E_1 X_{MS(t-1)} \qquad 4.4$$

ii. Non-Metal Mining Industry

Long-run Demand Function for Salaried Workers

$$\bar{Y}_{NSDt} = a_2 + b_2 X_{iNSDt} + c_2 X_{NHSt} + d_2 Y_{NSPt} \qquad 4.5$$

Adjustment Function

$$Y_{NSDt} = Y_{NSD(t-1)} = \beta_1 (\bar{Y}_{NSDt} - Y_{NSD(t-1)}) \qquad 4.6$$

Regression Equations with Observable Variables

$$Y_{NSDt} = a_2 \beta_1 + b_2 \beta_1 X_{iNSDt} + c_2 \beta_1 X_{NHSt} + d_2 \beta_1 Y_{NSPt} + (1 - \beta_1) Y_{NSD(t-1)} \qquad 4.7$$

$$Y_{NSDt} = A_2 + B_2 X_{iNSDt} + C_2 X_{NHSt} + D_2 Y_{NSPt} + E_2 X_{NS(t-1)} \qquad 4.8$$

Salaried Workers Supply

i. Metal Mining Industry

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{MSSt} = f_1 + g_1 X_{iMSSt} + h_1 Y_{NSSt} + k_1 Y_{NSPt} + l_1 Y_{MSPt} \qquad 4.9$$

Adjustment Function

$$Y_{MSSt} = Y_{MSS(t-1)} = \pi_1 (\bar{Y}_{MSSt} - Y_{MSS(t-1)}) \qquad 4.10$$

Regression Equations with Observable Variables

$$Y_{MSSt} = f_1 \pi_1 + g_1 \pi_1 X_{iMSSt} + h_1 \pi_1 Y_{NSSt} + k_1 \pi_1 Y_{NSPt} + l_1 \pi_1 Y_{MSPt} + (1 - \pi_1) Y_{MSS(t-1)} \qquad 4.11$$

$$Y_{MSSt} = F_1 + G_1 X_{iMSSt} + H_1 Y_{NSSt} + K_1 Y_{NSPt} + L_1 Y_{MSPt} + P_1 X_{MS(t-1)} \qquad 4.12$$

ii. Non-Metal Mining Industry

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{NMSSt} = f_2 + g_2 X_{iNSSt} + h_2 Y_{NSSt} + k_2 Y_{MSPt} + l_2 Y_{NSPt} \qquad 4.13$$

Adjustment Function

$$Y_{NSSt} - Y_{NSS(t-1)} = \Theta \quad (\bar{Y}_{NSSt} - Y_{NSS(t-1)}) \qquad 4.14$$

Regression Equations with Observable Variables

$$Y_{NSSt} = f_2 \, \Theta_1 + g_2 \, \Theta_1 \, X_{iNMSSt} + h_2 \, \Theta_1 \, Y_{MSSt}$$

$$k_2 \, \Theta_1 \, Y_{MSPt} + l_2 \, \Theta_1 \, Y_{NSPt} + (1- \Theta_1) \qquad 4.15$$

$$Y_{NSS(t-1)}$$

$$Y_{NSSt} = F_2 + G_2 \, X_{iNSSt} + H_2 \, Y_{MSSt} + K_2 \, Y_{MSPt} +$$

$$L_2 \, Y_{NSPt} + P_2 \, X_{NS(t-1)} \qquad 4.16$$

Identities

$$Y_{NSDt} = Y_{NSSt} \qquad 4.17$$

$$Y_{MSDt} = Y_{MSSt} \qquad 4.18$$

The structural form equations to be estimated using regression technique are equations 4.4, 4.8, 4.12 and 4.16. From these equations, the parameters (designated by the capital letters $A_1 \ldots P_2$) can be estimated. From these parameters, the adjustment coefficients (γ_1, ρ_1, π_1 and θ_1) and the long-run coefficients of independent variables with respect to supply and demand and the constant terms (a . . . d and f . . . k) can be estimated.

A similar model formulation is presented for hourly-paid workers.

1.B. Labor market for hourly-paid workers in the Canadian Mineral Mining Industry.

Hourly-Paid Workers Demand

i. Metal Mining Industry

Long-run Demand Function for Hourly-Paid Workers

$$\bar{Y}_{MHDt} = a_3 + b_3 X_{iMHDt} + c_3 X_{MSSt} + d_3 Y_{MHPt} \tag{4.19}$$

Adjustment Function

$$Y_{MHDt} - Y_{MHD(t-1)} = \Psi_1 (\bar{Y}_{MHDt} - Y_{MHD(t-1)}) \tag{4.20}$$

Regression Equations with Observable Variables

$$Y_{MHDt} = a_3 \Psi_1 + b_3 \Psi_1 X_{iMHDt} + c_3 \Psi_1 X_{MSSt} + d_3 \Psi_1 Y_{MHPt} + (1 - \Psi_1) Y_{MHD(t-1)} \tag{4.21}$$

$$Y_{MHDt} = A_3 + B_3 X_{iMHDt} + C_3 X_{MSSt} + D_3 Y_{MHPt} + E_3 X_{MH(t-1)} \tag{4.22}$$

ii. Non-Metal Mining Industry

Long-run Demand Function for Hourly-Paid Workers

$$\bar{Y}_{NHDt} = a_4 + b_4 X_{iNHDt} + c_4 X_{NSSt} + d_4 Y_{NHPt} \tag{4.23}$$

Adjustment Function

$$Y_{NHDt} - Y_{MHD(t-1)} = \delta_1 (\bar{Y}_{NHDt} - Y_{NHD(t-1)}) \tag{4.24}$$

Regression Equations with Observable Variables

$$Y_{NHDt} = a_4 \delta_1 + b_4 \delta_1 X_{iNHDt} + c_4 \delta_1 X_{NSSt} + d_4 \delta_1 Y_{NHPt} + (1-\delta_1) Y_{NHD(t-1)} \qquad 4.25$$

$$Y_{NHDt} = A_4 + B_4 X_{iNHDt} + C_4 X_{NSSt} + D_4 Y_{NHPt} + E_4 X_{NH(t-1)} \qquad 4.26$$

Hourly-Paid Workers Supply

i. Metal Mining Industry

Long-run Supply Function for Hourly-Paid Workers

$$\bar{Y}_{MHSt} = f_3 + g_3 X_{iMHSt} + h_3 Y_{NMHSt} + k_3 Y_{NMHPt} \quad l_3 Y_{MHPt} \qquad 4.27$$

Adjustment Function

$$Y_{MHSt} - Y_{MHS(t-1)} = \nu_1 (\bar{Y}_{MHSt} - Y_{MHS(t-1)}) \qquad 4.28$$

Regression Equations with Observable Variables

$$Y_{MHSt} = f_3 \nu_1 + g_3 \nu_1 X_{iMHSt} + h_3 \nu_1 Y_{NHSt} + k_3 \nu_1 Y_{NMHPt} + l_3 \nu_1 Y_{MHPt} + (1-\nu_1) Y_{MHS(t-1)} \qquad 4.29$$

$$Y_{MHSt} = F_3 + G_3 X_{iMHSt} + H_3 Y_{NHSt} + K_3 Y_{NHPt} + L_3 Y_{MHPt} + P_3 X_{MH(t-1)} \qquad 4.30$$

ii. Non-Metal Mining Industry

Long-run Supply Function for Hourly-Paid Workers

$$\tilde{Y}_{NHSt} = f_4 + g_4 X_{iNHSt} + H_4 Y_{MHSt} + k_4 Y_{MHPt} + l_4 Y_{NHPt} \qquad 4.31$$

Adjustment Function

$$Y_{NHSt} - Y_{NHS(t-1)} = \phi_1 (\tilde{Y}_{NHSt} - Y_{NHS(t-1)}) \qquad 4.32$$

Regression Equations with Observable Variables

$$Y_{NHSt} = f_4 \phi_1 + g_4 \phi_1 X_{iNHSt} + h_4 \phi_1 Y_{MHSt} + k_4 \phi_1 Y_{MHPt} + l_4 \phi_1 Y_{NHPt} + (1- \phi_1) Y_{NHS(t-1)} \qquad 4.33$$

$$Y_{NMHSt} = F_4 + G_4 X_{iNHSt} + H_4 Y_{MHSt} + K_4 Y_{MHPt} + L_4 Y_{NHPt} + P_4 X_{NH(t-1)} \qquad 4.34$$

Identities

$$Y_{NHDt} = Y_{NHSt} \qquad 4.35$$

$$Y_{MHDt} = Y_{MHSt} \qquad 4.36$$

The structural form equations to be estimated in this model are equations 4.22, 4.26, 4.30 and 4.34. From these equations, the structural form parameters will be estimated. From these parameters the adjustment coefficients, long-run coefficients and intercept terms for demand and supply functions can be estimated.

2. Metal and Non-Metal Mining Sectors in Two Separate Models

2.A. Labor market for the metal mining sector.

Demand for Labor in the Metal Mining Sector

i. Salaried Workers

Long-run Demand Function for Salaried Workers

$$\bar{Y}_{MSDt} = a_5 + b_5 X_{iMSDt} + c_5 Y_{MHSt} + d_5 Y_{MSPt} \qquad 4.37$$

Adjustment Function

$$Y_{MSDt} - Y_{MSD(t-1)} = \gamma_2 (\bar{Y}_{MSDt} - Y_{MSD(t-1)}) \qquad 4.38$$

Regression Equations with Observable Variables

$$Y_{MSDt} = a_5 \gamma_2 + b_5 \gamma_2 X_{iMSDt} + c_5 \gamma_2 Y_{MHSt} + d_5 \gamma_2 Y_{MSPt} + (1- \gamma_2) Y_{MSD(t-1)} \qquad 4.39$$

$$Y_{MSDt} = A_5 + B_5 X_{iMSDt} + C_5 Y_{MHSt} + D_5 Y_{MSP} + E_5 X_{MS(t-1)} \qquad 4.40$$

ii. Hourly-Paid Workers

Long-run Demand Function for Hourly-Paid Workers

$$\bar{Y}_{MHDt} = a_6 + b_6 X_{iMHDt} + c_6 Y_{MSSt} + d_6 Y_{MHPt} \qquad 4.41$$

Adjustment Function

$$Y_{MHDt} - Y_{MHD(t-1)} = \Psi_2 (\bar{Y}_{MHDt} - Y_{MHD(t-1)}) \qquad 4.42$$

Regression Equations with Observable Variables

$$Y_{MHDt} = a_6 \Psi_2 + b_6 \Psi_2 X_{iMHDt} + c_6 \Psi_2 Y_{MSSt} + d_6 \Psi_2 Y_{MHPt} + (1 - \Psi_2) Y_{MHD(t-1)} \qquad 4.43$$

$$Y_{MHDt} = A_6 + B_6 X_{iMHDt} + C_6 Y_{MSSt} + D_6 Y_{MHPt} + E_6 X_{MH(t-1)} \qquad 4.44$$

Supply of Labor in the Metal Mining Sector

i. Salaried Workers

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{MSSt} = f_5 + g_5 X_{MSSt} + h_5 X_{NSSt} + l_5 Y_{MSPt} \qquad 4.45$$

Adjustment Function

$$Y_{MSSt} - Y_{MSS(t-1)} = \Pi_2 (\bar{Y}_{MSSt} - Y_{MSS(t-1)}) \qquad 4.46$$

Regression Equations with Observable Variables

$$Y_{MSSt} = f_5 \Pi_2 + g_5 \Pi_2 X_{MSSt} + h_5 \Pi_2 X_{NSSt} + l_5 \Pi_2 Y_{MSPt} + (1 - \Pi_2) Y_{MSS(t-1)} \qquad 4.47$$

$$Y_{MSSt} = F_5 + G_5 X_{MSSt} + H_5 X_{NSSt} + L_5 Y_{MSPt} + P_5 X_{MS(t-1)} \qquad 4.48$$

ii. Hourly-Paid Workers

Long-run Supply Function for Hourly-Paid Workers

$$\bar{Y}_{MHSt} = f_6 + g_6 X_{MHSt} + h_6 X_{NHSt} + l_6 Y_{MHPt} \qquad 4.49$$

Adjustment Function

$$Y_{MHSt} - Y_{MHS(t-1)} = \nu_2 (\bar{Y}_{MHSt} - Y_{MHS(t-1)}) \qquad 4.50$$

Regression Equations with Observable Variables

$$Y_{MHSt} = f_6 \nu_2 + g_6 \nu_2 X_{MHSt} + h_6 \nu_2 X_{NHSt} + l_6 \nu_2 Y_{MHPt} + (1- \nu_2) Y_{MHS(t-1)} \qquad 4.51$$

$$Y_{MHSt} = F_6 + G_6 X_{MHSt} + H_6 X_{NHSt} + L_6 Y_{MHPt} + P_6 X_{MH(t-1)} \qquad 4.52$$

Identities

$$Y_{MSDt} = Y_{MSSt} \qquad 4.53$$

$$Y_{MHDt} = Y_{MHSt} \qquad 4.54$$

The structural form equations to be estimated in this model are equations 4.40, 4.44, 4.48 and 4.52. From these equations the structural form parameters will be estimated and from them, the adjustment coefficients, long-run demand and supply coefficients and the intercept terms are calculated.

2.B. Labor market for the non-metal mining sector.

Demand for Labor in the Non-Metal Mining Sector

i. Salaried Workers

Long-run Demand Function for Salaried Workers

$$\tilde{Y}_{NSDt} = a_7 + b_7 X_{iNSDt} + c_7 Y_{NHSt} + d_7 Y_{NSPt} \qquad 4.55$$

Adjustment Function

$$Y_{NSDt} - Y_{NSD(t-1)} = \delta_2 (\tilde{Y}_{NSDt} - Y_{NSD(t-1)}) \qquad 4.56$$

Regression Equations with Observable Variables

$$Y_{NSDt} = a_7 \delta_2 + b_7 \delta_2 X_{iNSDt} + c_7 \delta_2 Y_{NHSt} + d_7 \delta_2 Y_{NSPt} + (1 - \delta_2) Y_{NSD(t-1)} \qquad 4.57$$

$$Y_{NSDt} = A_7 + B_7 X_{iNSDt} + C_7 Y_{NHSt} + D_7 Y_{NSPt} + E_7 X_{NS(t-1)} \qquad 4.58$$

ii. Hourly-Paid Workers

Long-run Demand Function for Hourly-Paid Workers

$$\tilde{Y}_{NHDt} = a_8 + b_8 X_{iNHDt} + c_8 Y_{NSSt} + d_8 Y_{NHPt} \qquad 4.59$$

Adjustment Function

$$Y_{NHDt} - Y_{NHD(t-1)} = \delta_2 (\bar{Y}_{NHDt} - Y_{NHD(t-1)}) \quad 4.60$$

Regression Equations with Observable Variables

$$Y_{NHDt} = a_8 \delta_2 + b_8 \delta_2 X_{iNHDt} + c_8 \delta_2 Y_{NHSt} + d_8 \delta_2 Y_{NHPt} + (1- \delta_2) Y_{MHD(t-1)} \quad 4.61$$

$$Y_{NHDt} = A_8 + B_8 X_{iNHDt} + C_8 Y_{NHSt} + D_8 Y_{NHPt} + E_8 X_{NH(t-1)} \quad 4.62$$

Supply of Labor in the Non-Metal Mining Sector

i. Salaried Workers

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{NSSt} = f_7 + g_7 X_{NSSt} + h_7 X_{MSSt} + l_7 Y_{NSPt} \quad 4.63$$

Adjustment Function

$$Y_{NSSt} - Y_{NSS(t-1)} = \theta_2 (\bar{Y}_{NSSt} - Y_{NSS(t-1)}) \quad 4.64$$

Regression Equations with Observable Variables

$$Y_{NSSt} = f_7 \theta_2 + g_7 \theta_2 X_{NSSt} + h_7 \theta_2 X_{MSSt} + l_7 \theta_2 Y_{NSPt} + (1- \theta_2) Y_{MSS(t-1)} \quad 4.65$$

$$Y_{NSSt} = F_7 + G_7 X_{NSSt} + H_7 X_{MSSt} + L_7 Y_{NSPt} \quad 4.66$$

$$+ P_7 \, X_{NS(t-1)}$$

ii. <u>Hourly-Paid Workers</u>

Long-run Supply Function for Hourly-Paid Workers

$$\tilde{Y}_{NHSt} = f_8 + g_6 \, X_{NHSt} + h_8 \, X_{MHSt} + l_8 \, Y_{NHPt} \qquad 4.67$$

Adjustment Function

$$Y_{NHSt} = Y_{NHS(t-1)} = \phi_2 \, (\tilde{Y}_{NHSt} - Y_{NHS(t-1)}) \qquad 4.68$$

Regression Equations with Observable Variables

$$Y_{NHSt} = f_8 \, \phi_2 + g_8 \, \phi_2 \, X_{NHSt} + h_8 \, \phi_2 \, X_{MHSt} + l_8 \, \phi_2 \, Y_{NHPt} + (1 - \phi_2) \, Y_{NHS(t-1)} \qquad 4.69$$

$$Y_{NHSt} = F_8 + G_8 \, X_{NHSt} + H_8 \, X_{MHSt} + L_8 \, Y_{NHPt} + P_8 \, X_{NH(t-1)} \qquad 4.70$$

<u>Identities</u>

$$Y_{NHS} = Y_{NHD} \qquad 4.71$$

$$Y_{NSS} = Y_{NSD} \qquad 4.72$$

In this model the structural form regression equations to be estimated are 4.58, 4.62, 4.66 and 4.70. From the estimated coefficients of supply and demand for the non-metal mining sector are calculated.

3. Separate Models For Each Category of Worker in Each Mining Sector

3.A. The labor market for salaried workers in the metal mining sector.

Demand

Long-run Demand Function for Salaried Workers

$$\bar{Y}_{MSDt} = a_9 + b_9 X_{iMSDt} + c_9 X_{MHSt} + d_9 Y_{MSPt} \quad 4.73$$

Adjustment Function

$$Y_{MSDt} - Y_{MSD(t-1)} = \gamma_3 (\bar{Y}_{MSDt} - Y_{MSD(t-1)}) \quad 4.74$$

Regression Equations with Observable Variables

$$Y_{MSDt} = a_9 \gamma_3 + b_9 \gamma_3 X_{iMSDt} + c_9 \gamma_3 X_{MHSt} + d_9 \gamma_3 Y_{MSPt} + (1- \gamma_3) Y_{MSD(t-1)} \quad 4.75$$

$$Y_{MSDt} = A_9 + B_9 X_{iMSDt} + C_9 X_{MHSt} + D_9 Y_{MSPt} + E_9 X_{MS(t-1)} \quad 4.76$$

Supply

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{MSSt} = f_9 + g_9 X_{MSSt} + h_9 X_{NSSt} + l_9 Y_{MSPt} \quad 4.77$$

Adjustment Function

$$Y_{MSSt} - Y_{MSS(t-1)} = \pi_3 (\bar{Y}_{MSSt} - Y_{MSS(t-1)}) \quad 4.78$$

Regression Equations with Observable Variables

$$Y_{MSSt} = f_9 \pi_3 + g_9 \pi_3 X_{MSSt} + h_9 \pi_3 X_{NSSt} + l_9 \pi_3 Y_{MSPt} = (1 - \pi_3) Y_{MSS(t-1)} \qquad 4.79$$

$$Y_{MSSt} = F_9 + G_9 X_{MSSt} + H_9 X_{NSSt} + L_9 Y_{MSPt} + P_9 X_{MS(t-1)} \qquad 4.80$$

Identity

$$Y_{MSSt} = Y_{MSDt} \qquad 4.81$$

3.B. The labor market for salaried workers in the non-metal mining sector.

Demand

Long-run Demand Function for Salaried Workers

$$\bar{Y}_{NSDt} = a_{10} + b_{10} X_{iNSDt} + c_{10} X_{NHSt} + d_{10} Y_{NSPt} \qquad 4.82$$

Adjustment Function

$$Y_{NSDt} - Y_{NSD(t-1)} = \beta_3 (\bar{Y}_{NSDt} - Y_{NSD(t-1)}) \qquad 4.83$$

Regression Equations with Observable Variables

$$Y_{NSDt} = a_{10} \beta_3 + b_{10} \beta_3 X_{iNSDt} + c_{10} \beta_3 X_{NHSt} + d_{10} \beta_3 Y_{NSPt} + (1 - \beta_3) Y_{MSD(t-1)} \qquad 4.84$$

$$Y_{NSDt} = A_{10} + B_{10} X_{iNSDt} + C_{10} X_{MHSt} + D_{10}$$

$$Y_{NSPt} + E_{10} X_{NS(t-1)} \quad 4.85$$

Supply

Long-run Supply Function for Salaried Workers

$$\bar{Y}_{NSSt} = f_{10} + g_{10} X_{NSSt} + h_{10} X_{MSSt} + l_{10} Y_{NSPt} \quad 4.86$$

Adjustment Function

$$Y_{NSSt} - Y_{NSS(t-1)} = \theta_3 (\bar{Y}_{NSSt} - Y_{NSS(t-1)}) \quad 4.87$$

Regression Equations with Observable Variables

$$Y_{NSSt} = f_{10} \theta_3 + g_{10} \theta_3 X_{NSSt} + h_{10} \theta_3 X_{MSSt}$$

$$+ l_{10} \theta_3 Y_{NSPt} + (1 - \theta_3) Y_{NSS(t-1)} \quad 4.88$$

$$Y_{NSSt} = F_{10} + G_{10} X_{NSSt} + H_{10} X_{MSSt} + L_{10} Y_{NSPt}$$

$$+ P_{10} X_{NS(t-1)} \quad 4.89$$

Identity

$$Y_{NSSt} = Y_{NSDt} \quad 4.90$$

3.C. The labor market for hourly-paid workers in the metal mining sector.

Demand

Long-run Demand Function for Hourly-Paid Workers

$$\bar{Y}_{MHDt} = a_{11} + b_{11} X_{iMHDt} + c_{11} X_{MSSt} + d_{11} Y_{MHPt} \qquad 4.91$$

Adjustment Function

$$Y_{MHDt} - Y_{MHD(t-1)} = \Psi_3 (\bar{Y}_{MHDt} - Y_{MHD(t-1)}) \qquad 4.92$$

Regression Equations with Observable Variables

$$Y_{MHDt} = a_{11} \Psi_3 + b_{11} \Psi_3 X_{iMHDt} + c_{11} \Psi_3 X_{MSSt} + d_{11} \Psi_3 Y_{MHPt} + (1 - \Psi_3) Y_{MHD(t-1)}) \qquad 4.93$$

$$Y_{MHDt} = A_{11} + B_{11} X_{iMHDt} + C_{11} X_{MSSt} + D_{11} Y_{MHPt} + E_{11} X_{MH(t-1)} \qquad 4.94$$

Supply

Long-run Supply Function for Hourly-Paid Workers

$$\bar{Y}_{MHSt} = f_{11} + g_{11} X_{MHSt} + h_{11} X_{NHSt} + l_{11} Y_{MHPt} \qquad 4.95$$

Adjustment Function

$$Y_{MHSt} - Y_{MHS(t-1)} = \nu_3 (\bar{Y}_{MHSt} - Y_{MHS(t-1)}) \qquad 4.96$$

Regression Equations with Observable Variables

$$Y_{MHSt} = f_{11} \nu_3 + g_{11} \nu_3 X_{MHSt} + h_{11} \nu_3 X_{NHSt} + l_{11} \nu_3 Y_{MHPt} + (1 - \nu_3) Y_{MHS(t-1)} \qquad 4.97$$

$$Y_{MHSt} = F_{11} + G_{11} X_{MHSt} + H_{11} X_{NHSt} + L_{11} Y_{MHPt} + F_{11} X_{MH(t-1)} \qquad 4.98$$

Identity

$$Y_{MHSt} = Y_{MHDt} \qquad 4.99$$

3.D. The labor market for hourly-paid workers in the non-metal mining sector.

Demand

Long-run Demand Function for Hourly-Paid Workers

$$\bar{Y}_{NHDt} = a_{12} + b_{12} X_{iNHDt} + c_{12} X_{NSSt} + d_2 Y_{NHPt} \qquad 4.100$$

Adjustment Function

$$Y_{NHDt} - Y_{NHD(t-1)} = \phi_3 (\bar{Y}_{NHDt} - Y_{NHD(t-1)}) \qquad 4.101$$

Regression Equations with Observable Variables

$$Y_{NHDt} = a_{12} \phi_3 + b_{12} \phi_3 X_{iNHDt} + c_{12} \phi_3 X_{NSSt} + d_{12} \phi_3 Y_{NHPt} + (1- \phi_3) Y_{NHD(t-1)} \qquad 4.102$$

$$Y_{NHDt} = A_{12} + B_{12} X_{iNHDt} + C_{12} X_{NSSt} + D_{12} Y_{NHPt} + E_{12} X_{NH(t-1)} \qquad 4.103$$

Supply

Long-run Supply Function for Hourly-Paid Workers

$$\bar{Y}_{NHSt} = f_{12} + g_{12} X_{NHSt} + h_{12} X_{MHSt} + l_{12} Y_{NHPt} \qquad 4.104$$

Adjustment Function

$$Y_{NHSt} - Y_{NHS(t-1)} = \delta_3 (\bar{Y}_{NHSt} - Y_{NHS(t-1)}) \qquad 4.105$$

Regression Equations with Observable Variables

$$Y_{NHSt} = f_{12} \delta_3 + g_{12} \delta_3 X_{NHSt} + h_{12} \delta_3 X_{MHSt} + l_{12} \delta_3 Y_{NHPt} + (1 - \delta_3) Y_{NHS(t-1)} \qquad 4.106$$

$$Y_{NHSt} = F_{12} + G_{12} X_{NHSt} + H_{12} X_{MHSt} + L_{12} Y_{NHPt} + P_{12} X_{NH(t-1)} \qquad 4.107$$

Identity

$$Y_{NHSt} = Y_{NHDt} \qquad 4.108$$

For the labor market for salaried workers, the metal mining sector, the estimated structural form equations are 4.76 and 4.80. For salaried workers in the non-metal mining sector, the estimated structural form equations are 4.85 and 4.89. In the case of hourly-paid workers in the metal and non-metal mining sectors, the estimated regression equations are 4.94 and 4.98 and 4.103 and 4.107.

The Method of Analysis

The structural relationships thought to be appropriate in explaining the Canadian mineral industry labor market have been specified as simultaneous equation systems.

In the estimation of the structural relationships in a simultaneous equation system, the method of estimation depends on the number of endogenous variables contained in the relationships and the degree of identification.[21] Before the appropriate method of analysis to be used can be determined, it is necessary to decide which variables in the equation system are endogenous and which are predetermined or exogenous and the degree of identification of the system.

Foote[22] defines an endogenous variable "as one that is correlated with the unexplained residuals in the structural equation in which it appears." Endogenous variables are those that are simultaneously determined within a system, such as price and quantity in a demand and supply model.

He defines a predetermined variable as one that:

> . . . is independent of the unexplained residuals in the structural equation in which it appears. Predetermined variables are generally defined to include exogenous variables, or those determined outside the particular economic sector under consideration, and lagged values of endogenous variables.

The relationships between the endogenous and exogenous variables in the equation systems to be tested have been set out earlier in this chapter.

It remains to test the identifiability of these relationships and to establish the method of estimation.

---

[21] Prior information necessary to provide single value estimates of the regression coefficients.

[22] Richard J. Foote, Analytical Tools for Studying Demand and Price Structures, Agricultural Handbook No. 146, United States Department of Agriculture.

The Identification Problem

The general form of the structural equations in a simultaneous system is given by equation 4.109.

$$y \Gamma + x B = e \qquad 4.109$$

Where:

y is the row vector of endogenous variables in the equation system.

x is the row vector of exogenous variables in the equation system.

Γ is the matrix of parameters associated with the endogenous variables.

B is the matrix of parameters associated with the exogenous variables.

e is the row vector of error terms.

The reduced form is given by equation 4.110.

$$y = x \Pi + v \qquad 4.110$$

Where:

$$\Pi = -B \Gamma^{-1}$$

$$v = e \Gamma^{-1}$$

That is:

$$y = -x B \Gamma^{-1} + e \Gamma^{-1}$$

The reduced form equations express the endogenous variables solely in terms of exogenous variables.

Identification means that there should be enough prior information to give single values to the parameters Γ and B in the structural form equations from the estimated Π in the reduced form.

Wonnacott and Wonnacott define it as "an equation of the structure is identified if there are unique . . . . . . values of its parameters corresponding to a given reduced form . . ."[23]

For identification of each equation in the system the necessary (order) condition and the necessary and sufficient (rank) conditions must be met.

Order Condition:

The order condition for identification of any structural equation is that the total number of endogenous and exogenous variables excluded from that equation must be at least as great as the total number of endogenous variables in the model less one.

Rank Condition:

There must exist at least one non-vanishing determinant of order (M-1), (where M is the number of endogeneous variables in the model) derived from the coefficients of the variables excluded from the equation being considered, but appearing in the other (M-1) structural equations.

These conditions are met by all equations in the complete equation sets when specified in their entirety. All equations are over-identified and two-stage least squares is the appropriate econometric technique to apply.

---

[23]R.J. Wonnacott and T.H. Wonnacott, Econometrics (New York: John Wiley and Sons, Inc., 1970).

CHAPTER V

RESULTS

The purpose of this chapter is to outline the procedure used to test the models, present the general results of the analysis and elaborate upon the shortcomings of the analysis and the usefullness and meaning of the results and discuss in detail the results for each model.

Procedure To Test The Models

All models formulated in Chapter IV were tested to establish if one particular formulation provides better estimates of the labor supply and demand functions for the industry. The equations were tested initially in both logarithmic and linear forms. Specification in logarithmic form did not give higher statistical significance on the independent variables and was abandoned. After extensive testing of the linear formulations, the final equations in all models were found to be similar. The same regression variables proved to be statistically significant[1] in all equations, except for the salaried non-metal demand equation in the non-metal hourly and salaried model. In this model, the number of hourly-paid workers employed in the non-metal mining industry (Y_{NH}) was an endogenous variable and was statistically insignificant. It was not included in the final equation. Each of the other demand

[1]At the 90 percent level or higher for a one tailed t-test.

equations were identical in terms of the variables included and their regression coefficients in all models. The endogenous independent variables, describing the wage rate and level of employment within the sector in these formulations were statistically insignificant and were dropped from the equations. These equations were therefore estimated by ordinary least squares technique. All other equations, although they contained the same independent variables, were estimated by two stage least squares method[2] and consequently had slightly different values for the regression coefficient because the reduced form equation for each structural equation was different in each model.

Each model was tested initially with all variables hypothesized to be important included. Both annual and hourly wage rates were tested. All dollar values were tested in both current dollars and in constant 1948 dollars. The use of hourly wages and salaries gave more statistically significant results and is a more reasonable variable to consider in view of the dependent variable being measured in average weekly man-hours. The use of constant 1948 dollars allowed for the inflationary effect on wage rates, mineral prices and capital values. The regression results for constant dollar values were more significant than those for current dollars.

All equations are therefore in terms of real wages and prices and include hourly wages and salaries rather than annual levels. The employment level in all equations is in man-hours. The original equations, with all variables hypothesized to be important, included and with the relevant ones expressed on an hourly basis and in real dollar

---

[2]Because they contained wages or salaries as dependent endogenous variables.

terms are shown in Appendix D. The results for these initial formulations show low statistical significance and signs on the regression coefficients that are generally inconsistent with those hypothesized.

The lowest level of statistical significance that was taken as acceptable was 90 percent for a one tailed t-test. A number of wage rate variables, in the current year and lagged one and two years, were tested in those cases where the endogenous wage rate variable proved to be statistically insignificant. Those variables to be substituted for the endogenous wage or salary variable were:

i. The endogenous variable, lagged one and two years.

ii. Wage or salary in the other mineral mining sector in the current year and lagged one and two periods.

iii. Wage or salary in the manufacturing sector in the current year and lagged one and two periods.

In the demand functions for hourly-paid workers in both the metal and non-metal mining sectors all wage rate variables tested were statistically insignificant at the 90 percent level. Consequently, the demand equations for hourly-paid workers in models 1a, 2a, 2b, 3c and 3d do not include any wage rate variable in them. The wage rate variable was dropped only after repeated testing of the equations, down to the point where the lagged dependent variable and the wage rate were the only variables included.

The equations, that include a wage rate variable in them and have the highest level of significance on the variables included, show the wage rate for the corresponding sector in the previous year, to be statistically significant at the 80 percent level. The employment level in the preceding year and the quantity of ore mined were also significant and included in these equations. These equations are presented in Appendix E.

In the complete model formulations, the demand equations for salaried workers in the metal mining sector had all variables hypothesized as important, show as statistically significant at the greater than the 90 percent level. The exception was the lagged dependent variable, which proved to be statistically insignificant. Removal of the employment level of hourly-paid workers from the equations led to the lagged variable and all other variables showing as statistically significant. However, after adjustment of the other equations in the model sets, the demand equation for salaried employees by the metal mining sector was altered. The salary level although statistically significant no longer showed the hypothesized negative sign on the regression coefficient. After dropping other variables one at a time from the demand equation and in groups, to the point that the only variables included were the lagged dependent variable and the salary level, it was decided to remove the salary level variable in the current period from the equation. Tests were conducted on the effect of the salary level one and two years previously, but these tests gave similar results. The salary level in the manufacturing sector, was finally tested and proved to be statistically significant at the 90 percent level with the negative regression coefficient, consistent with economic theory. The demand for salaried workers by the metal mining sector may depend on the general salary level in the economy, as represented by the manufacturing industries. Although this statement is supported by the empirical results, the logical foundation for it is not strong.

The complete model for salaried workers (Model 1a) was also tested with the lagged dependent variable excluded from all equations. This was done to establish if this improved the explanation of the market for salaried workers in the mineral mining sector, particularly the demand equation for the metal mining sector. The results are shown in Appendix F. This static model formulation did not give any substantial improvement in the statistical results.

The model for salaried workers (1a) was also tested with the trend variable removed from all equations. The results in this case were not greatly different to that for the complete model. The statistical results for this formulation are also summarized in Appendix G. Apart from testing the model specifically for the purpose of establishing the effect of salaries on demand in the metal sector these two variables were dropped separately, as an initial test to determine if this approach would be worth following to improve the general explanatory power of all models examined in this study. The tests did not indicate this for Model 1a and was not pursued any further. However, further investigation of these approaches (that is, the use of a static model for removal of the trend variable) is a possibility for more extensive testing of the model. This topic is continued in more detail under the discussion the multicollinearity problem, later in this chapter.

General Discussion of Results

The complete results are presented for each set of equations as put forward in Chapter III and later in this chapter. No one model set proved to explain the labor market better than the others. The final regression equations in all models include the same variables with approximately the same values on the coefficients. The exception is Model

2 in which the employment level of hourly-paid workers in the non-metal mining sector (X_{NH}) is omitted from the final supply equation for salaried workers to that sector. The choice of one model over others as being more appropriate to explaining the labor market for hourly-paid and salaried workers in the metal and non-metal mining sectors depends then on the model structure. The models were constructed on the basis, that there existed an interrelationship in terms of the labor markets between each category of worker and between the sectors of the industry. The statistical results do not indicate that these hypothesized interdependencies exist and the choice of a model set over the others on this basis as better explaining the labor market is not sound. For the purpose of summarizing the results, Model 1 (salaried and hourly-paid workers in two separate models) was chosen. The long-run and short-run elasticities for this model set are presented in Table XIX. These are restated later in Tables XX and XXI for this model set and for the model sets in Tables XXII, XXIII, XXIV and XXV.

The discussion in this section applies to the three model sets tested. Because the regression coefficients were very similar in all models to avoid repetition, only the empirical results of Model 1 are discussed here. Specific results for each model set are discussed later in this chapter.

Multicollinearity

A high level of correlation exists between some of the independent variables included in the final regression equations. Refer to Appendix H for the matrix of simple correlation coefficients. The effect of multicollinearity is to give higher standard errors on the estimated

TABLE XIX

SHORT-RUN AND LONG-RUN ELASTICITIES FOR FACTORS AFFECTING THE DEMAND FOR AND SUPPLY OF WORKERS IN THE CANADIAN MINERAL MINING INDUSTRY-MODEL 1[a]

	Salaried				Hourly-Paid			
	Demand		Supply		Demand		Supply	
	Metal	Non-Metal	Metal	Non-Metal	Metal	Non-Metal	Metal	Non-Metal
Demand Variables:								
Tons of metal ore mined	0.1384 (0.3426)				-			
Tons of non-metal ore mined		-			0.1451 (0.9224)	-		
Price per ton of metals	0.4737 (1.1725)				-			
Price per ton of non-metals		-				0.3357 (0.7497)		
Total net capital stock	-	-			-	-		
Trend variable	0.5334 (1.3203)	0.9122 (1.9347)			-0.1563 (-0.9936)	0.1757 (0.3924)		
Supply Variables:								
Unemployment rate			-	-0.1006 (-0.1934)			-	-0.0716 (-0.1894)
Available labor force			-	0.6745 (1.2967)			-0.6017 (-1.0428)	
Employment Levels:								
Man-hours of salaried workers in metal mining					-			
Man-hours of hourly-paid workers in metal mining	-							
Man-hours of salaried workers in non-metal mining						-		
Man-hours of hourly-paid workers in non-metal mining		0.2917 (0.6187)						
Man-hours of salaried workers in metal mining one year earlier	0.5681		0.5093					
Man-hours of hourly-paid workers in metal mining one year earlier					0.8344		0.4189	
Man-hours of salaried workers in non-metal mining one year earlier		0.5042		0.4578				
Man-hours of hourly-paid workers in non-metal mining one year earlier						0.5455		0.6144
Wage Rates or Salaries:								
Salaries in metal mining	-		0.8958 (1.9236)					
Wages in metal mining					-		0.4505 (0.7808)	
Salaries in non-metal mining		-1.8330 (-3.8876)		0.4428 (0.8512)				
Wages in non-metal mining						-		0.2229 (0.5897)
Salaries in metal mining one or two years earlier	-							
Wages in metal mining one or two years earlier					-1.1640[b] (-3.6150)			
Salaries in non-metal mining one or two years earlier								
Wages in non-metal mining one or two years earlier						-0.1968[b] (-0.8186)		
Salaries in manufacturing	-0.7004 (-1.7337)							
Wages in manufacturing								
Adjustment Coefficient	0.4040	0.4715	0.4657	0.5202	0.1573	0.4478	0.5770	0.3780

[a]The long-run elasticities are shown in brackets below the short-run elasticity in each case.

[b]Taken from regression equations in Appendix E. Significant at 80 percent level for a one tailed t-test. In both cases this was for the wage rate two years earlier.

-Indicates that the variable was tested but proved to be statistically insignificant at the 90 percent level for a one tailed t-test.

coefficients and hence lead to lower t values. This could result in the omission of variables that may otherwise have proved to be statistically significant. The other problem associated with the inclusion of variables that are correlated, is that there is a loss in the precision of the estimates.[3] The regression results show high statistical significance on the variables in the final equations and the coefficients generally have the hypothesized signs, suggesting that the effect of multicollinearity is not severe.

As explained in the discussion of the procedure used to test the regression equations, removal of the trend variable and lagged endogeneous variable from Model 1a was carried out to test if the effect of other variables was being hidden by the inclusion of these two variables. The results for these tests are shown in Appendices F and G. There was not any substantial improvement in the statistical significance of the other variables and this approach was not pursued any further although further investigation of the static formulation could refine the model.

Autocorrelation

The Durbin-Watson statistic indicates that autocorrelation is not a problem.

Omitted Variables

The only variable omitted from the complete model formulations that economic theory indicates as a factor effecting the demand for labor, is the cost of capital or more directly the capital-labor cost ratio. Refer to Figure 7 and the discussion in Chapter III. The cost

[3] J. Johnston, Econometric Methods, 2nd ed. (New York: McGraw-Hill Book Company, 1972).

of labor is included in the analysis. The trend variable, as a proxy for technological change and as a variable that accounts for those factors not explicitly included in the analysis, does account for the change in the capital labor ratio over the period and implicitly includes the factor cost ratio.

The supply equations included all variables established as important in the theoretical framework. The supply of workers was hypothesized to be affected by the wage rate or salary in the manufacturing sector. This hypothesis was not confirmed by the empirical analysis. Investigation of the effect of wages and salaries in other sectors, such as forrestry, agriculture and construction, could be used as alternatives.

The Interrelationship Between Models

Implicit in the formulation of the three model sets investigated, was the assumption of interdependence between the labor markets for each category of worker in both mineral mining sectors. In the demand equations, a complementary relationship was hypothesized between the demand for a category of worker by a sector and the employment level of the other type of worker in that sector. In the supply equation for a category of worker to a sector, the employment level of that category of worker in the other mineral mining sector was hypothesized to reduce the supply. Similarly the wage rate or salary in the other sector was also hypothesized to reduce the supply of workers to the sector.

These relationships were not confirmed by the empirical results. In only one equation did any of these variables proved to be statistically significant. This was the demand function for salaried workers by the non-metal mining sector.

It was also hypothesized that the mining industry and manufacturing industries compete for workers and that the wage rate in the manufacturing sector would effect the supply of workers to the mineral mining sector. This hypothesis was not confirmed by the regression results. This variable was statistically insignificant in all supply equations.

Demand Equation

The wage rate and salary levels in the current year were generally insignificant in determining the demand for either salaried or hourly-paid workers in the two sectors of the mineral mining industry. The exception was the demand for salaried workers by the non-metal mining sector. The short-run elasticity of salary level on the demand for salaried workers was -1.8, while the elasticity in the long-run was -3.9. The wage rates in the metal and non-metal sectors two years earlier were statistically significant only at the 80 percent level for a one tailed t-test, in their effect on the demand for hourly-paid workers by those two sectors. The long-run and short-run wage elasticities of demand in metal mining were considerably higher than those in the non-metal mining sector. Salary level in the metal mining sector in the current period and lagged one and two years was not significant at the 90 percent level. The salary level in manufacturing had a short-run elasticity of demand for salaried workers by the metal mining sector of -0.7. The long-run elasticity was -1.7.

The long-run and short-run elasticities of the trend variable were lower for hourly-paid workers (negative for hourly-paid workers in the metal mining sector) than for salaried employees. For salaried workers the effect of the trend appears to be exceeded only by the salary levels. For hourly-paid workers, the employment level in the previous year has the highest elasticity in both mineral mining sectors.

The demand for salaried workers in both sectors is explained by the lagged dependent variable, the trend variable and the salary level.[4] In the metal mining sector, the demand for salaried workers also depends on the tons of metal ore mined and the price of metals. In the non-metal mining sector, the only other variable affecting the demand is the employment level of hourly-paid workers.

The demand for hourly-paid workers in both sectors depends on the wage rate, lagged dependent variable and trend variable. In the metal mining sector it also depends on the tons of metal ore mined, while in the non-metal mining sector the mineral price is a factor.

Supply Equations

The wage rate and salary levels in the current year were statistically significant in determining the supply of each category of worker to both sectors. The wage rates and salaries either in the manufacturing sector or competing mineral sector did not prove to be significant factors effecting supply. The elasticity of labor price with respect to supply was greatest in the supply equation for salaried workers to the metal mining sector (long-run elasticity of 1.9).

The salary level and previous years employment were the only two factors that proved statistically significant in the supply equation for salaried workers in the metal mining sector. For non-metal salaried workers supply was also affected by the rate of unemployment and size of

---

[4]In the case of the metal mining sector, this is the salary level in the manufacturing sector.

the labor force. For hourly-paid workers, the unemployment rate was statistically significant in affecting the supply to the non-metal sector, while the size of the available labor force affected the supply to the metal sector. The negative sign on this variable was contrary to the hypothesized relationships.

The Adjustment Coefficients

The adjustment coefficients indicate a faster rate of response in the case of supply than for demand in all models.

For salaried workers, the demand and supply equations in both sectors of the mineral mining industry have adjustment coefficients close to 0.5. In the supply function the coefficient is marginally higher and in the demand equation the coefficient is slightly lower.

For hourly-paid workers the adjustment coefficients were not as uniform. In the non-metal mining sector the adjustment coefficient in the demand equation was approximately 0.5 while for the supply equation it was around 0.4. In the metal mining sector the adjustment coefficients for the hourly-paid workers were approximately 0.2 in the demand equation and 0.8 in the supply equation.

In summary, it appears that in all cases, except hourly-paid workers in the metal mining sector, that it takes from two to three years for the market to adjust completely to a change in labor market conditions. For the hourly-paid workers in the metal mining sector it appears to take over six years for the supply function and just over one year for the demand function to respond completely.

The Results for Each Model Set

The three model sets investigated are:

1. Hourly-paid and salaried workers in two separate models.

   a. The labor market for salaried workers.

   b. The labor market for hourly-paid workers.

2. The metal and non-metal mining sector in two separate models.

   a. The labor market for the metal mining sector.

   b. The labor market for the non-metal mining sector.

3. Separate models for each category of worker in each mining sector.

   a. The labor market for salaried employees in the metal mining sector.

   b. The labor market for salaried employees in the non-metal mining sector.

   c. The labor market for hourly-paid employees in the metal mining sector.

   d. The labor market for hourly-paid employees in the non-metal mining sector.

The initial model formulation tested is presented and the investigative procedure is described in each case, before the empirical results are discussed. The general results already discussed are not repeated for each model in the following discussion.

1. Hourly-Paid and Salaried Workers in Two Separate Models

1a. Salaried workers. The complete formulation of this model as tested initially in the regression analysis was:

$$Y_{MSD} = f\,(X_{6M}, X_{5M}, X_3, X_1, X_{NH}, X_{MS(t-1)}, Y_{2Mii})$$

$$Y_{MSS} = f(X_{10}, X_{11}, X_{8Maii}, X_{MS(t-1)}, Y_{2Nii}, Y_{NS}, Y_{2Mii})$$

$$Y_{NSD} = f(X_{6N}, X_{5N}, X_{3}, X_{1}, X_{NH}, X_{NS(t-1)}, Y_{2Nii})$$

$$Y_{NSS} = f(X_{10}, X_{11}, X_{8Maii}, X_{NS(t-1)}, Y_{2Mii}, Y_{MS}, Y_{2Nii})$$

As stated earlier, current prices were tested as well. In the demand equations the mineral price variables in constant 1948 dollars (X_{5M} and X_{5N}) replaced the corresponding variables (X_{4M} and X_{4N}) in current dollar terms and the net capital stock variable (X_3) replaced the corresponding X_2 (expressed in current dollars). The endogenous salary variables were originally included as annual rates in current and constant dollars, before the hourly rates in constant 1948 dollars (Y_{2Mii} and Y_{2Nii}) were tested.

In the supply equations, the endogenous salary variables were also tested as current and constant annual dollar rates, before the hourly rates in constant 1948 dollars were tested.

The salary level in the manufacturing sector in both constant and current dollar terms and on an hourly and annual basis were tested in the supply functions.

The constant dollar values and hourly rather than annual salary levels, gave more statistically significant and theoretically consistent results.

Repeated testing of the equation set as originally proposed, established that shown in Table XX as best describing the market for salaried employees in the metal and non-metal mining sectors of the Canadian mineral mining industry.

In the demand equations, the number of hourly-paid workers

TABLE XX

MODEL 1a

REGRESSION EQUATIONS FOR THE DEMAND FOR AND SUPPLY OF SALARIED WORKERS IN THE CANADIAN MINERAL MINING INDUSTRY

Demand in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	14.9707[b]	0.5334	2.3360	37.0562	1.3203
X_3 Capital stock	-0.0015[c]	-0.0096	1.5161	-0.0037	-0.0238
X_{5M} Metal price	16.3895[b]	0.4737	2.5055	40.5681	1.1725
X_{6M} Metal ore mined	0.0004[b]	0.1384	1.9192	0.0010	0.3426
$X_{MS(t-1)}$ Employment in previous year	0.5960[a]	0.5681	3.6782		
X_{8Mii} Salaries in manufacturing	-127.1144[c]	-0.7004	1.3624	-314.6396	1.7337
Intercept	-1.2915		-0.0059	3.1968	

R^2 value = 0.9899 F-value of equation = 276.6475

Significance Level = 99% Durbin Watson Statistic = 2.0975

Adjustment Coefficient = 0.4040

Supply in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
$X_{MS(t-1)}$ Employment in previous year	0.5343[b]	0.5093	2.4224		
Y_{2Mii} Hourly salaries in metal mining (constant dollars)	138.0343[b]	0.8958	2.2474	296.4018	1.9236
Intercept	-142.1210[c]		-0.8797	305.1772	

R^2 value = 0.9819 F-value of equation = 570.3491

Significance Level = 99% Durbin Watson Statistic = 2.0975

Adjustment Coefficient = 0.4657

Demand in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	5.4104[a]	0.9122	4.0128	11.4749	1.9347
X_{NH} Employment of hourly workers-non-metal	0.0514[b]	0.2917	1.8265	0.1090	0.6187
$X_{NS(t-1)}$ Employment in previous year	0.5258[a]	0.5042	3.5293		
Y_{2Nii} Hourly salaries in non-metal mining (constant dollars)	-65.9977[a]	-1.8330	3.4308	-139.9739	-3.8876
Intercept	83.4034[b]		1.7888	176.8895	

R^2 value = 0.9825 F-value of equation = 266.5158

Significance Level = 99% Durbin Watson Statistic = 1.8917

Adjustment Coefficient = 0.4715

Supply in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	0.1890[b]	0.6745	1.8451	0.3633	1.2967
X_{12} Unemployment rate	-1.7125[b]	-0.1006	1.9756	-3.2920	-0.1934
$X_{NS(t-1)}$ Employment in previous year	0.4798[a]	0.4578	2.8942		
Y_{2Nii} Hourly salaries in non-metal mining (constant dollars)	15.9446[c]	0.4428	1.3561	30.6509	0.8512
Intercept	-35.1799		-0.8984	67.6276	

R^2 value = 0.9802 F-value of equation = 234.6361

Significance Level = 99% Durbin Watson Statistic = 2.1468

Adjustment Coefficient = 0.5202

[a] Significant at the 99 percent level for a one tailed t-test.

[b] Significant at the 95 percent level for a one tailed t-test.

[c] Significant at the 90 percent level for a one tailed t-test.

employed in the sector (X_{MH} and X_{NH} respectively) was statistically insignificant in both equations and was dropped. In the demand equation for salaried workers in the metal mining sector, all other variables were statistically significant at the 90 percent level for a one tailed t-test except the endogeneous salary variable (Y_{2Mii}). The salary levels in the metal mining sector, one and two years earlier ($X_{8Mii(t-1)}$ and $X_{8Mii(t-2)}$) were tested as exogeneous variables but were not statistically significant. The salary level in the manufacturing sector (X_{8Maii}) was significant at the 90 percent level and showed the hypothesized sign. That is, the demand for salaried workers by the metal mining sector is determined by the general salary level of all salaried employees, as represented by the manufacturing sector. In the non-metal mining sector the hourly rate of pay to salaried workers in constant 1948 dollars was statistically significant at the 99 percent level.

All variables in the demand function for salaried workers in the metal mining sector showed the hypothesized relationships with the dependent variable. Increases in the quantity of ore mined, and particularly the mineral price, lead to increases in the demand for salaried employees. Capitalization, showed the hypothesized inverse relationship to the demand for salaried employees - capital substitution for labor. The trend variable (X_1 included as a proxy for improved technology) had a positive coefficient. This relationship is consistent with the notion that increased technology will require more professional or skilled employees (that is, salaried employees). It appears then that as the industry becomes more capital intensive the demand for labor drops as labor saving techniques are employes, but when more technologically advanced methods are employed the demand for skilled employees increases.

In the non-metal mining sector, the mineral price, quantity of ore mined and the level of capital stock[5] were statistically insignificant. The trend variable and employment level of hourly-paid workers showed the hypothesized positive relationships.

In the supply functions for salaried workers, the salaries variables had the highest coefficients of all variables included in the final equations. In the metal mining sector, the only other variable that proved to be significant in determining the supply of salaried workers was the level of employment in the previous year, included to enable estimation of the adjustment coefficient and the long-run supply function.

In the supply function for salaried workers to the non-metal mining sector, the available labor force and the level of unemployment proved to be statistically significant as well. The unemployment rate however did not have the hypothesized positive sign.

All equations in this model had high R^2 values and were significant at the 99 percent level for the F test. The Durbin-Watson statistic in all cases did not indicate that autocorrelation was a problem.

1b. Hourly-paid workers. The complete formulation of this model, as tested initially in the regression analysis, was:

$$Y_{MHD} = f\ (X_{6M}, X_{5M}, X_3, X_1, X_{MS}, X_{MH(t-1)}, Y_{1Mii})$$

$$Y_{MHS} = f\ (X_{10}, X_{11}, X_{7Maii}, X_{MH(t-1)}, Y_{1Nii}, Y_{NH}, Y_{1Mii})$$

[5]The capital stock variable is for the total mineral mining industry which is dominated by the metal mining sector.

$$Y_{NHD} = f\ (X_{6N}, X_{5N}, X_3, X_1, X_{NS}, X_{NH(t-1)}, Y_{1Nii})$$

$$Y_{NHS} = f\ (X_{10}, X_{11}, X_{7Maii}, X_{NH(t-1)}, Y_{1Mii}, Y_{MH}, Y_{1Nii})$$

This equation set was tested extensively, as in Model 1a of this formulation, for alternative variables to those specified above. Current and constant dollar values as well as annual and hourly wage rates were tested. X_{10} was replaced by other national labor market indicators and lags of the wage rate and employment level variables were tested.

The wage rates in both sectors were not shown to be statistically significant at the 90 percent level in determining the demand for hourly-paid workers. The wage rates for each sector at time t and lagged one and two years were tested. The wage rate in the manufacturing sector in the current year and lagged one and two years was also tested. The wage rate in the metal mining sector was also tested for its effect on the demand for hourly-paid workers in the smaller non-metal mining sector.

Of all wage rate variables tested, that in the metal mining sector lagged two periods showed the highest level of statistical significance at the 80 percent level.

This lack of response to the wage rate in terms of its low statistical significance and the two year lag in response is not surprising. The demand for hourly-paid workers depends more on the quantity of ore mined, in the case of the metal mining sector, and the mineral price, in the case of non-metal mining. The trend variable (X_1) was also statistically significant in both demand equations but had a negative regression coefficient in the metal mining sector and a positive coefficient in the non-metal sector.

All other variables proposed in the initial formulations (except employment in the previous year) were statistically insignificant at the 90 percent level.

Table XXI shows the final regression equations for hourly-paid workers in the metal and non-metal mining sectors. The demand equations, including the wage rate in manufacturing two years earlier ($X_{7Maii(t-2)}$), are shown in Appendix D.

In the supply functions, the wage rate in the current year in the respective mineral mining sectors (Y_{1Mii} and Y_{1Nii}) were statistically significant at the 95 percent level and showed the hypothesized positive relationship. The available labor force (X_{10}) and the level of unemployment (X_{11}) had negative regression coefficients in the metal and non-metal supply equations respectively. This is contrary to the positive relationships proposed between these variables and the supply of labor.

In periods when the labor force is large, conditions in the economy, and more specifically in the labor market, are favorable. Under such circumstances, it appears that workers are attracted to other sectors rather than to seeking employment in the metal mining sector. That is, the higher labor force participation is in response to generally favorable working conditions throughout the economy. These conditions also lead to workers being drawn away from the metal mining sector, to other industries where better pecuniary and other benefits exist.

The inverse relationship between the unemployment rate and the supply of hourly-paid workers to the non-metal mining sector is difficult to explain.

TABLE XXI

MODEL 1b

REGRESSION EQUATIONS FOR THE DEMAND FOR AND SUPPLY OF HOURLY-PAID WORKERS IN THE CANADIAN MINERAL MINING INDUSTRY

Demand in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	-25.6964^c	-0.1563	1.6071	-163.3592	-0.9936
X_6 Metal ore mined	0.0026^c	0.1451	1.5665	0.0165	0.9224
$X_{MH(t-1)}$ Employment in previous year	0.8427^a	0.8344	4.3836		
Intercept	363.3712		0.7327	2310.0521	

R^2 value = 0.6021 F-value of the equation = 10.0897
Significance Level = 99% Durbin Watson Statistic = 2.5751
Adjustment Coefficient = 0.1573

Supply in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	-4.6737^b	-0.6017	2.3818	-8.1000	-1.0428
$X_{SH(t-1)}$ Employment in previous year	0.4230^a	0.4189	3.1401		
Y_{1Mii} Hourly wages in metal (constant dollars)	568.0958^b	0.4505	2.3153	984.5681	0.7808
Intercept	1505.4796^b		2.0722	2609.1501	

R^2 value = 0.6500 F-value of the equation = 12.3783
Significance Level = 99% Durbin Watson Statistic = 2.3482
Adjustment Coefficient = 0.5770

Demand in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	5.9071^a	0.1757	3.6236	13.1914	0.3924
X_{5N} Non-metal price (constant dollars)	74.8241^a	0.3357	3.1603	167.0927	0.7497
$X_{NH(t-1)}$ Employment in previous year	0.5522^a	0.5455	3.7040		
Intercept	-23.8843		-0.2866	-53.3370	

R^2 value = 0.7719 F-value of the equation = 22.5609
Significance Level = 99% Durbin Watson Statistic = 1.8447
Adjustment Coefficient = 0.4478

Supply in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{12} Unemployment rate	-6.9154^b	-0.0716	1.8206	-18.2947	-0.1894
$X_{NH(t-1)}$ Employment in previous year	0.6220^a	0.6144	3.6019		
Y_{1Nii} Hourly wages in non-metal (constant dollars)	64.9048^b	0.2229	2.4369	171.7058	0.5897
Intercept	98.5001		1.1203	260.5823	

R^2 value = 0.7101 F-value of the equation = 16.3260
Significance Level = 99% Durbin Watson Statistic = 1.9237
Adjustment Coefficient = 0.3780

[a] Significant at the 99 percent level for a one tailed t-test.

[b] Significant at the 95 percent level for a one tailed t-test.

[c] Significant at the 90 percent level for a one tailed t-test.

2. The Metal And Non-Metal Mining Sectors As Two Separate Models

This information of the labor market to the mineral mining industry establishes two sets of simultaneous equations on the basis of the two sectors in the industry rather than on the two classes of labor. The equation systems, as originally proposed, are identical to those specified for the preceding formulation, except that some variables were endogenous in one model and not so in the other. The wage rate and salary level of a sector and the supply of and demand for man-hours in that sector are endogenous in both systems. In the formulation based on the type of labor, the wage or salary of the same type of worker in the other sector and the number of workers of the same type in the other sector were endogenous variables in the supply functions. In this formulation, these variables are not endogenous. The number of employees of the other type employed in the sector are endogenous variables in the demand functions.

The equations in this model set were tested with current and constant dollar values, annual and hourly wages and salaries, lags of one and two years on the wages and salaries and employment levels and alternative variables to the unemployment rate (X_{10}) as discussed previously.

The regression results in this model set were essentially the same as those in the one based on a breakdown of the industry by type of worker. The demand equations for hourly-paid workers in both sectors and for salaried workers in the metal mining sector are the same in all model formulations.[6]

---

[6]No independent endogenous variables are included in these equations.

The final demand equations for hourly-paid workers in the metal mining sector (Model 2a) and in the non-metal mining sector (Model 2b) do not include any wage rate variable. The equations that do include the most statistically significant wage rate variable ($X_{7Maii(t-2)}$: the wage rate in the manufacturing sector two years earlier) are shown in Appendix D.

The other equations, in both sets of models, had the same variables included in the final equations (except X_{NH} is not included in the demand equation for salaried workers in the non-metal sector model) but had slightly different values on the coefficients because of the different reduced form equation in each model.

2a. Metal mining sector. The complete formulation of this model, as tested initially in the regression analysis, was:

$$Y_{MHD} = f\,(X_{6M}, X_{5M}, X_3, X_1, X_{MH(t-1)}, Y_{MS}, Y_{1Mii})$$

$$Y_{MHS} = f\,(X_{10}, X_{11}, X_{7Maii}, X_{MH(t-1)}, X_{1Nii}, X_{NH}, Y_{1Mii})$$

$$Y_{MSD} = f\,(X_{6M}, X_{5M}, X_3, X_1, X_{MS(t-1)}, Y_{MH}, Y_{2Mii})$$

$$Y_{MSS} = f\,(X_{10}, X_{11}, X_{8Maii}, X_{MS(t-1)}, X_{2Nii}, X_{NS}, Y_{2Mii})$$

The supply function for hourly-paid workers in the metal mining sector in this model had lower significance levels on the intercept term and wage rate (Y_{1Mii}) and had a slightly lower R^2 value than the corresponding equation for the metal mining sector in the model for hourly-paid workers (Model 1b).

2b. Non-metal mining sector. The complete formulation of this

TABLE XXII

MODEL 2a

REGRESSION EQUATIONS FOR LABOR DEMAND AND SUPPLY IN THE METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Hourly-Paid Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	-25.6964[c]	-0.1563	1.6071	-165.3592	-0.9936
X_6 Metal ore mined	0.0026[c]	0.1451	1.5665	0.0165	0.9224
$X_{MH(t-1)}$ Employment in previous year	0.8427[a]	0.8344	4.3836		
Intercept	363.5712		0.7327	2310.0521	

R^2 value = 0.6021
Significance Level = 99%
Adjustment Coefficient = 0.1573
F-value of the equation = 10.0897
Durbin Watson Statistic = 2.5751

Supply of Hourly-Paid Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	-5.0907[b]	-0.6554	1.7361	-10.1692	-1.3092
$X_{MH(t-1)}$ Employment in previous year	0.4994[a]	0.4945	3.7993		
Y_{1Mii} Hourly wages in metal (constant dollars)	510.6350[c]	0.5655	1.6769	1020.0459	1.1296
Intercept	1223.8536		1.1215	2444.7735	

R^2 value = 0.6108
Significance Level = 99%
Adjustment Coefficient = 0.5006
F-value of the equation = 10.4642
Durbin Watson Statistic = 2.4793

Demand for Salaried Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	14.9707[b]	0.5334	2.3360	37.0562	1.3203
X_3 Capital stock	-0.0015[c]	-0.0096	1.5161	-0.0037	-0.0238
X_{5M} Metal price	16.3895[b]	0.4737	2.5055	40.5681	1.1725
X_{6M} Metal ore mined	0.0004[b]	0.1384	1.9192	0.0010	0.3426
$X_{MS(t-1)}$ Employment in previous year	0.5960[a]	0.5681	3.6782		
X_{8Maii} Salaries in manufacturing	-127.1144[c]	-0.7004	1.3624	-314.6396	1.7337
Intercept	-1.2915		-0.0059	3.1968	

R^2 value = 0.9899
Significance Level = 99%
Adjustment Coefficient = 0.4040
F-value of the equation = 276.6475
Durbin Watson Statistic = 2.0975

Supply of Salaried Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
$X_{MS(t-1)}$ Employment in previous period	0.5631[a]	0.5368	2.7549		
Y_{2Mii} Hourly salaries in metal (constant dollars)	130.0997[c]	0.8443	2.2863	297.7791	1.9325
Intercept	-133.6887		-0.8916	305.9938	

R^2 value = 0.9820
Significance Level = 99%
Adjustment Coefficient = 0.4369
F-value of the equation = 574.2827
Durbin Watson Statistic = 1.6167

[a] Significant at the 99 percent level for a one tailed t-test.

[b] Significant at the 95 percent level for a one tailed t-test.

[c] Significant at the 90 percent level for a one tailed t-test.

model, as tested initially in the regression analysis, was:

$$Y_{NHD} = f\,(X_{6N}, X_{5N}, X_3, X_1, X_{NH(t-1)}, Y_{NS}, Y_{1Nii})$$

$$Y_{NHS} = f\,(X_{10}, X_{11}, X_{7Maii}, X_{NH(t-1)}, X_{1Mii}, X_{MH}, Y_{1Nii})$$

$$Y_{NSD} = f\,(X_{6N}, X_{5N}, X_3, X_1, X_{NS(t-1)}, Y_{NH}, Y_{2Nii})$$

$$Y_{NSS} = f\,(X_{10}, X_{11}, X_{8Maii}, X_{NS(t-1)}, X_{2Mii}, X_{MS}, Y_{2Mii})$$

The final regression equations derived are shown in Table XXIII. The demand equation for hourly-paid workers is identical to that estimated in Model 1b. The supply equation for the same group of workers to the non-metal mining sector is almost identical in both Model 1b and in this model. The demand function for salaried workers in this model besides having the employment level of hourly-paid workers excluded as a variable because of statistical insignificance, has lower significance levels on the salaries variable (Y_{2Nii}) and the intercept term. The R^2 value is also marginally lower. The values of the coefficients are also slightly different in both models. The supply functions for salaried workers in both models only differ slightly in the values of the derived regression coefficients.

3. Separate Models For Each Category Of Worker In Each Mining Sector

The four models for each category of worker in each mineral mining sector together describes the Canadian mineral mining industry labor market overall.

These models were tested for the purpose of completeness in the investigative process. It was expected that the results would be poor

TABLE XXIII

MODEL 2b

REGRESSION EQUATIONS FOR LABOR DEMAND AND SUPPLY IN THE NON-METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Hourly-Paid Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	5.9071[a]	0.1757	3.6236	13.1914	0.3923
X_{5N} Non-metal price (1948 dollars)	74.[illegible]241[a]	0.3357	3.1603	167.0927	0.7496
$X_{NH(t-1)}$ Employment in previous year	0.5522[a]	0.5455	3.7040		
Intercept	-23.8843		-0.2866	-53.3370	

R^2 value = 0.7719

Significance Level = 99%

Adjustment Coefficient = 0.4478

F-value of the equation = 22.5609

Durbin Watson Statistic = 1.8447

Supply of Hourly-Paid Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{12} Unemployment rate	-6.9119[b]	-0.0716	1.8173	-18.2951	-0.1895
$X_{NH(t-1)}$ Employment in previous year	0.6222[a]	0.6146	3.5983		
Y_{1Nii} Hourly wages in non-metal (constant dollars)	64.8654[b]	0.2228	2.4299	171.6924	0.5897
Intercept	98.4771		1.1185	260.6593	

R^2 value = 0.7097

Significance Level = 99%

Adjustment Coefficient = 0.3778

F-value of the equation = 16.2960

Durbin Watson Statistic = 1.9118

Demand for Salaried Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	4.1826[a]	0.7052	2.9047	13.5623	2.2866
$X_{NH(t-1)}$ Employment in previous year	0.6916[a]	0.6599	5.1525		
Y_{2Nii} Hourly salaries in non-metal (constant dollars)	-51.6560[b]	-1.4347	2.3896	-167.4968	4.6520
Intercept	79.3002[c]		1.5936	257.1342	

R^2 value = 0.9775

Significance Level = 99%

Adjustment Coefficient = 0.3084

F-value of the equation = 290.0352

Durbin Watson Statistic = 1.8034

Supply of Salaried Workers	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	0.1663[c]	0.5937	1.6600	0.3024	1.0796
X_{12} Unemployment rate	-1.9852[b]	-0.1166	2.3217	-3.6101	-0.2120
$X_{NS(t-1)}$ Employment in previous year	0.4501[a]	0.4294	2.7819		
Y_{2Nii} Hourly salaries in non-metal (constant dollars)	20.6585[b]	0.5738	1.7640	37.5677	1.0434
Intercept	-35.6128		-0.9232	-64.7623	

R^2 value = 0.9813

Significance Level = 99%

Adjustment Coefficient = 0.5499

F-value of the equation = 249.2553

Durbin Watson Statistic = 2.1370

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

compared to those of the previous two model sets, however, the results are generally comparable.[7]

The procedure of equation testing was similar to that described for the preceding two model sets.

3a. The labor market for salaried employees in the metal mining sector. The complete formulation of this model as tested initially in the regression analysis was:

$$Y_{MSD} = f\,(X_{6M}, X_{5M}, X_3, X_1, X_{MH}, X_{MS(t-1)}, Y_{2Mii})$$

$$Y_{MSS} = f\,(X_{10}, X_{11}, X_{8Maii}, X_{NS}, X_{2Nii}, X_{MS(t-1)}, Y_{2Mii})$$

The final regression results are shown in Table XXIV. The demand equation does not contain an endogenous independent variable and is identical to the corresponding equations determined in Models 1a and 2a. The supply equation is similar to the supply equations as determined in these two models.

3b. The labor market for salaried employees in the non-metal mining sector. The complete formulation of this model as tested initially in the regression analysis was:

$$Y_{NSD} = f\,(X_{6N}, X_{5N}, X_3, X_1, X_{NH}, X_{NS(t-1)}, Y_{2Nii})$$

$$Y_{NSS} = f\,(X_{10}, X_{11}, X_{8Maii}, X_{MS}, X_{2Mii}, X_{NS(t-1)}, Y_{2Nii})$$

---

[7]The demand equations for hourly-paid workers in both the metal and non-metal mining sectors (Models 3c and 3d) are identical to those already discussed and do not include a wage rate variable. Refer to Appendix D for the equations that show the wage rate in the manufacturing sector included.

TABLE XXIV

MODEL 3a

REGRESSION EQUATIONS FOR THE DEMAND FOR AND SUPPLY OF SALARIED WORKERS IN THE METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Salarked Workers in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	14.9707[b]	0.5334	2.3360	37.0562	1.3205
X_3 Capital stock	-0.0015[c]	-0.0096	1.5161	-0.0037	-0.0238
X_{5M} Metal price	16.3895[b]	0.4737	2.5055	40.5661	1.1725
X_{6M} Metal ore mined	0.0004[b]	0.1384	1.9192	0.0010	0.3426
$X_{MS(t-1)}$ Employment in previous year	0.5960[a]	0.5681	3.6782		
X_{8Maii} Salaries in manufacturing	-127.1144[c]		1.3624	-314.6396	1.7337
Intercept	-1.2915		-0.0039	3.1968	

R^2 value = 0.9899 F-value of equation = 276.6475

Significance Level = 99% Durbin Watson Statistic = 2.0975

Adjustment Coefficient = 0.4040

Supply of Salaried Workers in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
$X_{MS(t-1)}$ Employment in previous year	0.4792[b]	0.4569	2.1612		
X_{2Mii} Hourly salaries in metal (constant dollars)	153.5084[b]	0.9962	2.4847	294.7550	1.9128
Intercept	-158.9434		-0.9787	-305.1909	

R^2 value = 0.9827 F-value of equation = 595.3838

Significance Level = 99% Durbin Watson Statistic = 1.5790

Adjustment Coefficient = 0.5208

[a] Significant at the 99 percent level for a one tailed t-test.

[b] Significant at the 95 percent level for a one tailed t-test.

[c] Significant at the 90 percent level for a one tailed t-test.

The regression results are shown in Table XXV. In this model the unemployment rate (X_{11}) is statistically significant, and is included in the final equation. This variable was included in the final salaried worker supply function of Model 1a but was omitted in Model 2b.

3c. The labor market for hourly-paid workers in the metal mining sector. The complete formulation of this model as tested initially in the regression analysis was:

$$Y_{MHD} = f\ (X_{6M}, X_{5M}, X_3, X_1, X_{MS}, X_{MH(t-1)}, Y_{1Mii})$$

$$Y_{MHS} = f\ (X_{10}, X_{11}, X_{7Maii}, X_{NH}, X_{1Nii}, X_{MH(t-1)}, Y_{1Mii})$$

The regression results are shown in Table XXVI. The equations are similar to those discussed earlier. The employment level in the preceding year ($X_{MH(t-1)}$) is not statistically significant at the 90 percent level in the supply equation but it is required that it be left in the regression equation to enable estimation of the adjustment coefficient.

3d. The labor market for hourly-paid workers in the non-metal mining sector. The complete formulation of this model, as tested initially in the regression analysis, was:

$$Y_{NHD} = f\ (X_{6N}, X_{5N}, X_3, X_1, X_{NS}, X_{NH(t-1)}, Y_{1Nii})$$

$$Y_{NHS} = f\ (X_{10}, X_{11}, X_{7Maii}, X_{MH}, X_{1Mii}, X_{NH(t-1)}, Y_{1Nii})$$

The regression results are shown in Table XXVII. The demand function is identical to the corresponding ones in Models 1b and 2b. The supply function has the same variables included and the values of the coefficients are very close to those in the models already discussed.

TABLE XXV

MODEL 3b

REGRESSION EQUATIONS FOR THE DEMAND FOR AND SUPPLY OF SALARIED WORKERS IN THE NON-METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Salaried Workers in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	5.2662[a]	0.8879	3.4549	11.2936	1.9041
X_{NH} Employment of hourly workers non-metal	0.0504[c]	0.2858	1.6773	0.1081	0.6129
$X_{NS(t-1)}$ Employment in previous year	0.5337[a]	0.5092	3.3435		
Y_{2Nii} Hourly salaries in non-metal (constant dollars)	-63.8177[a]	-1.7724	2.9122	-136.8597	-3.8010
Intercept	80.7861[c]		1.5355	173.2492	

R^2 value = 0.9804 F-value of equation = 237.5144

Significance Level = 99% Durbin Watson Statistic = 1.9818

Adjustment Coefficient = 0.4663

Supply of Salaried Workers in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	0.1672[c]	0.5969	1.6683	0.3047	1.0876
X_{12} Unemployment rate	-1.9746[b]	-0.1160	2.3107	-3.5980	-0.2114
$X_{NS(t-1)}$ Employment in previous year	0.4512[a]	0.4306	2.7877		
Y_{2Nii} Hourly salaries in non-metal (constant dollars)	20.4758[b]	0.5687	1.7510	37.3101	1.0363
Intercept	-35.5954		-0.9213	-64.8604	

R^2 value = 0.9813 F-value of equation = 248.7332

Significance Level = 99% Durbin Watson Statistic = 2.1350

Adjustment Coefficient = 0.5488

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

TABLE XXVI

MODEL 3c

REGRESSION EQUATIONS FOR THE DEMAND FOR AND SUPPLY OF HOURLY PAID WORKERS IN THE METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Hourly-Paid Workers in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	-25.6964[c]	-0.1563	1.6071	-163.3592	-0.9936
X_6 Metal ore mined	0.0026[c]	0.1451	1.5665	0.0165	0.9224
$X_{MH(t-1)}$ Employment in previous year	0.8427[a]	0.8344	4.3836		
Intercept	363.3712		0.7327	2310.0521	

R^2 value = 0.6021
Significance Level = 99%
Adjustment Coefficient = 0.1573
F-value of equation = 10.0897
Durbin Watson Statistic = 2.5751

Supply of Hourly-Paid Workers in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{10} Available labor force	-10.1136[a]	-1.3020	3.1848	-12.6105	-1.6234
$X_{MH(t-1)}$ Employment in previous year	0.1980	0.1961	1.2034		
X_{1Mii} Hourly wages in metal (constant dollars)	1262.5842[a]	1.0011	3.1351	1574.2945	1.2483
Intercept	2271.0448[b]		2.0053	2831.7267	

R^2 value = 0.7024
Significance Levels = 99%
Adjustment Coefficient = 0.8020
F-value of equation = 15.7337
Durbin Watson Statistic = 2.0419

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

TABLE XXVII

MODEL 3d

REGRESSION EQUATIONS FOR THE DEMAND FOR AND THE SUPPLY OF HOURLY PAID WORKERS IN THE NON-METAL MINING SECTOR OF THE CANADIAN MINERAL MINING INDUSTRY

Demand for Hourly-Paid Workers in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_1 Trend variable	5.9071[a]	0.1757	3.6236	13.1914	0.3924
X_{SN} Non-metal price (1948 dollars)	74.8241[a]	0.3357	3.1603	167.0927	0.7497
$X_{NH(t-1)}$ Employment in previous year	0.5522[a]	0.5455	3.7040		
Intercept	-23.8843		-0.2866	-53.3370	

R^2 value = 0.7719 F-value of equation = 22.5609

Significance Level = 99% Durbin Watson Statistic = 1.8447

Adjustment Coefficient = 0.4478

Supply of Hourly-Paid Workers in the Non-metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{12} Unemployment rate	-6.9306[b]	-0.0718	1.8236	-18.3010	0.1896
$X_{NH(t-1)}$ Employment in previous year	0.6213[a]	0.6138	3.5962		
X_{1Nii} Hourly wages in non-metal (constant dollars)	65.0745[b]	0.2235	2.4389	171.8365	0.5902
Intercept	98.5963		1.1206	260.3546	

R^2 value = 0.7102 F-value of equation = 16.3350

Significance Level = 99% Durbin Watson Statistic = 1.9146

Adjustment Coefficient = 0.3787

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

CHAPTER VI

ANALYSIS OF RESULTS AND CONCLUSIONS

In this chapter three major topics are covered:

i. Summary of the empirical results.

ii. Policy implications and application of the results.

iii. Further research possibilities.

Analysis of the Empirical Results

A number of major research objectives were specified in Chapter I. Before analyzing the empirical results with respect to the information provided on these major concerns, the discussion is prefaced by some comments about the reliability of the results. The shortcomings of the analysis are discussed in the preceding chapter.

The major cause for reservations about the reliability of the results is the high level of multicollinearity that existed between many of the variables analyzed. The effect of some variables may not have shown in the final results due to multicollinearity, while in fact the variable may be important. The proposals for further research related to this particular problem are discussed later in this chapter.

The results for the three model sets were similar in terms of the variables included in the final equations and the estimated regression coefficients on them. Model set 1 was chosen for detailed discussion of the general results in Chapter V. The following summary of results is taken from that model. The results show:

i. The level of production and/or the mineral price are statistically significant in determining the demand for all categories of worker in all sectors except the demand for salaried workers by the non-metal mining sector. For hourly-paid workers, a one percent change in industry production, in the case of the metal sector, and non-metal price for that sector causes a 0.9 percent and 0.7 percent change respectively in the level of labor demanded. For salaried workers in the metal mining sector, the long-run elasticity of metal price with respect to labor demand is elastic at 1.2. For the level of production the metal price elasticity of demand for salaried workers in the metal sector is 0.3.

ii. The level of capital investment did not prove to be statistically significant in any demand equation probably due to data problems. A cost of real capital experiment is required but not available.

iii. The rate of industry adjustment to changing labor market conditions is derived from the estimated adjustment coefficients.

The adjustment coefficient is derived from the regression coefficient on the lagged dependent variable. It indicates the time period for the labor supply or demand function to adjust completely to a change in the variables. The long-run elasticity of labor demand or supply with respect to a factor is estimated by dividing the regression elasticity for that factor, by the adjustment coefficient. The long-run elasticity indicates the magnitude of the change of sector labor demand or supply in response to a change in the factor.[1]

[1]Refer to discussion in Appendix C.

In all cases except for hourly-paid workers in the metal mining sector, it takes two to three years for labor to adjust completely to changes in labor market conditions. For hourly-paid workers in the metal mining sector it appears to take over six years for the supply function and just over one year for the demand function to respond completely.

iv. The response of the metal mining sector to wages on the level of demand for hourly-paid workers is indicated by the analysis, to take an additional two years over that shown by the adjustment coefficient.[2] The time for the demand for hourly-paid workers in the metal mining sector to respond completely to a change in the wage rate is eight years. The relationship between wages and demand in this case is highly elastic at 3.6. For non-metal hourly-paid workers the time for complete response in the level of labor demanded due to change in the wage rate is approximately four years.

The current year wage or salary proved to be statistically significant in all other cases except for salaried metal demand.[3] The long-run elasticities were less than one in cases except non-metal salaried and metal hourly demand functions and the salaried metal supply function.

v. The interrelationship between mineral sectors and category of worker was not supported by the empirical results.

---

[2]The wage rate lagged two years was statistically significant in the final regression equation.

[3]The salary level in manufacturing two years earlier was statistically significant but some doubt about the validity of including this variable is expressed.

Policy Implications and Application of the Results

Manpower stability is a problem recognized by many industry personnel as a "serious threat to the future viability of mining operations."[4]

It is a complex problem and many factors interact to determine the level of manpower employed. Seasonal variation associated with climatic conditions cause changes in the number of workers employed throughout a year. Worker preference patterns and conditions of employment cause workers to leave the mining industry or be attracted into it are important factors omitted. Industry fluctuations, such as product demand and the value of ore mined, cause variations in labor employed between years and long term trends within the industry, such as increased technology and capitalization, affect the role of labor in the industry and the demand for it are analyzed.

The major value of the results are in:

i. enabling predictions of the length industry labor demand and supply adjustment lags, and

ii. providing a tentative explanation of how patterns affect the Canadian mineral mining industry labor market.

These two applications are of importance in first, obtaining an understanding of the overall functioning and reaction of the Canadian labor market with respect to the mineral mining sector of the economy and secondly in its application to government industry and firm planning. The particular value of the model is in its application to prediction of

---

[4]Mr. Moss in his 1971-72 address to the Canadian Institute of Mining and Metallurgy.

labor requirements and flows into and out of the industry sectors. The application of the model to this latter purpose will enable industry personnel to more accurately forecast future labor requirements and supply in an industry characterized by rapid expansion and considerable variation in labor requirement both seasonally and due to fluctuations in world demand for minerals.[5] The model is of value to government in:

i. providing estimates of the potential employment that the mining sector will require and the time required for adjustments in response to demand changes, as well as,

ii. enabling estimation of future manpower movement to Canadian mining communities and planning of community facilities and roads for northern development given forecasts of exogenous variables.

Further Research Possibilities

A number of research possibilities directly related to this study are suggested.

i. A more thorough examination of the capital-labor relationship could be engaged. The level of capital investment, in its affect on the demand for labor, has been examined in this analysis. There does exist a need to establish the empirical relationships between mining industry capital and labor and the effects of technology and changing factor costs. These factors have been included implicitly in the trend variable, however, inclusion of a capital cost variable or capital-labor

[5] For an analysis of the factors affecting labor mobility on a site basis, refer to J.A. MacMillan et al, Determinants of Labor Turnover in Canadian Mining Communities, report prepared for the University of Manitoba, Centre for Settlement Studies under contract with the Canada Department of Energy, Mines and Resources (Department of Agricultural Economics, University of Manitoba, 1974).

cost ratio and a more accurate proxy variable for technology would be improvements. This possibility is severely limited by the availability of data and was not performed in this analysis for that reason. Alternatively, estimation of sectoral production functions in the mineral mining industry would be of considerable value in enabling planning of future labor requirements for the industry.

ii. The regression results for the influence of the national supply of labor and the level of unemployment in the economy, on the supply of labor to the Canadian mineral mining industry are not consistent with the hypothesized effects.

The wage rate and salary in the manufacturing sector was tested in the supply functions for hourly-paid and salaried workers respectively as representative of the income workers could receive elsewhere. The results did not show these variables to be statistically significant.

Further analysis of the effect of conditions in the national labor market on the supply of workers to the mineral mining industry would be worthwhile. The effect of the wage and salary level in other sectors of the economy, such as forestry, agriculture and construction could be tested.

iii. The models were tested in logarithmic form, but further testing of the variables in alternative forms may result in higher statistical significance on the variables omitted from the final equations and reduce the level of multicollinearity between variables. The specification of variables in first differences may give improved estimates.

The model for salaried workers (Model 1a) was tested in static form and with the trend variable removed, to determine if other variables hypothesized as affecting labor demand and supply in the mineral mining industry showed as being statistically significant. This test did not result in a marked change in the value of coefficients or their statistical significance. However, further testing of these alternatives could give some improvement in the final model estimates.

iv. The wage and salary levels lagged one and two years and the dependent variable lagged one year were tested. Lags on the other variables, may lead to these variables becoming statistically significant.

Other types of studies of the mineral industry based on this type of analysis would be:

i. Analysis on a provincial basis - either in terms of a national model with provincial variables included or separate models for those provinces to be considered.

ii. Consideration of the demand and supply within particular mineral sectors (for example, the asbestos mining industry in Quebec).

iii. Analysis of the fuel mining sector and integration of the three sectors (metal, non-metal and fuel) into a three part model of the form presented here.

The analysis carried out in this study and the refinements and alternative approaches suggested, could also be applied to investigation of the labor market in other sectors of the Canadian economy. Application of the model to the labor markets in the forestry industry, specific sectors of the manufacturing industries and others are possibilities.

BIBLIOGRAPHY

A. BOOKS

Bodkin, R. G. The Wage-Price-Productivity Nexus. University of Pennsylvania Press, 1966.

Branson, W. H. Macroeconomic Theory and Policy. Harper and Row Publishers, 1972.

Fair, R. C. The Short-run Demand for Workers and Hours, Contributions to Economic Analysis. Amsterdam: North-Holland Publishing Company, 1969.

Hicks, J. R. The Theory of Wages. London: MacMillan and Company, Limited, 1935.

Johnston, J. Econometric Methods. 2d ed. New York: McGraw-Hill Book Company, 1972.

Leven, C. L., J.B. Legler, and P. Shapiro. An Analytical Framework for Regional Development Policy. The Regional Science Studies Series, No. 9. The M.I.T. Press, 1970.

Millis, H. A., and R.E. Montgomery. The Economics of Labor. New York: McGraw-Hill Book Company, 1938-1945.

Owen, J. D. The Price of Leisure. Montreal: McGill-Queen's University Press, 1970.

Phelps, E. S. et al. Microeconomic Foundations of Employment and Inflation Theory. New York: W.W. Norton and Company Inc., 1970.

Samuelson, P. A., and A. Scott. Economics. 3d ed. McGraw-Hill Company Limited, 1971.

Scitovsky, T. Welfare and Competition, The Economics of a Fully Employed Economy. Unwin University Books, 1964.

Wonnacott, R. J., and T.H. Wonnacott. Econometrics. New York: John Wiley and Sons, Inc., 1970.

B. GOVERNMENT DOCUMENTS

Canada Yearbook. Ottawa: Information Canada, annual.

Statistics Canada. Earnings and Hours of Work in Manufacturing. Catalogue No. 72-204. Ottawa: Information Canada, annual.

_______. Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926-1960: Methodology. Catalogue No. 13-522. Ottawa: Information Canada.

_______. General Review of the Mineral Industries. Catalogue No. 26-201. Ottawa: Information Canada, annual.

_______. Private and Public Investment in Canada, Outlook and Regional Estimates. Catalogue No. 61-205. Ottawa: Information Canada.

_______. Review of Man-Hours and Hourly Earnings. Catalogue No. 72-202. Ottawa: Information Canada, annual.

C. PERIODICALS

Arrow, K. G., H. B. Chenery, B.S. Minhas, and R.M. Solow. "Capital Labour Substitution and Economic Efficiency," Review of Economics and Statistics, Vol. XLIII, August, 1961.

Bennion, E. G. "The Cowles Commission's Simultaneous-Equation Approach: A Simplified Explanation," Revue of Economics and Statistics, 34: 49-56.

Fisher, I. "Our Unstable Dollar and the So-called Business Cycle," Journal of American Statistical Association, 20:179-202.

Foote, R. J. "A Comparison of Single and Simultaneous Equation Techniques," Journal of Farm Economics, 37:975-990.

Haavelmo, T. "The Statistical Implications of a System of Simultaneous Equations," Econometrica, 11:1-12.

Ireland, N. J., and D.J. Smyth. "The Specification of Short-Run Employment Models," Review of Economic Studies, Vol. 37 (2), No. 110, April, 1970.

Marzouk, M. S. "An Econometric Analysis of the Supply and Marketing of Apples in Nova Scotia," Canadian Journal of Agricultural Economics, Vol. 20, No. 3, November, 1972.

Meyer, J. R., and H.L. Lawrence. "Some Comments on the 'Simultaneous-Equations' Approach," Revue of Economics and Statistics, 36:88-92, 1954.

Nerlove, M. "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations," Journal of Farm Economics, 40:301-311, May, 1958.

_______, and W. Addison. "Statistical Estimation of Long-Run Elasticities of Supply and Demand," Journal of Farm Economics, 40:861-880, November, 1958.

Strand, K., and T. Dernburg. "Cyclical Variation in Civilian Labor Force Participation," Revue of Economics and Statistics, November, 1964.

Swan, N. M. "Differences in the Response of the Demand for Labour to Variations in Output Among Canadian Regions," Canadian Journal of Economics, August, 1972.

Tyrchniewicz, E. W., and G.E. Schuh. "Econometric Analysis of the Agricultural Labour Market," American Journal of Agricultural Economics, Vol. 51, No. 4, November, 1969.

Working, E. "What do Statistical 'Demand Curves' Show?," Quarterly Journal of Economics, 4:212-235.

Yeh, M. H. "The Labour Market with Particular Reference to Canadian Agriculture," Journal of Farm Economics, Vol. 49, No. 5, December, 1967.

________, and Lew-king Li. "Regional Analysis of the Supply and Demand for Farm Labour in Canada," Canadian Journal of Agricultural Economics, 14 (2):15-31, 1966.

D. UNPUBLISHED WORKS

Li, Lew-king. "A Market Structure for Hired and Family Labor in Canadian Agriculture." Unpublished M.Sc. dissertation, University of Manitoba, 1965.

Tyrchniewicz, E. W. "An Econometric Study of Agricultural Labor Market." Unpublished Doctor's dissertation, Purdue University, January, 1967.

E. WORKS IN A SERIES

Dawson, J. Productivity Change in Canadian Mining Industry. Economic Council of Canada Staff Study, No. 30, 1971.

Donner, A. Labor Turnover, Expectations and the Determination of Money Wage Changes in U.S. Manufacturing. Working Paper No. 71-19. Ontario: Department of Economics, McMaster University.

Economic Council of Canada. Patterns of Growth. Seventh Annual Review, September, 1970.

Foote, R. J. Analytical Tools for Studying Demand and Price Structures. Agriculture Handbook No. 146. Washington, D.C.: United States Department of Agriculture.

Friedman, J., and R.J. Foote. Computational Methods for Handling Systems of Simultaneous Equations. Agricultural Handbook 94, U.S. Department of Agriculture.

Hardy, H. M. Seasonal Unemployment in Canada, 1955-1970. Working Paper No. 70-21. Ontario: McMaster University.

Long, C. D. The Labor Force Under Changing Income and Employment. National Bureau of Economic Research General Series No. 65. Princeton: Princeton University Press, 1958.

MacMillan, J.A., J.R. Tulloch, D. O'Brien, and M. Ahmad. Determinants of Labor Turnover in Canadian Mining Communities. Report prepared for the University of Manitoba, Centre for Settlement Studies under contract with the Canada Department of Energy, Mines and Resources. Department of Agricultural Economics, University of Manitoba, 1974.

Nerlove, M. Distributed Lags and Demand Analysis for Agricultural and Other Commodities. Agricultural Handbook 141 (1958), U.S. Department of Agriculture.

Soligo, R. The Short-Run Relationship Between Employment and Output. Yale Economic Essays, VI, spring 1966.

F. OTHER SOURCES

Green, C. "The Impact of Unemployment Insurance on the Unemployment Rate." Paper presented to Canadian Economic Association Meeting, Queen's University, Kingston, Ontario, 1973.

Ketchum, E. J. D. "Short-Run Demand Functions for Employment and Hours in Canadian Manufacturing." Paper presented at the Canadian Economics Association Seventh Annual Meeting, Queen's University, Kingston, Ontario, June, 1973.

Lazar, F. "The Cyclical Variability of Employment in Canada." Paper presented to the Canadian Economic Association Meeting, 1973.

Meltz, N. M. "The Use of Information on Individual Labour Markets in Canada for Purposes of Manpower and Employment Policy." Paper presented to the Canadian Economics Association Seventh Annual Meeting, Queen's University, Kingston, Ontario, 1973.

Montague, J. T., and J. Vanderkamp. "A Study in Labour Market Adjustment." Institute of Industrial Relations, University of British Columbia, 1966.

Paraskevopoulos, C. C. "The Impact of Wage Differentials on Regional Employment: The Case of Canadian Manufacturing Industry." Paper presented to the Canadian Economic Association Seventh Annual Meeting, 1973.

Perkins, B. B. "Projections of Annual Employment in Canadian Agriculture: 1966-71, 1976 and 1981." A report to the Minister of Manpower and Immigration, Department of Agricultural Economics, University of Guelph, 1967.

Tulloch, J. R. "A Framework for Manpower Planning in the Interlake Area of Manitoba." Department of Agricultural Economics, University of Manitoba, 1971.

<u>United Nations Statistical Yearbook</u>. 1971

APPENDIX A

CAPITAL STOCK ESTIMATION PROCEDURE

In estimating the value of capital stock, addition of successive investments is strictly valid only under specific circumstances.[1] The marginal productivity, the expected life and the level of utilization of the capital should all be accounted for in evaluating the capital stock. Complete information on the type of capital, was not available and the refinements in estimation discussed by Leven et al were not possible. Essentially, the method of determination of net capital stock in this study is similar to that used by Statistics Canada[2] except straight line depreciation was assumed over the average economic life of the capital, compared to the once and for all depreciation of the capital at the end of its economic life as assumed by Statistics Canada.

Statistics Canada, Catalogue Number 13-522[3] estimates gross and net fixed capital formation and gross and net stocks of fixed capital for both construction and machinery and equipment in a number of industrial classifications for the years 1926 and 1960. To obtain the gross capital stock flow for the total mining industry in current dollars, with no allowance for capital consumption or depreciation, the gross capital

---

[1]C.L. Leven, J.G. Legler and P. Shaprio, An Analytical Framework for Regional Development Policy, The Regional Science Studies Series No. 9 (The M.I.T. Press, 1970).

[2]Statistics Canada, Catalogue Number 13-522, Fixed Capital Flows and Stocks, Manufacturing, Canada 1926-1960, Methodology, February, 1967.

[3]Ibid.

stocks of: i) machinery and equipment, and ii) construction capital in 1926, as estimated in this catalogue for: (1) non-ferrous metals and electrical apparatus, (2) iron and steel products and (3) non-metalic mineral products and products of petroleum and coal were used. Successive addition of the gross capital formation in each year for each category gave the flow of gross capital stock to 1946.

For the years 1947 to 1962, the gross capital formation for mining, quarrying and oil wells, as recorded in Statistics Canada Catalogue Number 61-205,[4] was used to calculate the gross capital stock for machinery and equipment and construction capital in the total mining industry. Statistics Canada, Catalogue Number 26-201[5] provides data on the value of production by sector for the Canadian mining industry. By assuming that the value of production-capital ratio is the same for the metal and non-metal sector and total mining, it is possible to calculate the gross capital stock of the mineral mining industry for the years 1926 to 1962.

$$G.K.S._S = G.K.S._I \cdot \frac{V_S}{V_I}$$

Where:

$G.K.S._S$ is the gross capital stock for the metal and non-metal sector.

$G.K.S._I$ is the gross capital stock for the total mining industry.

---

[4]Statistics Canada and Department of Trade and Commerce, Catalogue Number 61-205, Private and Public Investment in Canada, Outlook, various issues.

[5]Statistics Canada, Catalogue Number 26-201, General Review of the Mineral Industries, Mines, Quarries and Oil Wells, various issues.

V_S is the value of production of the metal and non-metal sector.

V_I is the value of production of the total mining industry.

The gross capital formation for the mineral-mining sector, each year is the difference between successive gross capital stock values, as calculated by this method.

For the years 1963 to 1966 the gross capital formation of machinery and equipment and construction capital for the mineral-mining sector was obtained directly from Statistics Canada, Catalogue Number 61-205.[6] For the years 1967 to 1973 the gross capital formation data was reported in the same catalogue for the non-metal sector, including capital investment into coal mining. The average investment into the coal mining sector in the last three years for which figures are available (1966 actual, 1967 preliminary actual and 1968 expected) is $0.6 million for construction capital and $1.5 million for machinery and equipment capital. These figures were subtracted from investment into each of the two types of capital, as reported in the catalogue, to obtain estimates of the gross capital formation into the mineral mining industry consistent with the definitions of the mineral mining industry and in this study.

To obtain the net capital stock flow from this gross capital stock flow and formation series in the two types of capital, it was necessary to estimate the series of capital depreciation over the years in each type of capital. It was assumed that the machinery and equipment capital had an expected life of 23 years and that construction capital

[6]Statistics Canada, Catalogue Number 61-205, op. cit.

had an expected life of 43 years.[7] It was assumed that the gross capital stock in machinery and equipment and construction in 1926 (the earliest years for which figures were available) was formed equally in each of the preceding 23 and 43 years respectively. This gave a capital formation series running from 1883 in the case of construction capital and from 1903 for machinery and equipment capital.

Straight line depreciation was assumed; that is, one forty-third of capital formed in any one year was written off in each subsequent year for forty-three years in the case of construction capital and one twenty-third each year for twenty-three years for machinery and equipment capital.

The total depreciation for each category of capital in any one year is given by:

1. $$DMT_{(n)} = \sum_{i=n-1}^{n-24} Dm_{i(n)}$$

$$= \sum_{i=n-1}^{n-24} \frac{1}{23} GKFm_i$$

$$Dm_{i(n)} = \frac{1}{23} (G.K.F.m_i)$$

where $n \leq i + 44$

[7]These are the average of the expected economic lives of machinery and equipment and construction capital in the three industrial divisions considered in Statistics Canada, Catalogue Number 13-522, op. cit.

2. $$DCT_{(n)} = \sum_{i=n}^{n-42} Dc_{i(n)}$$

$$= \sum_{i=n-1}^{n-44} \frac{1}{43} \, G.K.F.c_i$$

$$Dc_{i(n)} = \frac{1}{43} \, (G.K.F.c_i)$$

where $n \leq i + 44$

The total depreciation of all capital in any one year is given by:

$$DST_{(n)} = DMT_{(n)} + DCT_{(n)}$$

Where:

$DMT_{(n)}$ is the depreciation of machinery and equipment capital in year n.

$Dm_{i(n)}$ is the depreciation in year n of machinery and equipment capital formed in year i.

$DCT_{(n)}$ is the depreciation of construction capital in year n.

$Dc_{i(n)}$ is the depreciation in year n of construction capital formed in year i.

$G.K.F.m_i$ is the gross capital formation of machinery capital in year i.

$G.K.F.c_i$ is the gross capital formation of construction capital in year i.

$DST_{(n)}$ is the total depreciation of machinery and equipment and construction capital in year n.

In the mineral-mining industry over the years 1948 to 1973 it was necessary to determine the total depreciation of capital for the series to 1948 and subtract this from the gross capital stock estimate for that year to obtain the net capital stock in 1948. From this, the series of net capital stock from 1948 to 1973 was obtained by subtracting, total depreciation to that year and depreciation in that year, from the gross capital stock figure.

$$NKSs_{(n)} = GKSs_{(n)} - \sum_{j=o}^{n} DST_j$$

Where:

$NKSs_{(n)}$ is the net capital stock in the mineral mining sector in year n.

$GKSs_{(n)}$ is the gross capital stock in the mineral mining sector in year n.

DST_j is the depreciation of machinery and equipment and construction capital in year j, where j is the first year in the series.

Table XXVIII shows the figures used to estimate the net capital stock series for the mineral mining sector shown in Table VII.

TABLE XXVIII

DETERMINATION OF THE NET CAPITAL STOCK IN THE CANADIAN MINERAL MINING INDUSTRY

	GKS_c	GKS_m	GKF_c	GKF_m	$Dc_{i(n)}$	$Dm_{i(n)}$ *	$DCT_{(n)}$	$DMT_{(n)}$ +	$\sum_{j=o}^{n} DCT_j$	$\sum_{j=o}^{n} DMT_j$	$\sum_{j=o}^{n} DST_j$ #	NKS_s	Index of NKS_s
1948	700	771	18	12	1.37	3.22	14.1	23.0	329.9	496.0	825.9	645	100
49	735	796	35	25	0.78	0.52	14.8	23.0	344.7	519.1	863.7	667	103.4
1950	796	839	61	43	0.81	1.09	15.5	23.6	360.1	542.7	902.8	732	113.5
51	882	902	86	63	1.42	1.87	16.8	25.7	376.9	568.4	945.2	839	130.1
52	936	909	54	7	2.00	2.74	18.6	27.6	395.5	596.0	991.5	853	132.3
53	996	911	60	2	1.26	0.30	19.8	27.3	415.3	623.3	1038.6	868	134.6
54	1119	976	123	65	1.40	0.09	21.1	26.9	436.4	650.2	1086.6	1008	156.3
55	1295	1048	176	72	2.86	2.83	23.8	29.2	460.2	679.4	1139.6	1203	186.5
56	1508	1137	213	89	4.09	3.13	27.8	30.7	487.9	710.1	1198.0	1447	224.3
57	1708	1222	200	85	4.95	3.87	32.6	32.5	520.5	742.6	1263.1	1667	258.5
58	1857	1283	149	61	4.65	3.70	37.1	35.3	557.7	777.8	1335.5	1804	279.7
59	2107	1405	250	122	3.47	2.65	40.5	37.5	598.1	815.3	1413.5	2099	325.4
1960	2301	1467	194	62	5.81	5.30	46.2	42.3	644.3	857.6	1501.9	2266	351.3
61	2414	1451	113	-16	4.51	2.70	50.6	43.9	694.9	901.5	1596.3	2269	357.8
62	2535	1486	121	35	2.63	-0.70	53.1	42.6	747.9	944.1	1692.0	2329	361.1
63	2672	1598	137	112.4	2.81	1.52	55.8	43.9	803.7	988.0	1791.7	2478	384.2
64	2856	1736	183.7	137.8	3.19	4.89	58.8	47.7	862.5	1035.7	1898.2	2694	417.7
65	3035	1850	179.5	114	4.27	5.99	63.0	50.2	925.5	1085.9	2011.4	2874	445.6
66	3352	2058	316.6	207.4	4.17	4.96	67.0	52.4	992.5	1138.3	2130.8	3279	508.4
67	3711	2273	358.6	215.2	7.36	9.02	74.3	59.6	1066.8	1197.8	2264.7	3719	576.6
68	4085	2505	374.4	232.1	8.34	9.36	82.5	64.6	1149.3	1262.5	2411.8	4178	647.8
69	4508	2716	422.6	210.6	8.71	10.09	91.1	78.3	1240.4	1340.8	2581.2	4643	719.8
1970	4951	2980	442.9	264.7	9.83	9.16	100.8	88.8	1341.2	1429.6	2770.8	5160	800.0
71	5282	3298	331.1	317.9	10.3	11.51	111.1	97.1	1452.3	1526.7	2979.0	5601	868.4
72	5722	3640	440.1	341.4	7.7	13.82	118.1	110.4	1570.4	1637.1	3207.5	6155	954.3
73	6397	3983	674.8	343.9	10.2	14.84	127.6	124.1	1698.0	1761.2	3459.3	6921	1073.0

*In this case $Dm_{i(n)}$ and $Dc_{i(n)}$ are the respective depreciations in year n of machinery and construction capital, formed in the preceding year. That is i=n-1 in this case.

+$DMT_{(n)}$ and $DCT_{(n)}$ are the respective depreciations in year n of machinery and construction capital.

$\sum_{j=o}^{n} DCT_j$, $\sum_{j=o}^{n} DMT_j$ and $\sum_{j=o}^{n} DST_j$ allow for depreciation of capital from the start by the series (that is year 0).

Source:

Statistics Canada, Catalogue Number 13-522, Fixed Capital Flows and Stocks, Manufacturing, Canada 1926-1960, Methodology, February, 1967.

Statistics Canada, Catalogue Number 26-201, General Review of the Mineral Industries, Mines, Quaries and Oil Wells, various issues.

Statistics Canada and Department of Trade and Commerce, Catalogue Number 61-205, Private and Public Investment in Canada, Outlook, various issues.

APPENDIX B

THE ORIGINALLY PROPOSED MODEL

The original model included fourteen endogenous variables and a series of proposed exogenous variables, as specified in Chapter III.

Endogenous Variables

1	Y_{MHS}	Supply of hourly paid workers to the metal mining industry.
2	Y_{MSS}	Supply of salaried workers to the metal mining industry.
3	Y_{NHS}	Supply of hourly paid workers to the non-metal mining industry.
4	Y_{NSS}	Supply of salaried workers to the non-metal mining industry.
5	Y_{MHD}	Demand for hourly paid workers in the metal mining industry.
6	Y_{MSD}	Demand for salaried workers in the metal mining industry.
7	Y_{NHD}	Demand for hourly paid workers in the non-metal mining industry.
8	Y_{NSD}	Demand for salaried workers in the non-metal mining industry.
9	Y_{MHP}	Price of hourly paid workers in the metal mining industry.
10	Y_{MSP}	Price of salaried workers in the metal mining industry.
11	Y_{NHP}	Price of hourly paid workers in the non-metal mining industry.
12	Y_{NSP}	Price of salaried workers in the non-metal mining industry.
13	Y_{TD}	Total demand for all workers in the mineral mining industry.

14 Y_{TS} Total supply of all workers in the mineral mining industry.

The equation system was a simultaneous equation system describing the demand for and supply of each category of labor in both sectors of the mineral mining industry. The system also included three market clearing identities.

The exogenous variables are not specified in the following equation system. X_{MHD}, X_{MSD}, X_{NHD} and X_{NSD} denote the exogenous variables associated with the respective dependent demand variables. X_{MHS}, X_{MSS}, X_{NHS} and X_{NSS} are exogenous variables associated with the dependent supply variables denoted by the subscript.

Demand for Mineral Mining Industry Labor

1 $Y_{MHD} = f\,(X_{iMHD} \cdot \ldots X_{jMHD}, Y_{MHP}, Y_{MSS}, Y_{NHS}, Y_{NSS})$

2 $Y_{MSD} = f\,(X_{iMSD} \cdot \ldots X_{jMSD}, Y_{MSP}, Y_{MHS}, Y_{NHS}, Y_{NSS})$

3 $Y_{NHD} = f\,(X_{iNHD} \cdot \ldots X_{jNHD}, Y_{NHP}, Y_{MSS}, Y_{MHS}, Y_{NSS})$

4 $Y_{NSD} = f\,(X_{iNSD} \cdot \ldots X_{jNSD}, Y_{NSP}, Y_{MSS}, Y_{NHS}, Y_{NHS})$

Supply of Mineral Mining Industry Labor

5 $Y_{MHS} = f\,(X_{iMHS} \cdot \ldots X_{jMHS}, Y_{MHP}, Y_{MSD}, Y_{NHD}, Y_{NSD})$

6 $Y_{MSS} = f\,(X_{iMSS} \cdot \ldots X_{jMSS}, Y_{MSP}, Y_{MHD}, Y_{NHD}, Y_{NSD})$

7 $Y_{NHS} = f\,(X_{iNHS} \cdot \ldots X_{jNHS}, Y_{NHP}, Y_{MSD}, Y_{MHD}, Y_{NSD})$

8 $Y_{NSS} = f\,(X_{iNSS} \cdot \ldots X_{jNSS}, Y_{NSP}, Y_{MSD}, Y_{MHD}, Y_{NSD})$

Market Clearing Identities

9 $\quad Y_{TD} = Y_{MHD} + Y_{MSD} + Y_{NHD} + Y_{NSD}$

10 $\quad Y_{TS} = Y_{MHS} + Y_{MSS} + Y_{NHS} + Y_{NSS}$

11 $\quad Y_{TD} = Y_{TS}$

There were four demand and four supply functions and three identities, giving a total of eleven equations in the system. The number of endogenous variables was fourteen. For the system to be identified, the first requirement is that the number of equations is as great as the number of endogenous variables. This requirement could not be met under this model specification and this particular formulation was abandoned.

APPENDIX C

INCORPORATION OF DISTRIBUTED LAGS INTO THE MODEL[1]

The long-run is defined conventionally as the period required for complete adjustment of a factor to a change within the economic system of which it is part. The short-run is a period in which only partial adjustment occurs. Determination of the long-run elasticity of demand or supply with respect to a particular factor is relatively straight forward, however, there is a range of short-run elasticities corresponding to the length of each run. As the length of the run increases factors are less and less fixed and the short-run demand or supply curve and elasticity approaches that of the corresponding long-run curve.

Under conditions of certainty[2] the short-run elasticity is always less than or equal to the long-run elasticity. Under conditions of non-static or uncertain expectations two basic problems in analysis are present:

i. expectations are not generally single valued, and

ii. a wide variety of non-quantifiable factors determine the expectations.

---

[1]A review of Marc Nerlove's original paper, Distributed Lags and Demand Analysis for Agricultural and Other Commodities, Agricultural Handbook 141(1958), U.S. Department of Agriculture.

[2]Static expectations exist when people believe that current conditions will persist indefinitely.

Nerlove presents a formulation, based on Hick's definition of elasticity of expectation, that treats expectations as single valued.

$$Z_t^* - Z_{t-1}^* = \beta \ (Z_t - Z_{t-1}^*) \qquad \text{C.1}$$

Where:

Z_t^* and Z_{t-1}^* are the expected "normal" level of the variable at times t and t-1 respectively.

Z_t and Z_{t-1} are the actual level of the variable at times t and t-1 respectively.

β is the elasticity or coefficient of expectations.

This formulation states that in each period, people revise their notion of what is normal in proportion to the difference between what actually happened and what they previously considered as normal. A once and for all change in price will lead to an adjustment of the demand curve, over time, to that of the long-run curve.

Continuous changes in supply[3] or price are shown in Figure 12. The original equilibrium point lies on the long-run demand curve (DD_{LR}) at B (period 1). When the price falls from OA to OC (in period 2) the quantity demanded drops to CD as indicated by the intersection of the supply curve (CD) and the short-run demand curve (DD_{S1}). If no further change in price occurs, the demand will increase in the next period (period 3) to CW as the short-run demand curve approaches that for the long-run and eventually to CX on the long-run demand curve. If price decreases further to OE in period 3, the quantity demanded will not

[3]Nerlove assumes a perfectly elastic supply function to avoid the complications associated with simultaneous determination.

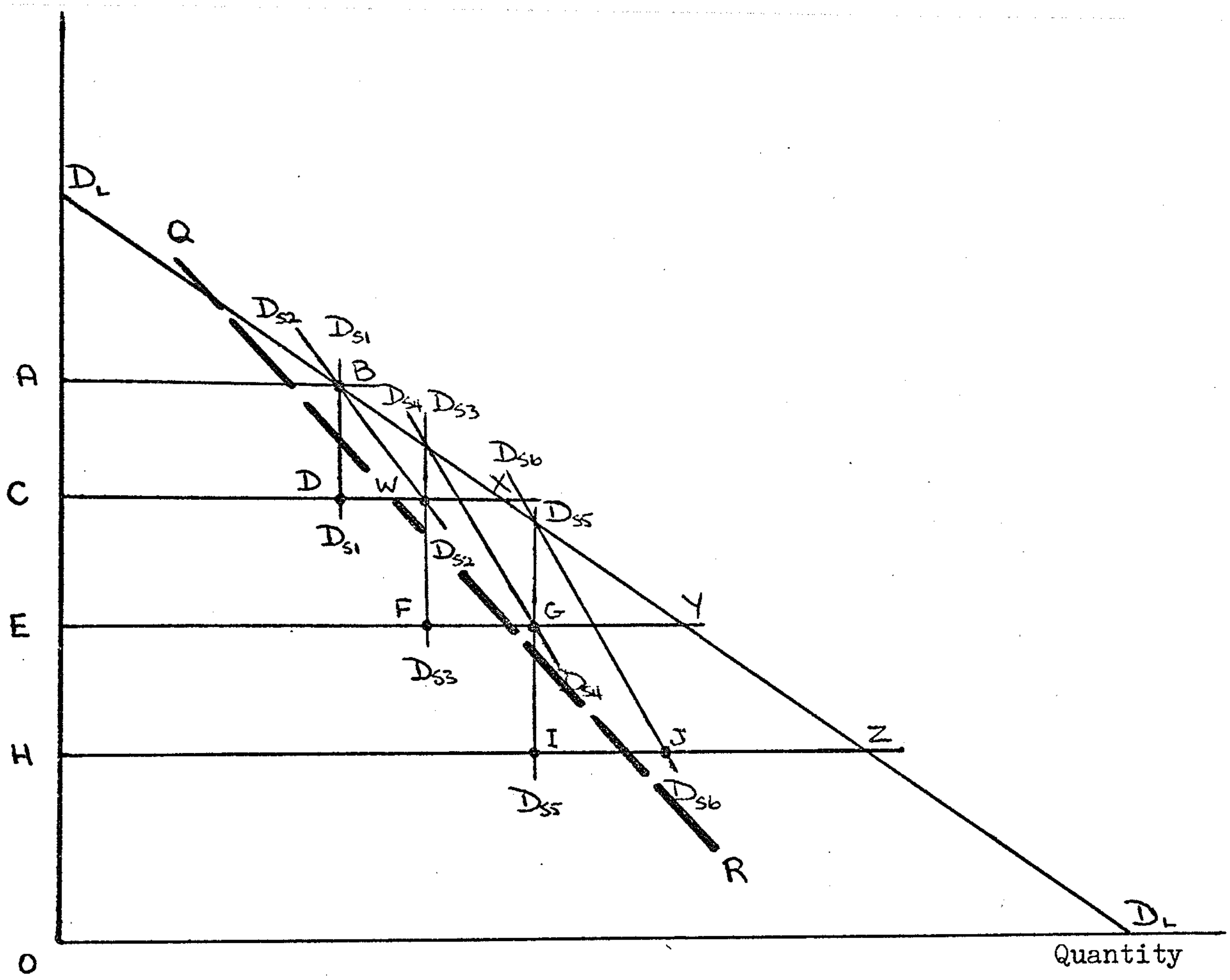

Figure 12. Adjustment of the Quantity Demanded to Successive Changes in Price[4]

change (EF = CW). The short-run equilibrium price and quantity will be designated by the intersection of the supply curve (EY) and the short-run demand curve (DD_{S3}). With no further price change, the quantity demanded would increase towards the long-run equilibrium between the supply curve (EY) and the long-run demand curve; however if a further price decrease occured in period 5, the quantity-price equilibrium would adjust from the intersection of EY and DD_{S4} at G established in period 4

[4]Adapted from Figure 2 of Marc Nerlove, op. cit.

in the way just shown.

Figure 12 shows a series of price decreases. Regression analysis of the price and observed quantities demanded would give the line QR, which is not the demand curve. The position and slope of the derived line is the regression line of the observed points and depends on the sequence of price increases or decreases. The observed points lie along the series of different short-run demand curves associated with new price levels.

Nerlove applies adjustment functions to estimate the long-run demand and supply functions under conditions of static expectation.[5]

He uses an adjustment function of the form similar to that in equation C.2. On the demand side:

$$q_{dt} - q_{d(t-1)} = \gamma (\bar{q}_{dt} - q_{d(t-1)}) \qquad \text{C.2}$$

$$0 < \gamma \leq 1$$

Where $\bar{q}_{dt}$ is the quantity demanded in long-run equilibrium and q_{dt} is the current quantity demanded. γ is the constant of proportionality or the elasticity or coefficient of adjustment, depending on whether the quantity is expressed in logarithms or not.

The current quantity demanded will change in proportion to the difference between the long-run equilibrium quantity and the current quantity.

Let the demand curve be:

---

[5]Nerlove also tested the model under conditions of non-static expectations and reported that little improvement was gained in the parameter estimations and that the introduction of this condition considerably complicates the model.

$$\bar{q}_t = a\,p_t + b\,v_t + c \qquad \text{C.3}$$

Where p_t is the price, v_t is some other variable determining demand and c is a constant.[6] Substitution of equation C.1 into C.2 gives:

$$q_t = a\,\gamma\,p_t + b\,\gamma\,v_t + (1-\gamma)\,q_{t-1} + c\,\gamma \qquad \text{C.4}$$

Equation C.4 is not a demand function but all variables in it are observable, whereas $\bar{q}_t$ in the long-run demand function (equation C.3) is not observable and therefore cannot be regressed.

Similarly on the supply side:

$$q_t - q_{t-1} = \alpha\,(\bar{q}_t - q_{t-1}) \qquad \text{C.5}$$

$$0 < \alpha \leq 1$$

Where $\bar{q}_{st}$ is the quantity supplied in long-run equilibrium and q_{st} is the current quantity supplied. α is the elasticity or coefficient of adjustment.

Let the supply curve be:

$$\bar{q}_{st} = d\,p_t + f\,w_t + g \qquad \text{C.6}$$

Where p_t is the price, w_t is some other variable determining supply and g is a constant.

Substitution of equation C.5 into C.6 gives:

---

[6] Nerlove uses relative price and expresses the variables in logarithmic form.

$$q_{st} = d\,\alpha\, p_t + (1-\alpha)\, q_{s(t-1)} + g\alpha \qquad \text{C.7}$$

All variables in this equation are observable and regression analysis of it is possible.

APPENDIX D

REGRESSION RESULTS FOR COMPLETE MODEL

TABLE XXIX

INITIAL REGRESSION EQUATION FOR THE DEMAND FOR AND SUPPLY OF WORKERS TO THE MINERAL MINING SECTOR-MODEL 1 (HOURLY-PAID AND SALARIED WORKERS IN TWO SEPARATE MODELS)

			Demand Equation							Supply Equation						
			Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary	Labor Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
1a. Salaried	Metal	Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MS(t-1)}$	X_{MH}	Y_{2Mii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Nii}	$X_{MS(t-1)}$	Y_{MS}	Y_{2Mii}
		Regression coefficient	0.0011[a]	15.0541[a]	-0.0015[b]	9.0943[a]	0.7593[a]	0.0164	-167.0637[a]	0.0001	0.0004	0.0226	-0.0193	0.0000	1.0001[a]	-0.0207
		Elasticity	0.3499	0.4351	-0.0094	0.3240	0.7238	0.0963	-1.0841	0.0003	0.0000	0.0006	-0.0005	0.0001	1.0001	-0.0006
		t-value	4.4801	3.0890	1.8096	3.7058	4.7304	0.6596	2.8882	0.0005	0.0004	0.0006	0.0006	0.0002	3.4174	0.0009
		Long-run coefficient	0.0046	62.5430	-0.0062	37.7827		0.0687	-694.0744	0.0001	0.0004	0.0226	0.0193		1.0001	-0.0207
		Long-run elasticity	1.4537	1.8076	-0.0391	1.3461		0.4001	-4.5039	0.0003	0.0000	0.0006	-0.0005		-1.0001	-0.0006
		R^2-value	0.9935							0.9862						
		Regression Intercept	57.6987							0.0088						
		Durbin Watson Statistic	2.7753							2.5830						
		F-value	350.7157							162.8775						
		Long-run Intercept	239.7120							0.0088						
		Adjustment Coefficient	0.2407							1.0000						
	Non-Metal	Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NS(t-1)}$	X_{NH}	Y_{2Nii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Mii}	$X_{NS(t-1)}$	Y_{MS}	Y_{2Nii}
		Regression coefficient	0.0002	0.7993	0.0001	1.0509	0.4411[b]	0.0446	-11.7971	0.1124	-1.9904[b]	2.5205	4.5553	0.3419[c]	0.0509	10.9231
		Elasticity	0.2440	0.0203	0.0034	0.1772	0.4209	0.2526	-0.3276	0.4012	-0.1169	0.0657	0.1399	0.3262	0.2411	0.3034
		t-value	1.2405	0.1117	0.3680	0.3513	2.1289	1.0340	0.2934	0.7203	2.0268	0.0575	0.2083	1.3574	0.6055	0.2913
		Long-run coefficient	0.0004	1.4301	0.0002	1.8803		0.0798	21.1077	0.1708	-3.0245	3.8300	6.9219		0.0773	16.5979
		Long-run elasticity	0.4336	0.0363	0.0061	0.3171		0.4520	-0.5862	0.6096	-0.1776	0.0998	0.2126		0.3664	0.4610
		R^2-value	0.9805							0.9814						
		Regression Intercept	15.5123							-26.7286						
		Durbin Watson Statistic	1.9503							2.1833						
		F-value	114.9989							120.3093						
		Long-run Intercept	27.7550							-40.6148						
		Adjustment Coefficient	0.5589							0.6581						
1b. Hourly	Metal	Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MH(t-1)}$	X_{MS}	Y_{1Mii}	X_{10}	X_{11}	X_{7Maii}	Y_{1Nii}	$X_{MH(t-1)}$	Y_{MH}	Y_{1Mii}
		Regression coefficient	0.0016	6.6682	0.0008	-30.7037	0.7722[a]	1.1005	-47.8314	-3.1943	-2.1456	537.5696	-480.4644	0.5638[a]	0.1977	411.6716
		Elasticity	0.0888	0.0334	0.0009	-0.1867	0.7646	0.1878	-0.0379	-0.4112	-0.0046	0.3538	-0.3374	0.5582	0.0404	0.3264
		t-value	0.6250	0.1543	0.1181	1.3029	3.2846	0.8061	0.1120	0.8093	0.0648	1.0401	0.8992	2.9247	0.1698	0.6960
		Long-run coefficient	0.0070	29.7550	0.0035	-134.7836		4.8310	-209.9710	-7.3250	-4.9188	1232.3925	-1101.4773		0.4532	943.7680
		Long-run elasticity	0.3898	0.1466	0.0040	-0.8196		0.8244	-0.1664	0.9427	-0.0105	0.8111	-0.7735		0.0926	0.7483
		R^2-value	0.6241							0.6575						
		Regression Intercept	306.4223							975.0632						
		Durbin Watson Statistic	2.8067							2.5303						
		F-value	3.7948							4.3886						
		Long-run Intercept	1345.1374							2235.3580						
		Adjustment Coefficient	0.2278							0.4362						
	Non-Metal	Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NH(t-1)}$	X_{NS}	Y_{1Nii}	X_{10}	X_{11}	X_{7Maii}	Y_{1Mii}	$X_{NH(t-1)}$	Y_{MH}	Y_{1Nii}
		Regression coefficient	0.0000	66.3744[b]	-0.0012	1.3566	0.4439[c]	0.2417	77.3089	-2.3158[c]	-20.7991[b]	70.5275	276.6817[c]	0.0821	0.0113	94.2419
		Elasticity	0.0105	0.2978	-0.0623	0.0403	0.4385	0.0426	0.2655	-1.4579	-0.2155	0.2270	1.0728	0.0811	0.0554	0.3237
		t-value	0.0634	2.2211	0.6620	0.1373	1.5957	0.1664	0.4408	1.6487	2.1690	0.4653	1.3483	0.2224	0.1682	0.6511
		Long-run coefficient	0.0000	119.3570	-0.0022	2.4395		0.4346	139.0198	-2.5229	-22.6594	76.8357	301.4290		0.0123	102.6712
		Long-run elasticity	0.0189	0.5355	-0.1120	0.0725		0.0766	0.4774	1.5883	-0.2348	0.2473	1.1688		0.0604	0.3527
		R^2-value	0.7802							0.7775						
		Regression Intercept	-37.4425							383.9757						
		Durbin Watson Statistic	1.9170							1.9953						
		F-value	8.1157							7.9860						
		Long-run Intercept	-67.3305							418.3197						
		Adjustment Coefficient	0.5561							0.9179						

[a] Significant at the 99 percent level for a one tailed t-test.

[b] Significant at the 95 percent level for a one tailed t-test.

[c] Significant at the 90 percent level for a one tailed t-test.

TABLE XXX

INITIAL REGRESSION EQUATION FOR THE DEMAND FOR AND SUPPLY OF WORKERS TO THE MINERAL MINING SECTOR-MODEL 2 (THE METAL AND NON-METAL SECTORS IN TWO SEPARATE MODELS)

2a. Metal — Salaried

Demand Equation	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MS(t-1)}$	Y_{MH}	Y_{2Mii}
Regression coefficient	0.0008[b]	12.7562[b]	-0.0015[c]	7.5386[b]	0.6134[a]	0.0275	-73.9644
Elasticity	0.2684	0.3687	-0.0096	0.2686	0.5840	0.1609	-0.4000
t-value	2.5147	2.0935	1.4676	2.4574	3.0335	0.7986	0.9505
Long-run coefficient	0.0021	32.9959	-0.0039	19.4997		0.0711	-191.3202
Long-run elasticity	0.6943	0.9537	-0.0248	0.6948		0.4162	-1.2416

R^2-value = 0.9899 F-value = 224.0919
Regression Intercept = -56.7921 Long-run Intercept = -146.9014
Durbin Watson Statistic = 2.2859 Adjustment Coefficient = 0.3866

Supply Equation	Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{8Maii}	X_{2Nii}	$X_{MS(t-1)}$	X_{NS}	Y_{2Mii}
Regression coefficient	0.2174	1.6941	-11.9264	41.5405	0.4443[b]	1.4689[c]	20.9109
Elasticity	0.1640	0.0210	-0.0657	0.2438	0.4236	0.3104	0.1357
t-value	0.3543	0.3842	0.1161	0.6633	1.8809	1.7153	0.2418
Long-run coefficient	0.3912	3.0486	-21.4619	74.7535		2.6433	37.6298
Long-run elasticity	0.2951	0.0378	-0.1182	0.4387		0.5586	0.2442

R^2-value = 0.9867 F-value = 169.9214
Regression Intercept = -81.6655 Long-run Intercept = 146.9596
Durbin Watson Statistic = 1.9650 Adjustment Coefficient = 0.5557

2a. Metal — Hourly-Paid

Demand Equation	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MH(t-1)}$	Y_{MS}	Y_{1Mii}
Regression coefficient	0.0025	13.4693	-0.0004	-24.7035	0.8224[a]	0.1412	30.9939
Elasticity	0.1385	0.0664	-0.0004	-0.1502	0.8144	0.0241	0.0246
t-value	0.8640	0.2895	0.0568	0.9625	3.2998	0.0824	0.0704
Long-run coefficient	0.0141	75.8407	-0.0023	-139.0963		0.7950	174.5152
Long-run elasticity	1.7777	0.5646	-0.0034	-1.2772		0.2049	0.2092

R^2-value = 0.6079 F-value = 3.5440
Regression Intercept = 169.9962 Long-run Intercept = 957.1858
Durbin Watson Statistic = 2.6798 Adjustment Coefficient = 0.1776

Supply Equation	Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{7Maii}	X_{1Nii}	$X_{MH(t-1)}$	X_{NH}	Y_{1Mii}
Regression coefficient	-5.0360[c]	-17.6707	591.4087	-380.8973	0.5626[a]	-0.5260	608.2309
Elasticity	-0.6483	-0.0374	0.3892	-0.2675	0.5571	-0.1076	0.4823
t-value	1.4640	0.6123	1.1846	0.8344	3.0595	0.5823	1.0928
Long-run coefficient	-11.5135	-40.3994	1352.1004	-870.8214		-1.2026	1390.5599
Long-run elasticity	1.4822	-0.0855	0.8898	-0.6116		-0.2460	1.1027

R^2-value = 0.6643 F-value = 4.5226
Regression Intercept = 1299.7395 Long-run Intercept = 2971.5123
Durbin Watson Statistic = 2.4977 Adjustment Coefficient = 0.4374

2b. Non-Metal — Salaried

Demand Equation	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NS(t-1)}$	Y_{NH}	Y_{2Nii}
Regression coefficient	0.0002	2.6244	0.0000	1.0888	0.4820[c]	0.0237	-10.3656
Elasticity	0.2295	0.0668	0.0027	0.1836	0.4599	0.1343	-0.2879
t-value	1.4435	0.4038	0.2914	0.5442	2.2495	0.5177	0.4272
Long-run coefficient	0.0004	5.0664	0.0000	2.1019		0.0458	-20.0108
Long-run elasticity	0.4431	0.1290	0.0052	0.3544		0.2593	-0.5558

R^2-value = 0.9797 F-value = 110.3529
Regression Intercept = 15.6498 Long-run Intercept = 30.2119
Durbin Watson Statistic = 1.8795 Adjustment Coefficient = 0.5180

Supply Equation	Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{8Naii}	X_{2Mii}	$X_{NS(t-1)}$	X_{MS}	Y_{2Nii}
Regression coefficient	0.1117	-1.9369[b]	7.5647	6.7606	0.3611[c]	0.0407	5.9048
Elasticity	0.3986	-0.1138	0.1972	0.2076	0.3445	0.1925	0.1640
t-value	0.7380	1.9506	0.2464	0.3825	1.4939	0.6688	0.2643
Long-run coefficient	0.1748	-3.0316	11.8402	10.5816		0.0637	9.2421
Long-run elasticity	0.6239	-0.1781	0.3087	0.3249		0.3013	0.2567

R^2-value = 0.9808 F-value = 116.7460
Regression Intercept = -28.9699 Long-run Intercept = 45.3434
Durbin Watson Statistic = 2.0685 Adjustment Coefficient = 0.6389

2b. Non-Metal — Hourly-Paid

Demand Equation	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NH(t-1)}$	Y_{NS}	Y_{1Nii}
Regression coefficient	0.0008	69.4423[b]	-0.0013	-1.7697	0.5414[b]	-1.5292	156.4708
Elasticity	0.1758	0.3115	-0.0068	-0.0526	0.5348	-0.2697	0.5374
t-value	0.8887	2.3806	0.7527	0.1973	1.8465	0.7778	0.9998
Long-run coefficient	0.0017	151.4224	-0.0028	-3.8589		-3.3345	341.1923
Long-run elasticity	0.3833	0.6792	-0.0148	-0.1147		-0.5881	1.1718

R^2-value = 0.7958 F-value = 8.9078
Regression Intercept = -96.8434 Long-run Intercept = -211.1718
Durbin Watson Statistic = 1.8463 Adjustment Coefficient = 0.4586

Supply Equation	Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{7Naii}	X_{1Mii}	$X_{NH(t-1)}$	X_{MH}	Y_{1Nii}
Regression coefficient	-1.9609[c]	-15.7192[b]	116.4263	157.1542	0.2371	-0.0327	121.3526
Elasticity	-1.2345	-0.1629	0.3747	0.6094	0.2342	-0.1600	0.4168
t-value	1.5686	1.8302	0.8042	0.8846	0.7055	0.5930	0.8050
Long-run coefficient	-2.5703	-20.6045	152.6102	205.9958		-0.0429	159.0675
Long-run elasticity	-1.6182	-0.2135	0.4912	0.7988		-0.2097	0.5457

R^2-value = 0.7715 F-value = 7.7166
Regression Intercept = 387.6885 Long-run Intercept = 508.1773
Durbin Watson Statistic = 1.9165 Adjustment Coefficient = 0.7629

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

TABLE XXXI

INITIAL REGRESSION EQUATION FOR THE DEMAND FOR AND SUPPLY OF WORKERS TO THE MINERAL MINING SECTOR-MODEL 3 (SEPARATE MODELS FOR EACH CATEGORY OF WORKER IN EACH MINING SECTOR)

3a. Salaried Employees in the Metal Mining Sector

Demand Equation

	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MS(t-1)}$	X_{MH}	Y_{2Mii}
Regression coefficient	0.0011	14.8508[b]	-0.0015[c]	8.9575	0.7468[a]	0.0176	-159.3014[c]
Elasticity	0.3434	0.4292	-0.0095	0.3192	0.7120	0.1034	-1.0338
t-value	3.2437	2.5516	1.5925	2.9442	3.4938	0.5806	1.6711
Long-run coefficient	0.0043	58.6524	-0.0059	35.3772		0.0695	-629.1524
Long-run elasticity	1.3502	1.6951	-0.0375	1.2607		0.4084	-4.0829

R^2-value = 0.9916 F-value = 270.2423
Regression Intercept = 47.7494 Long-run Intercept = 188.5837
Durbin Watson Statistic = 2.6346 Adjustment Coefficient = 0.2532

Supply Equation

	Labor Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{8Maii}	X_{2Nii}	$X_{MS(t-1)}$	X_{NS}	Y_{2Mii}
Regression coefficient	0.3691	1.5678	28.4714	18.9055	0.5251[b]	1.5981[b]	-38.3536
Elasticity	0.2784	0.0195	0.1569	0.1110	0.5006	0.3377	-0.2489
t-value	0.5893	0.3563	0.2624	0.2882		1.8545	0.3799
Long-run coefficient	0.7772	3.3013	59.9524	39.8094		3.3651	80.7614
Long-run elasticity	0.5862	0.0411	0.3304	0.2337		0.7111	-0.5241

R^2-value = 0.9868 F-value = 170.8423
Regression Intercept = -54.4369 Long-run Intercept = -114.6281
Durbin Watson Statistic = 2.0348 Adjustment Coefficient = 0.4749

3b. Salaried Employees in the Non-Metal Mining Sector

Demand Equation

	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NS(t-1)}$	X_{NH}	Y_{2Nii}
Regression coefficient	0.0001	-0.9634	0.0001	2.2648	0.4693[b]	0.0526	-28.8492
Elasticity	0.1759	-0.0245	0.0025	0.3818	0.4478	0.2981	-0.8012
t-value	0.8720	0.1336	0.2776	0.7284	2.2785	1.2212	0.6874
Long-run coefficient	0.0002	-1.8153	0.0002	4.2676		0.0991	-54.3607
Long-run elasticity	0.3314	-0.0462	0.0047	0.7194		0.5617	-1.5097

R^2-value = 0.9810 F-value = 117.8160
Regression Intercept = 38.5200 Long-run Intercept = 72.5833
Durbin Watson Statistic = 1.9263 Adjustment Coefficient = 0.5307

Supply Equation

	Labor Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{8Naii}	X_{2Mii}	$X_{NS(t-1)}$	X_{MS}	Y_{2Nii}
Regression coefficient	0.0813	-2.0508	-17.6219	16.1191	0.3160	0.0330	27.6568
Elasticity	0.2903	-0.1205	-0.4594	0.4950	0.3015	0.1562	0.7681
t-value	0.5348	2.0898	0.4302	0.7992	1.3053	0.5480	0.8515
Long-run coefficient	0.1189	-2.9982	-25.7630	23.5659		0.0482	40.4339
Long-run elasticity	0.4244	-0.1762	-0.6716	0.7237		0.2284	1.1230

R^2-value = 0.9815 F-value = 121.5984
Regression Intercept = -31.9689 Long-run Intercept = -46.7381
Durbin Watson Statistic = 2.0918 Adjustment Coefficient = 0.6840

3d. Hourly-Paid Employees in the Non-Metal Mining Sector

Demand Equation

	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6N}	X_{5N}	X_3	X_1	$X_{NH(t-1)}$	X_{NS}	Y_{1Nii}
Regression coefficient	0.0011	-3.9114	-0.0000	-35.4713	0.7507[a]	0.8038	178.7187
Elasticity	0.0630	-0.0193	-0.0000	-0.2157	0.7433	0.1372	0.1417
t-value	0.4354	0.0860	0.0003	1.4708	3.1866	0.5730	0.3580
Long-run coefficient	0.0044	-15.6895	-0.0000	-142.2836		3.2230	716.8821
Long-run elasticity	0.2527	-0.0774	-0.0000	-0.8652		0.5503	0.5684

R^2-value = 0.6268 F-value = 3.8387
Regression Intercept = 307.8882 Long-run Intercept = 1233.0108
Durbin Watson Statistic = 2.7199 Adjustment Coefficient = 0.2493

Supply Equation

	Labor Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{7Naii}	X_{1Mii}	$X_{NH(t-1)}$	X_{MH}	Y_{1Nii}
Regression coefficient	-0.3858[a]	-55.4570[b]	282.3617	-511.3047	0.6003[a]	-1.3786[c]	1627.2454[a]
Elasticity	-1.2083	-0.1175	0.1858	-0.3591	0.5945	-0.2819	1.2903
t-value	2.8680	2.0053	0.6456	1.3079	3.8241	1.6802	2.7829
Long-run coefficient	-23.4821	-138.7481	706.4341	-1279.2212		-3.4491	4071.1669
Long-run elasticity	3.0230	-0.2940	0.4648	-0.8984		-0.7053	3.2282

R^2-value = 0.7569 F-value = 7.1164
Regression Intercept = 1842.3534 Long-run Intercept = 4609.3405
Durbin Watson Statistic = 2.4941 Adjustment Coefficient = 0.3997

3c. Hourly-Paid Employees in the Metal Mining Sector

Demand Equation

	Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours Employed in (t-1)	Man-hours of Other Worker	Wage Rate or Salary
Variable notation	X_{6M}	X_{5M}	X_3	X_1	$X_{MH(t-1)}$	X_{MS}	Y_{1Mii}
Regression coefficient	0.0004	49.2678[b]	-0.0022	-12.8016	0.1639	0.0055	360.3143[b]
Elasticity	0.0874	0.2210	-0.0117	-0.3807	0.1817	0.0010	1.2375
t-value	0.5709	1.7741	1.3324	1.2481	0.6850	0.0042	1.9184
Long-run coefficient	0.0005	60.3698	-0.0027	-15.6863		0.0067	441.5075
Long-run elasticity	0.1071	0.2708	-0.0143	-0.4665		0.0012	1.5164

R^2-value = 0.8192 F-value = 10.3546
Regression Intercept = -141.3314 Long-run Intercept = -173.1790
Durbin Watson Statistic = 1.7301 Adjustment Coefficient = 0.8161

Supply Equation

	Labor Force Available	Unemployment Rate	Wage Rate or Salary in Manufacturing	Wage Rate or Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Wage Rate or Salary
Variable notation	X_{10}	X_{11}	X_{7Maii}	X_{1Nii}	$X_{MH(t-1)}$	X_{NH}	Y_{1Mii}
Regression coefficient	-2.5406[b]	-19.5494[b]	47.7208	193.8300	0.0848	-0.0357	237.4412[c]
Elasticity	-1.5994	-0.2025	0.1536	0:7516	0.0838	-0.1744	0.8155
t-value	2.0237	2.2747	0.3274	1.1312	0.2518	0.6768	1.5569
Long-run coefficient	-2.7760	-21.3608	52.1425	211.7898		-0.0390	259.4419
Long-run elasticity	1.7476	-0.2213	0.1678	0.8212		-0.1906	0.8911

R^2-value = 0.7918 F-value = 8.6945
Regression Intercept = 492.6500 Long-run Intercept = 538.2976
Durbin Watson Statistic = 1.9078 Adjustment Coefficient = 0.9152

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

APPENDIX E

REGRESSION EQUATIONS FOR THE DEMAND FOR HOURLY PAID WORKERS IN THE CANADIAN MINERAL MINING INDUSTRY- WAGE RATE VARIABLE INCLUDED

TABLE XXXII

REGRESSION EQUATIONS FOR THE DEMAND FOR HOURLY-PAID WORKERS IN THE CANADIAN MINERAL MINING INDUSTRY - WAGE RATE VARIABLE INCLUDED

Demand for Hourly-Paid Workers in the Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{6M} Metal ore mined	0.0011[d]	0.0624	1.0889	0.0034	0.1938
$X_{MH(t-1)}$ Employment in previous year	0.6780[a]	0.6713	4.9148		
$X_{1Mii(t-2)}$ Hourly wage in metal (constant dollars) two years previously	253.3812[d]	1.1640	1.1640	-786.8981	3.6149
Intercept	935.9222[b]		1.9940	2906.5907	

R^2 value = 0.5793 — F-value of equation = 9.1784

Significance Level = 99% — Durbin-Watson Statistic = 2.4434

Adjustment Coefficient = 0.3220

Demand for Hourly-Paid Workers in the Non-Metal Mining Sector	Regression Coefficient	Elasticity	t-value	Long-run Coefficient	Long-run Elasticity
X_{6N} Non-metal ore mined	0.0004[c]	0.1049	1.5414	0.0017	0.4364
$X_{NH(t-1)}$ Employment in previous year	0.7596[a]	0.7503	4.7272		
$X_{(t-2)}$ Hourly wage in non-metal (constant dollars) two years previously	-53.9581[d]	-0.1968	0.9926	-224.4513	-0.8186
Intercept	143.6022[d]		1.2418	597.3469	

R^2 value = 0.6842 — F-value of equation = 14.4433

Significance Level = 99% — Durbin Watson Statistic = 1.8558

Adjustment Coefficient = 0.2404

[a]Significant at the 99 percent level for a one tailed t-test.

[b]Significant at the 95 percent level for a one tailed t-test.

[c]Significant at the 90 percent level for a one tailed t-test.

[d]Significant at the 80 percent level for a one tailed t-test.

APPENDIX F

REGRESSION RESULTS FOR THE COMPLETE MODEL 1a - STATIC FORM (LAGGED DEPENDENT VARIABLE REMOVED)

TABLE XXXIII

INITIAL REGRESSION EQUATIONS FOR THE DEMAND AND SUPPLY OF SALARIED WORKERS TO THE MINERAL MINING SECTOR (MODEL 1a)–STATIC MODEL, LAGGED DEPENDENT VARIABLE REMOVED

		Demand Equation						Supply Equation					
		Quantity of Ore Mined	Price of Ore	Total Capital Stock	Trend Variable	Man-hours of Other Worker	Salary	Labor Force Available	Unemployment Rate	Salary in Manufacturing	Salary in Other Mineral Sector	Man-hours Employed in Other Sector	Salary
Metal	Variable notation	X_{6M}	X_{5M}	X_3	X_1	X_{MH}	Y_{2Mii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Nii}	Y_{NS}	Y_{2Mii}
	Regression coefficient	0.0011	12.6291	-0.0008	13.0971	0.0542	-47.5516	0.3555	7.2209	-173.9457	177.8525	3.113	30.9610
	Elasticity	0.3662	0.3650	-0.0050	0.4667	0.3177	-0.3086	0.2681	0.0896	-0.9584	1.0439	0.6575	0.2009
	t-value	3.1085	1.7611	0.6517	3.6254	1.5666	0.6547	0.5758	1.4021	1.0570	1.3061	2.1483	0.3517
	R^2-value = 0.9848			F-value = 184.0459				R^2-value = 0.9875				F-value = 224.2634	
	Regression Intercept = -70.8643							Regression Intercept = -105.8587					
	Durbin Watson Statistic = 1.6891							Durbin Watson Statistic = 1.7292					
Non-Metal	Variable notation	X_{6N}	X_{5N}	X_3	X_1	X_{NH}	Y_{2Nii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Mii}	Y_{NS}	Y_{2Nii}
	Regression coefficient	0.0003	4.2103	0.0001	0.0081	0.0671	11.6026	0.0502	-2.5211	-4.0305	16.4400	0.1114	14.9738
	Elasticity	0.4496	0.1071	0.0020	0.0014	0.3806	0.3222	0.1791	-0.1481	-0.1051	0.5048	0.5274	0.4159
	t-value	2.3727	0.5447	0.1923	0.0024	1.4309	0.2653	0.2939	2.6410	0.0841	0.7167	1.4812	0.3726
	R^2-value = 0.9749			F-value = 109.9978				R^2-value = 0.9779				F-value = 125.5127	
	Regression Intercept = -19.4848							Regression Intercept = -27.7302					
	Durbin Watson Statistic = [illegible].7963							Durbin Watson Statistic = 1.8264					

APPENDIX G

REGRESSION RESULTS FOR THE COMPLETE MODEL 1a -
TREND VARIABLE REMOVED

TABLE XXXIV

INITIAL REGRESSION EQUATIONS FOR THE DEMAND AND SUPPLY OF SALARIED WORKERS TO THE MINERAL MINING SECTOR (MODEL 1a)-TREND VARIABLE REMOVED

		Demand Equation						Supply Equation						
		Quantity of Ore Mined	Price of Ore	Total Capital Stock	Man-hours Employed in (t-1)	Man-hours of Other Worker	Salary	Labor Force Available	Unemployment Rate	Salary in Manufacturing	Salary in Other Mineral Sector	Man-hours Employed in (t-1)	Man-hours Employed in Other Sector	Salary
Metal	Variable notation	X_{6M}	X_{5M}	X_3	$X_{MS(t-1)}$	X_{MH}	Y_{2Mii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Nii}	$X_{MS(t-1)}$	Y_{NS}	Y_{2Mii}
	Regression coefficient	0.0010	6.3982	-0.0015	0.8907	0.0468	-76.9514	0.1120	5.3879	-49.4015	57.5354	0.4714	3.0859	-61.6379
	Elasticity	0.3149	0.1849	-0.0096	0.8492	0.2741	-0.4994	0.0845	0.0669	-0.2722	0.3377	0.4494	0.6522	-0.4000
	t-value	3.0646	1.1286	1.3948	4.3020	1.5005	1.1025	0.2112	1.2500	0.2885	0.3935	2.0867	2.6706	0.6461
	Long-run coefficient	0.0091	58.5380	0.0137	8.1491	0.4282	-704.0384	0.2119	10.1928	-93.4572	108.8449	0.8918	5.8379	-116.6059
	Long-run elasticity	2.8811	1.6917	0.0878	7.7694	2.5078	-4.5691	0.1599	0.1266	-0.5149	0.6389	0.8502	1.2338	-0.7567
	R^2-value = 0.9879				F-value = 231.9055			R^2-value = 0.9909				F-value = 248.5493		
	Regression Intercept = -40.0315				Long-run Intercept = 366.2534			Regression Intercept = 28.6030				Long-run Intercept = 54.1109		
	Durbin Watson Statistic = 2.3219				Adjustment Coefficient = 0.1093			Durbin Watson Statistic = 2.2016				Adjustment Coefficient = 0.5286		
Non-Metal	Variable notation	X_{6N}	X_{5N}	X_3	$X_{NS(t-1)}$	X_{NH}	Y_{2Nii}	X_{10}	X_{11}	X_{8Maii}	Y_{2Mii}	$X_{NS(t-1)}$	Y_{MS}	Y_{2Nii}
	Regression coefficient	0.0002	1.1438	0.0002	0.4376	0.0418	0.0900	-0.0001	0.0047	-0.2613	0.0760	0.0017	0.9996	0.1708
	Elasticity	0.3059	0.0291	0.0047	0.4175	0.2368	0.0025	-0.0001	0.0001	-0.0014	0.0005	0.0003	0.9996	0.0010
	t-value	3.2544	0.1773	0.5450	2.2091	1.0538	0.0077	0.0002	0.0020	0.0023	0.0014	0.0027	4.9133	0.0018
	Long-run coefficient	0.0004	2.0338	0.0004	0.7781	0.0743	0.1600	-0.0001	0.0047	-0.2617	0.0761	0.0017	1.0013	0.1711
	Long-run elasticity	0.5439	0.0517	0.0084	0.7424	0.4211	0.0044	-0.0001	-0.0001	-0.0014	0.0005	0.0003	1.0013	0.0010
	R^2-value = 0.9803				F-value = 141.2472			R^2-value = 0.9954				F-value = 499.2651		
	Regression Intercept = 0.2668				Long-run Intercept = 0.4744			Regression Intercept = 0.0011				Long-run Intercept = 0.0011		
	Durbin Watson Statistic = 2.0091				Adjustment Coefficient = 0.5624			Durbin Watson Statistic = 2.6581				Adjustment Coefficient = 0.9983		

APPENDIX H

SIMPLE CORRELATION MATRIX OF REGRESSED VARIABLES

TABLE XXXV

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN SALARIED LABOR IN THE METAL MINING SECTOR DEMAND EQUATION

	Man-hours Employed Y_{MS}	Quantity of Ore Mined X_{6M}	Price of Ore X_{5M}	Capital Stock X_3	Trend X_1	Man-hours Employed in (t-1) $X_{MS(t-1)}$	Man-hours of Other Worker X_{MH}	Wages or Salary Y_{2Mii}
Y_{MS}	1.000							
X_{6M}	0.975	1.000						
X_{5M}	-0.939	-0.953	1.000					
X_3	0.225	0.198	-0.190	1.000				
X_1	0.985	0.966	-0.958	0.251	1.000			
$X_{MS(t-1)}$	0.989	0.967	-0.946	0.274	0.984	1.000		
X_{MH}	0.250	0.127	-0.153	0.270	0.239	0.242	1.000	
Y_{2Mii}	0.978	0.982	-0.945	0.240	0.980	0.985	0.163	1.000

TABLE XXXVI

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN SALARIED LABOR IN THE NON-METAL MINING SECTOR DEMAND EQUATION

	Man-hours Employed Y_{NS}	Quantity of Ore Mined X_{6N}	Price of Ore X_{5N}	Capital Stock X_3	Trend X_1	Man-hours Employed in (t-1) $X_{NS(t-1)}$	Man-hours of Other Worker X_{NH}	Wages or Salary Y_{2Nii}
Y_{NS}	1.000							
X_{6N}	0.979	1.000						
X_{5N}	-0.801	-0.846	1.000					
X_3	0.184	0.195	-0.289	1.000				
X_1	0.967	0.977	-0.886	0.251	1.000			
$X_{NS(t-1)}$	0.983	0.970	-0.800	0.160	0.966	1.000		
X_{NH}	0.662	0.576	-0.271	-0.053	0.582	0.676	1.000	
Y_{2Nii}	0.941	0.947	-0.887	0.246	0.987	0.950	0.590	1.000

TABLE XXXVII

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN HOURLY-PAID LABOR IN THE METAL MINING SECTOR DEMAND EQUATION

	Man-hours Employed Y_{MH}	Quantity of Ore Mined X_{6M}	Price of Ore X_{5M}	Capital Stock X_3	Trend X_1	Man-hours Employed in (t-1) $X_{MH(t-1)}$	Man-hours of Other Worker X_{MS}	Wages or Salary Y_{1Mii}
Y_{MH}	1.000							
X_{6M}	0.127	1.000						
X_{5M}	-0.153	-0.953	1.000					
X_3	0.270	0.198	-0.190	1.000				
X_1	0.239	0.966	-0.958	0.251	1.000			
$X_{MH(t-1)}$	0.742	0.191	-0.283	0.356	0.388	1.000		
X_{MS}	0.250	0.975	-0.939	0.225	0.985	0.347	1.000	
Y_{1Mii}	0.258	0.966	-0.920	0.274	0.980	0.364	0.987	1.000

TABLE XXXVIII

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN HOURLY-PAID LABOR IN THE NON-METAL MINING SECTOR DEMAND EQUATION

	Man-hours Employed Y_{NH}	Quantity of Ore Mined X_{6N}	Price of Ore X_{5N}	Capital Stock X_3	Trend X_1	Man-hours Employed in (t-1) $X_{NH(t-1)}$	Man-hours of Other Worker X_{NS}	Wages or Salary Y_{1Nii}
Y_{NH}	1.000							
X_{6N}	0.575	1.000						
X_{5N}	-0.271	-0.846	1.000					
X_3	-0.053	0.195	-0.289	1.000				
X_1	0.582	0.977	-0.886	0.251	1.000			
$X_{NH(t-1)}$	0.789	0.491	-0.326	-0.028	0.535	1.000		
X_{NS}	0.662	0.979	-0.801	0.184	0.967	0.609	1.000	
Y_{1Nii}	0.654	0.951	-0.840	0.266	0.985	0.626	0.963	1.000

TABLE XXXIX

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN SALARIED LABOR IN THE METAL MINING SECTOR SUPPLY EQUATION

	Man-hours Employed Y_{MS}	Unemployment Rate X_{11}	Wages or Salaries in Manufacturing X_{8Maii}	Wages or Salaries in Other Sector Y_{2Nii}	Man-hours Employed in (t-1) $X_{MS(t-1)}$	Labor Force Available X_{10}	Man-hours Employed in Other Sector Y_{NS}	Wages or Salary Y_{2Mii}
Y_{MS}	1.000							
X_{11}	0.594	1.000						
X_{8Maii}	0.978	0.682	1.000					
Y_{2Nii}	0.970	0.678	0.988	1.000				
$X_{MS(t-1)}$	0.989	0.620	0.980	0.970	1.000			
X_{10}	0.981	0.527	0.965	0.953	0.979	1.000		
Y_{NS}	0.977	0.482	0.953	0.941	0.965	0.980	1.000	
Y_{2Mii}	0.978	0.586	0.977	0.983	0.985	0.983	0.972	1.000

TABLE XL

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN SALARIED LABOR IN THE NON-METAL MINING SECTOR SUPPLY EQUATION

	Man-hours Employed Y_{NS}	Unemployment Rate X_{11}	Wages or Salaries in Manufacturing X_{8Maii}	Wages or Salaries in Other Sector Y_{2Mii}	Man-hours Employed in (t-1) $X_{NS(t-1)}$	Labor Force Available X_{10}	Man-hours Employed in Other Sector Y_{MS}	Wages or Salary Y_{2Nii}
Y_{NS}	1.000							
X_{11}	0.482	1.000						
X_{8Maii}	0.953	0.682	1.000					
Y_{2Mii}	0.972	0.661	0.977	1.000				
$X_{NS(t-1)}$	0.983	0.525	0.959	0.976	1.000			
X_{10}	0.980	0.527	0.965	0.983	0.975	1.000		
Y_{MS}	0.978	0.594	0.978	0.978	0.983	0.981	1.000	
Y_{2Nii}	0.941	0.678	0.988	0.957	0.950	0.953	0.970	1.000

TABLE XLI

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN HOURLY-PAID LABOR IN THE METAL MINING SECTOR SUPPLY EQUATION

	Man-hours Employed Y_{MH}	Unemployment Rate X_{11}	Wages or Salaries in Manufacturing X_{7Maii}	Wages or Salaries in Other Sector Y_{1Nii}	Man-hours Employed in (t-1) $X_{MH(t-1)}$	Labor Force Available X_{10}	Man-hours Employed in Other Sector Y_{NH}	Wages or Salary Y_{1Mii}
Y_{MH}	1.000							
X_{11}	0.239	1.000						
X_{7Maii}	0.251	0.615	1.000					
Y_{1Nii}	0.259	0.646	0.983	1.000				
$X_{MH(t-1)}$	0.742	0.670	0.345	0.407	1.000			
X_{10}	0.104	0.527	0.964	0.963	0.238	1.000		
Y_{NH}	0.167	0.187	0.668	0.654	0.182	0.587	1.000	
Y_{1Mii}	0.258	0.661	0.984	0.985	0.364	0.970	0.641	1.000

TABLE XLII

SIMPLE CORRELATION COEFFICIENT MATRIX FOR VARIABLES IN HOURLY-PAID LABOR IN THE NON-METAL MINING SECTOR SUPPLY EQUATION

	Man-hours Employed Y_{NH}	Unemployment Rate X_{11}	Wages or Salaries in Manufacturing X_{7Maii}	Wages or Salaries in Other Sector Y_{1Mii}	Man-hours Employed in (t-1) $X_{NH(t-1)}$	Labor Force Available X_{10}	Man-hours Employed in Other Sector Y_{MH}	Wages or Salary Y_{1Nii}
Y_{NH}	1.000							
X_{11}	0.582	1.000						
X_{7Maii}	0.668	0.615	1.000					
Y_{1Mii}	0.641	0.661	0.984	1.000				
$X_{NH(t-1)}$	0.789	0.292	0.609	0.624	1.000			
X_{10}	0.587	0.527	0.964	0.970	0.513	1.000		
Y_{MH}	0.167	0.533	0.251	0.258	0.340	0.104	1.000	
Y_{1Nii}	0.654	0.646	0.983	0.985	0.626	0.963	0.259	1.000