THE UNIVERSITY OF MANITOBA

AN ECONOMETRIC ANALYSIS OF THE CANADIAN AGRICULTURAL LABOUR MARKET WITH SPECIFIC REFERENCE TO THE PRAIRIE REGION

BY

WAYNE DOUGLAS JONES

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

AND FARM MANAGEMENT

WINNIPEG, MANITOBA

MAY, 1978

AN ECONOMETRIC ANALYSIS OF THE CANADIAN AGRICULTURAL LABOUR MARKET WITH SPECIFIC REFERENCE TO THE PRAIRIE REGION

BY

WAYNE DOUGLAS JONES

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

ABSTRACT

AN ECONOMETRIC ANALYSIS OF THE CANADIAN AGRICULTURAL LABOUR MARKET WITH SPECIFIC REFERENCE TO THE PRAIRIE REGION

Wayne Douglas Jones

Major Advisor: Dr. E.W. Tyrchniewicz

The agricultural labour force declined by 713 thousand persons (60 percent) during the 1946 to 1974 period. This continual depletion of the agricultural labour force has led to a nation-wide shortage of qualified farm labour in recent years. Several reports have indicated that the lack of farm labour adversely affects the ability of Canadian agriculture to expand and develop. In view of possible world food shortages, the value of agriculture to the Canadian economy and the number of farm families affected, the problem of labour shortages restricting farm growth has become an important issue. The present study provides quantitative information about the market structure for farm labour in an attempt to aid policy-makers in the identification of specific economic problems, the selection of short-run and long-run solutions, the evaluation of existing policies and programs and the forecasting of future conditions.

The specific objectives of this study were: (1) to develop statistical estimates of the demand for and supply of hired, unpaid family and operator labour in agriculture for the Prairie provinces, the Prairie region and Canada as a whole; (2) to analyze the interrelations among the three components of the agricultural labour force; (3) to obtain short-run and long-run elasticities of demand and supply for each agricultural labour

component; (4) to examine the agricultural wage and employment characteristics of the Prairie region in light of the statistical results of this study; and (5) to derive some policy implications.

An economic model was developed from theories of demand for a factor of production, supply of labour to an industry, technological change, labour component interdependencies, secular influences in the labour force and lagged response to economic stimuli. Use of a Nerlove-type distributed lag model made it possible to separate short-run and long-run elasticities as well as to measure the demand and supply response lags. The procedure used to estimate the demand and supply relations was the Two-Stage Least Squares econometric technique, developed by Theil and Basmann. At the national level time series data from 1947 to 1973 were used. For the regional and provincial (Alberta, Saskatchewan, Manitoba) models time series data only from 1954 to 1973 were used due to the difficulty of obtaining some data.

One finding of this study was that disaggregation to the provincial level was useful. There was enough statistically significant evidence to indicate substantial differences among the agricultural labour markets of the three Prairie provinces. At the same time, however, it was shown that provincial time series data are not presently adequate for further studies in this area.

Experimentation on the interdependencies among the three components of the agricultural labour force lent support to the hypothesis of substitution between hired labour and unpaid family labour. Unpaid family labour and operator labour appeared to be complementary components.

These relationships generally held true in both the demand and supply equations. Hired labour and operator labour did not exhibit a consistent interdependent relationship.

The distributed lag hypothesis met with only partial statistical success which made it difficult to evaluate the findings. Although not conclusive, the results of this study suggest the supply of farm labour is more responsive to economic stimuli than the demand for farm labour. There was evidence that the demand for and supply of operator labour was less responsive to changes in economic conditions compared with the hired or unpaid family labour components. In addition, there was some indication that lagged responses were similar among the three Prairie provinces.

The predictive power of the model was tested by comparing a forecast for 1974 agricultural employment with actual employment levels. The equations were able to predict the trend reversal in agricultural employment which occurred in that year. Employment estimates were generally within ten percent of the reported level of employment.

The study concludes with a discussion on policy implications in the light of information obtained with respect to elasticities, component substitution and lagged responses.

ACKNOWLEDGEMENTS

I wish to express my gratitude to everyone who helped in the completion of this study. The following people are especially deserving of my sincere appreciation.

Dr. E.W. Tyrchniewicz, my major advisor, for his continuous guidance. His substantial knowledge of the subject and conscientious approach to research made a significant contribution to this study.

Dr. J.A. MacMillan and Dr. B. Tangri, the other members of the advisory committee, for their numerous suggestions and comments on the thesis.

The staff and students at the University of Manitoba for the many thought-provoking discussion experienced and constructive criticisms received.

And finally, a special acknowledgement is due to my wife, Kathy, for the excellent typing job and for the encouragement and understanding she provided all through graduate school.

TABLE OF CONTENTS

		Page
ABSTRACT		i
ACKNOWLEDGEMENTS		iv
LIST OF TABLES		ix
CHAPTER		
I	INTRODUCTION	1
	STATEMENT OF THE PROBLEM	1
	PRIOR CONTRIBUTIONS TO THE ECONOMETRIC STRUCTURE OF THE AGRICULTURAL LABOUR MARKET	4
	OBJECTIVES OF THIS STUDY	5
	PROCEDURE	6
	POLICY IMPLICATIONS	7
	ORGANIZATION OF THIS STUDY	8
II	BACKGROUND ANALYSIS	9
	OVERVIEW OF THE AGRICULTURAL LABOUR FORCE	9
	Agricultural Employment	9
	Economic Issues	23
	Government Involvement	28
	ANALYSIS OF AGRICULTURAL EMPLOYMENT IN THE PRAIRIE REGION	35
	REVIEW OF FARM LABOUR EMPLOYMENT IN 1975 AND 1976	39
III	THE CONCEPTUAL FRAMEWORK	41
	THE ECONOMIC THEORY	41
	The Demand for Labour	41

CHAPTER Page

Technological Change..... 45

The Supply of Labour..... 47

Labour Component Interdependencies..... 50

Secular Influences in the Labour Force..... 51

Lagged Response to Economic Stimuli..... 52

THE ECONOMIC MODEL..... 54

The Market for Hired Labour in Agriculture..... 54

Demand..... 54

Supply..... 56

The Market for Operator Labour in Agriculture..... 59

Demand..... 61

Supply..... 62

The Market for Unpaid Family Labour in Agriculture..... 63

Demand..... 64

Supply..... 65

IV THE EMPIRICAL FRAMEWORK..... 67

THE STATISTICAL MODELS..... 67

The Market for Hired Labour in Agriculture..... 69

Demand..... 69

Supply..... 69

The Market for Operator Labour in Agriculture..... 70

Demand..... 70

Supply..... 70

CHAPTER Page

The Market for Unpaid Family Labour in Agriculture..... 71

Demand..... 71

Supply..... 72

THE ESTIMATION PROCEDURE..... 72

The Calculation of Short-run and Long-run Elasticities..... 74

DATA PROBLEMS..... 77

Farm Employment..... 77

Farm Wages..... 78

Real Farm Prices..... 80

Agricultural Productivity..... 80

Nonfarm Wage Rate..... 81

V STATISTICAL RESULTS..... 83

PROCEDURE FOR MODEL EVALUATION..... 83

SUMMARY OF PRELIMINARY EXPERIMENTS..... 86

Hired Labour Market..... 88

Operator Labour Market..... 90

Unpaid Family Labour Market..... 93

RESULTS FROM MODEL IV..... 95

National Model..... 98

Regional Model..... 107

Provincial Models..... 110

MULTICOLLINEARITY PROBLEMS..... 120

UNDERIDENTIFICATION PROBLEMS..... 122

COMPARISON WITH AN EARLIER STUDY..... 123

CHAPTER Page

VI SUMMARY AND IMPLICATIONS..... 128

SUMMARY OF THE STUDY..... 128

THE PREDICTIVE POWER OF THE MODEL..... 132

POLICY IMPLICATIONS..... 137

SUGGESTIONS FOR FURTHER RESEARCH..... 141

BIBLIOGRAPHY..... 144

APPENDICES..... 151

APPENDIX A: REVIEW OF LITERATURE..... 152

APPENDIX B: DATA SERIES USED IN ESTIMATION..... 164

APPENDIX C: RESULTS FROM THE THEORETICAL MODEL..... 180

The Market for Hired Labour in Agriculture..... 180

Demand..... 180

Supply..... 187

The Market for Operator Labour in Agriculture..... 190

Demand..... 190

Supply..... 197

The Market for Unpaid Family Labour..... 199

Demand..... 199

Supply..... 206

APPENDIX D: SIMPLE CORRELATION COEFFICIENT MATRICES..... 209

LIST OF TABLES

Table		Page
2.1	Employment in Agriculture; Canada and Regions, 1954-1974	10
2.2	Annual Absolute Changes in Agricultural Employment; Canada and Regions, 1954-1974	12
2.3	Annual Percent Changes in Agricultural Employment; Canada and Regions, 1954-1974	13
2.4	Agricultural Employment as a Percentage of Total Employment (All Industries); Canada and Regions, 1954-1974	14
2.5	Employment in Agriculture by Class of Worker; Canada, 1954-1974	16
2.6	Absolute Changes in Employment in Agriculture by Class of Worker; Canada, 1954-1974	17
2.7	Percent Changes in Employment in Agriculture by Class of Worker; Canada, 1954-1974	19
2.8	Monthly Employment in Agriculture; Canada and Regions, 1974	20
2.9	Monthly Employment in Agriculture by Class of Worker, Canada, 1974	22
2.10	Agricultural Price and Productivity Indices, Canada, for Selected Years, 1961-1974	24
2.11	Estimates of Average Wage Rates in Agriculture and Major Industries; Canada, for Selected Years, 1961-1974	25
2.12	Labour Standards; Legislative Coverage, by Province, of Agricultural Workers, June 1974	29
2.13	Employees Supplied to Canadian Agriculture by Various Government Programs; Canada, 1974	32
2.14	Summary of Full-Time Agricultural Courses, Canada and the Prairie Provinces, for Selected Years, 1969-70, 1970-71, 1971-72, 1972-73, 1973-74, and 1974-75	34

Table		Page
2.15	Farms Reporting Paid Labour by Size of Farm; Prairie Region, 1971	36
2.16	Farm Enterprise Specialization; Prairie Region, 1971	37
5.1	Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Canada	99
5.2	Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Canada	100
5.3	Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Prairie Region	108
5.4	Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Prairie Region	109
5.5	Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Alberta	112
5.6	Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Alberta	113
5.7	Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Saskatchewan	114
5.8	Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Saskatchewan	115
5.9	Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Manitoba	116
5.10	Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Manitoba	117
5.11	Comparison of Short-Run Elasticities and Adjustment Mechanism from Both Studies	124

Table		Page
6.1	Comparison of Data for National Farm Labour Model IV--1973 and 1974	134
6.2	Actual and Predicted Levels of Price, Demand and Supply for Each Farm Labour Component--Canada, 1974	136
B.1	Data Series Used in Estimation of National Models	165
B.2	Data Series Used in Estimation of Prairie Region Models	168
B.3	Data Series Used in Estimation of Models for Alberta	172
B.4	Data Series Used in Estimation of Models for Saskatchewan	176
B.5	Data Series Used in Estimation of Models for Manitoba	178
C.1	Estimates of Structural Demand and Supply Relationships for Hired Labour--Canada, 1947-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	181
C.2	Estimates of Structural Demand and Supply Relationships for Hired Labour--Prairie Region 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	182
C.3	Estimates of Structural Demand and Supply Relationships for Hired Labour--Alberta 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	183
C.4	Estimates of Structural Demand and Supply Relationships for Hired Labour--Saskatchewan 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	184
C.5	Estimates of Structural Demand and Supply Relationships for Hired Labour--Manitoba 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	185
C.6	Estimates of Structural Demand and Supply Relationships for Operator Labour--Canada, 1947-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV	191

Table Page

C.7 Estimates of Structural Demand and Supply Relationships for Operator Labour--Prairie Region 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 192

C.8 Estimates of Structural Demand and Supply Relationships for Operator Labour--Alberta 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 193

C.9 Estimates of Structural Demand and Supply Relationships for Operator Labour--Saskatchewan 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 194

C.10 Estimates of Structural Demand and Supply Relationships for Operator Labour--Manitoba 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 195

C.11 Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--Canada, 1947-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 200

C.12 Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--Prairie Region 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 201

C.13 Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--Alberta 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 202

C.14 Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--Saskatchewan 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 203

C.15 Estimates of Demand and Supply Relationships for Unpaid Family Labour--Manitoba 1954-73, Regression Coefficients and Standard Errors, Static and Dynamic Models, Model IV..... 204

D. 1 Simple Correlation Coefficient Matrix for Variables in Canada Demand and Supply Equations..... 210

D.2 Simple Correlation Coefficient Matrix for Variables in Prairie Region Demand and Supply Equations..... 211

Table Page

D.3 Simple Correlation Coefficient Matrix for Variables in Alberta Demand and Supply Equations..... 212

D.4 Simple Correlation Coefficient Matrix for Variables in Saskatchewan Demand and Supply Equations..... 213

D.5 Simple Correlation Coefficient Matrix for Variables in Manitoba Demand and Supply Equations..... 214

CHAPTER I

INTRODUCTION

Canadian agriculture has been characterized by rapid technological advancement, heavy capital investment and increasing farm size during the post-war period. The concomitant increase in the level of farm output exceeded the demand of both domestic and foreign markets thereby causing the price of agricultural products to fall in relation to other product prices and farm input prices. As a result, farm incomes and wages paid to hired farm labour have lagged behind the wages and salaries available off the farm. Moreover, Canada's post-war economic expansion created many new nonfarm employment opportunities with working conditions and fringe benefits considered preferable by the majority of the civilian labour force. The agricultural labour force consequently declined by 713 thousand persons (60.1 percent) from 1946 to 1974 as workers sought employment in industry.[1]

STATEMENT OF THE PROBLEM

The industrial boom and resultant off-farm migration were beneficial to both agriculture and industry at first because it gave persons, unable to make a living on farms, the opportunity to leave agriculture while providing the labour needed for industrial growth.

---

[1]The estimate of decline in agricultural employment was calculated using data for 1946 and 1974 from Statistics Canada, The Labour Force, Catalogue No. 71-001 monthly, Ottawa; Information Canada.

However, this continual depletion of the agricultural labour force has led to a nation-wide shortage of qualified farm labour in recent years. In addition, the complexity of farming associated with modern mechanization has altered the types of farm labour required. Agriculture must now compete directly with other sectors of the economy for highly skilled labour.

Several recent reports have indicated that the lack of skilled labour adversely affects the ability of Canadian agriculture to expand and develop.[2] In view of possible world food shortages, the value of agriculture to the Canadian economy ($3.8 billion worth of exports in 1974),[3] and the number of farms involved (300,118 farms in 1976),[4] the problem of labour shortages restricting farm growth has become an important issue.

The Prairie region, with over half of Canada's net farm income and most of Canada's agricultural exports, faces perhaps the most acute shortage of farm labour. Prairie farms commonly utilize complicated and expensive equipment which require skillful operation and maintenance.

---

[2]See for example, Canadian Federation of Agriculture, "Farm Labour Problems," Project No. 412010, a paper presented at the Canadian Federation of Agriculture - Dairy Farmers of Canada Seminar, Ottawa, February, 1974, section 2; National Working Group on Agricultural Manpower, "Report of the National Working Group on Agricultural Manpower," Ottawa, January, 1974, pp. 1-3; and S.H. Lane and D.R. Campbell, Farm Labour in Ontario, Ontario Agricultural College; Department of Agricultural Economics, 1954, pp. 5-8.

[3]Agriculture Canada, Selected Agricultural Statistics For Canada, Ottawa; Economics Branch Publication, June, 1975, p. 123.

[4]Statistics Canada, 1976 Census of Canada, Catalogue 96-857 (SA-7), Ottawa; Information Canada, April, 1977, Table 1.

The declining rural population has reduced the amount of local labour while the flow of immigrants from Europe, once a good supply of farm labour, has almost stopped. Today, immigrants looking for agricultural employment come from places such as the Caribbean and are unable to operate typical prairie farm equipment. The low rate of unemployment in Saskatchewan combined with low farm wages reduce the chance of farm operators finding workers. The northern oil wells in Alberta and the hydro construction projects in Manitoba hire a large number of workers in the summer, who might otherwise have offered their services to farmers, by offering wages the farmers cannot match.

All levels of government have attempted to solve the problem with a wide range of policies and programs. Changes in the labour legislation applying to agriculture, the new Canada Farm Labour Pool system, increased involvement in foreign worker programs, and the promotion of agricultural training courses are a few examples of the attempt to promote the supply of qualified farm labour required for agricultural production.[5] However, due to a lack of knowledge concerning the structure of the farm labour market these policies and programs may not be the most efficient method of solving the farm labour problem. Although several descriptive studies[6]

---

[5]For a brief description of government involvement in the agricultural manpower problem in Canada see, R.S. Rust and P.M. Stone, "Agricultural Manpower," Canadian Farm Economics, Vol. 10, No. 1, 1975, pp. 9-10.

[6]See for example, A.B. Andarawewa, The Structure of the Canadian Agricultural Labour Force, Agriculture Canada, Ottawa; Economics Branch Publication, April, 1970; and A. Foster and B. Proud, "Report on Wages and Hours of Work in Canadian Agriculture," a research report prepared for the International Labour Organization, Ottawa, September, 1970.

have reported the problem areas and possible solutions, additional quantitative knowledge of the factors determining the demand for and supply of farm labour would be of value to policy-makers in the identification of specific economic problems, the selection of short-run and long-run solutions, the evaluation of existing policies and programs, and in the forecasting of future conditions.

PRIOR CONTRIBUTIONS TO THE ECONOMETRIC STRUCTURE OF THE AGRICULTURAL LABOUR MARKET[7]

Econometrics employs mathematics and statistics to study economic conditions. When economic theory is expressed in mathematical language, statistical methods can be applied to measure the stated relationships and to test hypotheses.[8] A review of two econometric studies of agricultural labour markets illustrates the progress made in this area to date.

A study published by Yeh and Li[9] in 1966 examined the markets for hired and family farm labour by region and for Canada as a whole. It was postulated that farm labour demanded was dependent on the farm wage rate, the relative profitability of farming, the availability of labour substitutes, and the level of technology. On the supply side, the farm

---

[7]See Appendix A, Review of Literature, for a review of studies of the agricultural labour market that are not econometric in nature.

[8]For an introduction to econometric analysis see, M.H. Yeh, Application of Simple and Multiple Regression Analysis to Economic Problems, Technical Bulletin No. 4, University of Manitoba; Department of Agricultural Economics and Farm Management, June, 1962.

[9]M.H. Yeh and L.K. Li, "A Regional Analysis of the Supply and Demand of Farm Labour in Canada," Canadian Journal of Agricultural Economics, Vol. 14, No. 2, 1966, pp. 15-31.

wage rate, the nonfarm wage rate adjusted by the rate of unemployment, and the level of technology were used as explanatory variables. Both demand and supply equations included a lagged dependent variable to account for the lag in response to economic stimuli.

In general, the empirical results were difficult to interpret due to lack of statistical significance, with the hired labour market posing the most problems. The study's main contribution was the provision of empirical evidence identifying the existence of demand and supply adjustment lags and regional variation in the Canadian farm labour market.

In a later U.S. study, Tyrchniewicz and Schuh[10] extended previous work on agricultural labour markets by analyzing farm operator and unpaid family labour separately. They also measured the degree of substitution among farm operator, unpaid family and hired farm labour components. Considerable experimentation produced favourable results with most coefficients statistically significant and having the *a priori* expected sign. The study supported their hypothesis that three individual agricultural labour markets exist which exhibit a certain degree of interaction.

OBJECTIVES OF THIS STUDY

The general objective of this study is to provide information about the market structure for hired, unpaid family and operator labour

---

[10] E.W. Tyrchniewicz and G.E. Schuh, "Econometric Analysis of the Agricultural Labour Market," *American Journal of Agricultural Economics*, Vol. 15, No. 4, 1969, pp. 770-787.

at the provincial, regional, and national level with a view to pointing out policy implications for solving some agricultural labour problems.

The specific objectives of this study are as follows:

1. To develop statistical estimates of the demand for and supply of hired, unpaid family and operator labour in agriculture for the Prairie provinces, the Prairie region and Canada as a whole.

2. To analyze the inter-relations among the three components of the agricultural labour force.

3. To obtain short-run and long-run elasticities of demand and supply for each agricultural labour component.

4. To examine the agricultural wage and employment characteristics of the Prairie region in light of the statistical results of this study.

5. To derive some policy implications.

PROCEDURE

To accomplish the above objectives separate models will be developed for the hired, unpaid family and operator labour markets. Estimation will be by the two-stage least squares technique using time series data from 1954-1973. Each structural equation will be in the form of a Nerlove-type distributed lag model in order to characterize the lagged response to economic stimuli resulting from psychological, technological, and institutional factors.[11] This type of model also allows one to isolate and estimate short-run and long-run elasticities.

Estimates of the structural equations will be obtained for Canada and the Prairie region as well as for each Prairie province because of

---

[11] An early discussion of these factors was presented by, , M. Nerlove, "Distributed Lags and Estimates of Long-Run Supply and Demand Elasticities: Theoretical Considerations," Journal of Farm Economics, Vol. 40, No. 3, 1958, pp. 301-311.

three considerations. First, the data employed in this study become less reliable, in statistical terms, as the level of disaggregation increases. Comparison of the provincial, regional and national levels may indicate specific data problems that would otherwise go unnoticed. Secondly, differences in the provincial, regional and national agricultural labour markets can be identified. Finally, the development of regional and national models allows the comparison of the present study to previous Canadian econometric studies, none of which extended their analysis to the provincial level.

POLICY IMPLICATIONS

The empirical findings of the present research could provide certain implications for policy. Some illustrations follow:

1. Considerable controversy exists over whether or not minimum wage laws should be applied to agriculture. Policy-makers are unsure as to what effect such a move would have on the demand for and supply of hired farm labour. The impact could range from no effect to large increases in supply and/or large decreases in demand depending on the price elasticities of hired farm labour demand and supply. With the results from this study the feasibility of extending the minimum wage laws to agriculture could be examined.

2. Assuming the short-run demand and supply curves prove to be inelastic, programs that shift either curve will have a major impact on the price of labour and a minor impact on the quantity of labour demanded or supplied. Conversely, if long-run demand and supply elasticities are greater than one, a shift in either curve would have a major impact on the level of employment and a minor impact on the wage rate. Empirical findings of this nature can be used to evaluate the short-run and long-run implications of various programs in order to determine the expected equilibrium condition resulting from the implementation of a program or set of programs and, therefore, which programs to implement to achieve a specific set of objectives.

3. If the study results show the demand for hired labour is negatively influenced by the supply of unpaid family labour and it is known that unpaid family labour is continuously declining; an increase in the demand for hired labour could occur. Recognition of the magnitude of this substitution effect may indicate a need for policies aimed at keeping more of the farm population on the farm in an attempt to reduce the demand for hired labour.

4. Measurement of the lagged response to economic stimuli by components of the farm labour force may also be important in policy development. If the study shows the supply of operator labour is slow to respond to economic stimuli, this fact should be considered when defining policy goals and when evaluating program performance. For example, if it takes three years for the supply of operator labour to fully change in response to a particular program both the predetermined goals and any annual program appraisal must take account of this time lag.

ORGANIZATION OF THIS STUDY

Chapter II provides a background for this analysis by supplying information concerning the agricultural labour force of Canada in general and of the Prairie region in particular. Chapter III covers the theoretical models used as a conceptual framework for the study while the methodology or statistical models employed are presented in Chapter IV. Chapter V presents the statistical results. The economic interpretation of these results and conclusions follow in Chapter VI. Supplementary material pertaining to the study is contained in the Appendices.

CHAPTER II

BACKGROUND ANALYSIS

In Chapter I the problems confronting the Canadian agricultural labour market were briefly introduced. The object of this chapter is to provide the reader with a basic knowledge of the farm labour force and related economic issues in order that the results and interpretations, presented later, may be better understood.

OVERVIEW OF THE AGRICULTURAL LABOUR FORCE

This section describes the recent changes and current situations with respect to the farm labour force under the headings of: (1) Agricultural Employment, (2) Economic Issues, and (3) Government Involvement.

Agricultural Employment

In recent decades, employment on Canadian farms has been declining both in absoluté terms and as a proportion of the total labour force, although in 1974 farm employment increased slightly over the previous year.[1] Table 2.1 presents estimates of employment in agriculture. The Prairie region has always been the biggest employer of farm labour in Canada and accounted for just less than 50 percent of total agricultural

[1]Estimates of change in farm employment from 1973 to 1974, for both Canada and the regions, were calculated using data for 1973 and 1974 from Statistics Canada, The Labour Force, Catalogue No. 71-001 monthly, Ottawa; Information Canada. The size of the change falls within the bounds of statistical error present in Statistics Canada's labour force survey and therefore may or may not represent actual changes.

TABLE 2.1

Employment in Agriculture;
Canada and Regions, 1954-1974

Year	Canada[a]	Atlantic	Quebec	Ontario	Prairies	British Columbia
			Estimates In Thousands			
1954	878	50	214	253	388	23
1955	819	49	172	236	331	31
1956	777	49	165	214	324	26
1957	748	53	171	193	308	23
1958	718	55	162	177	300	24
1959	700	56	155	177	289	24
1960	683	55	135	179	285	30
1961	681	55	138	162	299	27
1962	660	44	132	158	299	27
1963	649	34	124	172	300	18
1964	630	38	114	160	296	22
1965	594	34	116	151	271	22
1966	544	32	106	140	240	25
1967	559	29	114	147	243	25
1968	546	26	121	143	229	26
1969	535	26	107	136	243	23
1970	511	26	105	132	226	23
1971	510	23	98	134	231	25
1972	481	19	97	117	226	22
1973	467	20	88	122	216	21
1974	473	22	85	120	226	20

[a] The regional estimates may not sum to the national total due to rounding.

Source: Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1974.

employment in 1974. British Columbia maintained an almost constant level of farm employment between 1954 and 1974 while farm employment in the other regions declined considerably. Table 2.2 indicates that the annual change in agricultural employment, in absolute terms, varied among regions from an average decline of six thousand persons in Quebec and the Prairie region to zero in British Columbia. For Canada as a whole, agricultural employment declined by 18 thousand persons annually, on average.

Table 2.3 shows the annual percent change in agricultural employment. Although there were large differences for individual years, the average percent change was relatively constant between the regions with the exception of British Columbia which had the only positive average value. From this table it can be seen that the almost consistent annual decline in farm employment present at the national level is not representative of the situation at the regional level. Regionally, there tends to be cyclical changes in the rate of change in farm employment which is characterized by short periods of decline in agricultural employment followed by short periods of increase. The size of the year-to-year percent change in agricultural employment varies dramatically in all regions.

Table 2.4 presents agricultural employment as a percent of total employment. From 16.7 percent of total employment in 1954, agricultural employment dropped to 5.2 percent in 1974. In the Prairie region, agriculture remains a significant sector of the economy in terms of employment with over 15 percent of the working force employed in agriculture in 1974. In the other regions, agricultural employment is of far less importance with 3.5 percent or less of total employment in any given region being agricultural.

TABLE 2.2

Annual Absolute Changes in Agricultural Employment; Canada and Regions, 1954-1974

Year	Canada[a]	Atlantic	Quebec	Ontario	Prairies	British Columbia
			Absolute Changes In Thousands			
1953-54	20	-6	11	33	-20	2
1954-55	-59	-1	-42	-17	-7	8
1955-56	-42	0	-7	-22	-7	-5
1956-57	-29	4	6	-21	-16	-3
1957-58	-30	2	-9	-16	-8	1
1958-59	-18	1	-7	0	-11	0
1959-60	-17	-1	-20	2	-4	6
1960-61	-2	0	3	-17	14	-3
1961-62	-21	-11	-6	-4	0	0
1962-63	-11	-10	-8	14	1	-9
1963-64	-19	4	-10	-12	-4	4
1964-65	-36	-4	2	-9	-25	0
1965-66	-50	-2	-10	-11	-31	3
1966-67	15	-3	8	7	3	0
1967-68	-13	-3	7	-4	-14	1
1968-69	-11	0	-14	-7	14	-3
1969-70	-24	0	-2	-4	-17	0
1970-71	-1	-3	-7	2	5	2
1971-72	-29	-4	-1	-17	-5	-3
1972-73	-14	1	-9	5	-10	-1
1973-74	6	2	-3	-2	10	-1
Average	-18	-2	-6	-5	-6	0

[a] Regional changes may not sum to total due to rounding of Table 2.1 estimates.

Source: Computed from Table 2.1.

TABLE 2.3

Annual Percent Changes in Agricultural Employment; Canada and Regions, 1954-1974

Year	Canada[a]	Atlantic	Quebec	Ontario	Prairies	British Columbia
			Percentage Changes			
1953-54	2.3	-10.7	5.4	15.0	-5.6	9.5
1954-55	-6.7	-2.0	-19.6	-6.7	-2.1	34.8
1955-56	-5.1	0.0	-4.1	-9.3	-2.1	-16.1
1956-57	-3.7	8.2	3.6	-9.8	-4.9	-11.5
1957-58	-4.0	3.8	-5.3	-8.3	-2.6	4.3
1958-59	-2.5	1.8	-4.3	0.0	-3.7	0.0
1959-60	-2.4	-1.8	-12.9	1.1	-1.4	25.0
1960-61	-0.3	0.0	2.2	-9.5	4.9	-10.0
1961-62	-3.1	-20.0	-4.3	-2.5	0.0	0.0
1962-63	-1.7	-22.7	-6.1	8.9	0.3	-33.3
1963-64	-2.9	11.8	-8.1	-7.0	-1.3	22.2
1964-65	-5.7	-10.5	1.8	-5.6	-8.4	0.0
1965-66	-8.4	-5.9	-8.6	-7.3	-11.4	13.6
1966-67	2.8	-9.4	7.5	5.0	1.2	0.0
1967-68	-2.3	-10.3	6.1	-2.7	-5.8	4.0
1968-69	-2.0	0.0	-11.6	-4.9	6.1	-11.5
1969-70	-4.5	0.0	-1.9	-2.9	-7.0	0.0
1970-71	-0.2	-11.5	-6.7	1.5	2.2	8.7
1971-72	-5.7	-17.4	-1.0	-12.7	-2.2	-12.0
1972-73	-2.9	5.3	-9.3	4.3	-4.4	-4.5
1973-74	1.3	10.0	-3.4	-1.6	4.6	-4.8
Average	-2.7	-3.9	-3.8	-2.6	-2.1	0.9

[a] Regional changes may not sum to total due to rounding of Table 2.1 estimates.

Source: Computed from Table 2.1.

TABLE 2.4

Agricultural Employment as a Percentage of Total Employment (All industries); Canada and Regions, 1954-1974

Year	Canada	Atlantic	Quebec	Ontario	Prairies	British Columbia
			Percentages			
1954	16.7	10.7	14.6	13.0	36.5	5.3
1955	15.3	10.3	11.5	11.8	35.3	6.7
1956	13.9	10.0	10.7	10.2	33.2	5.3
1957	13.1	10.8	10.9	8.9	31.0	4.5
1958	12.6	11.7	10.2	8.3	29.6	4.8
1959	11.9	11.6	9.6	8.1	27.6	4.6
1960	11.5	11.2	8.2	8.0	26.7	5.8
1961	11.2	10.8	8.4	7.1	27.2	5.1
1962	10.6	8.5	7.7	6.8	26.5	4.9
1963	10.2	6.5	7.0	7.2	26.4	3.2
1964	9.5	7.0	6.2	6.5	25.5	3.6
1965	8.7	6.0	6.1	5.9	22.7	3.4
1966	7.6	5.5	5.3	5.3	19.6	3.7
1967	7.6	4.9	5.5	5.4	19.6	3.5
1968	7.2	4.4	5.8	5.1	17.9	3.5
1969	6.9	4.3	5.0	4.6	18.5	2.9
1970	6.5	4.3	4.9	4.4	17.1	2.8
1971	6.3	3.7	4.5	4.4	17.3	3.0
1972	5.8	3.0	4.4	3.6	16.5	2.5
1973	5.3	3.0	3.7	3.6	15.1	2.2
1974	5.2	3.1	3.5	3.4	15.1	2.0

Source: Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1974.

Further insight can be gained on the farm labour market by examining the three labour components; farm operator labour, unpaid family labour, and hired farm labour, separately. Operator labour refers to self-employed farm operators who may or may not employ hired labour on their farms. Unpaid family labour are members of the operator's family who work on the farm without receiving a wage. A member of the family who works on the farm and receives a wage is classified as a hired worker. Hired farm labourers, then, are persons paid wages for agricultural employment including all seasonal or temporary employees as well as permanent staff.

Table 2.5 indicates that over half of total farm employment consists of farm operators. The remainder is fairly evenly split between unpaid family and hired labour. In 1954, there were an estimated 64 thousand more unpaid family workers than hired workers but by 1974 there was only a four thousand person difference. Assuming the current trend continues, hired workers will soon outnumber the unpaid family workers for the first time. The annual absolute change in employment by component is presented in Table 2.6. The overall average for the 1954-1974 period was an annual decline in the number employed of 18 thousand. However, the rate of change by component varied dramatically. During the same period, operator labour declined by 13 thousand persons annually while unpaid family labour declined by four thousand. The number of hired farm workers declined by an average of only one thousand persons annually. Consequently, hired labour employment has remained relatively constant compared to the other components and has become of increased importance in total farm employment.

TABLE 2.5

Employment in Agriculture by Class of Worker; Canada, 1954-1974

Year	Total	Operator Labour	Unpaid Family Labour	Hired Labour
		Estimates In Thousands		
1954	878	569	184	120
1955	819	500	170	106
1956	777	512	160	101
1957	748	498	152	96
1958	718	469	147	97
1959	700	451	133	109
1960	683	442	126	111
1961	681	432	131	111
1962	660	409	136	108
1963	649	401	140	101
1964	630	397	134	99
1965	594	363	126	105
1966	544	336	110	98
1967	559	338	122	99
1968	546	319	128	99
1969	535	315	125	96
1970	511	296	116	99
1971	510	291	118	102
1972	481	273	110	99
1973	467	270	100	96
1974	473	271	103	99

Source: Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1974.

TABLE 2.6

Absolute Changes in Employment in Agriculture
by Class of Worker;
Canada, 1954-1974

Year	Total	Operator Labour	Unpaid Family Labour	Hired Labour
	Absolute Change In Thousands			
1953-54	20	18	11	7
1954-55	-59	-69	-14	-14
1955-56	-42	12	-10	-5
1956-57	-29	-14	-8	-5
1957-58	-30	-29	-5	1
1958-59	-18	-18	-14	12
1959-60	-17	-9	-7	2
1960-61	-2	-10	5	0
1961-62	-21	-23	5	-3
1962-63	-11	-8	4	-7
1963-64	-19	-4	-6	-1
1964-65	-36	-34	-8	6
1965-66	-50	-27	-16	-7
1966-67	15	2	12	1
1967-68	-13	-19	6	0
1968-69	-11	-4	-3	-3
1969-70	-24	-18	-9	3
1970-71	-1	-7	2	3
1971-72	-29	-17	-8	-3
1972-73	-14	-3	-10	-3
1973-74	6	1	3	3
Average	-18	-13	-4	-1

Source: Computed from Table 2.5.

Table 2.7 shows the variation in component change is much less when examined in percentage terms. Operator and unpaid family labour declined at an average annual rate of 3.1 percent and 2.8 percent, respectively. The average annual rate of decline for hired labour was .5 percent. Of particular interest are the data for 1974. In this most recent year, employment of all three farm labour components increased. This complete reversal of the traditional downward trend may be a result of the improved economic climate in agriculture and the new government policies, aimed at facilitating a greater supply of agricultural labour, that have occurred over the last two years. Considering the current economic conditions, employment in agriculture should stabilize or increase slightly for the next year or two but because the general inequalities between agriculture and industry still remain, off-farm migration should soon begin again. The 1974 experience is likely a repeat of 1967 when employment of all farm labour components also increased, followed shortly by a return to the traditional annual decline.

The nature of agricultural production creates the need for seasonal labour. As the name would imply, the demand for seasonal workers is high in crop areas and low in livestock areas or, in climatic terms, high in the summer months and low in the winter months. The length of employment can be from one week to an entire crop season and the requirements can vary from casual unskilled labour to highly skilled specialists, such as tobacco curers. Table 2.8 presents monthly employment figures for Canada and the regions. In general, a similar trend exists in all regions. Agricultural employment is at its lowest in January and February, increasing gradually through March and April. Sharper increases are experienced in May and June with employment peaking in July. High

TABLE 2.7

Percent Changes in Employment in Agriculture
by Class of Worker;
Canada, 1954-1974

Year	Total	Operator Labour	Unpaid Family Labour	Hired Labour
		Percent Change		
1953-54	2.3	3.3	-5.6	6.2
1954-55	-6.7	-12.1	-7.6	-11.7
1955-56	-5.1	2.4	-5.9	-4.7
1956-57	-3.7	-2.7	-5.0	-5.0
1957-58	-4.0	-5.8	-3.3	1.0
1958-59	-2.5	-3.8	-9.5	12.4
1959-60	-2.4	-2.0	-5.3	1.8
1960-61	-.3	-2.3	4.0	0
1961-62	-3.1	-5.3	3.8	-2.7
1962-63	-1.7	-2.0	2.9	-6.5
1963-64	-2.9	-1.0	-4.3	-1.0
1964-65	-5.7	-8.6	-6.0	6.1
1965-66	-8.4	-7.4	-12.7	-6.7
1966-67	2.8	.6	10.9	1.0
1967-68	-2.3	-5.6	4.9	0
1968-69	-2.0	-1.3	-2.3	-3.0
1969-70	-4.5	-5.7	-7.2	3.1
1970-71	-0.2	-2.4	1.7	3.0
1971-72	-5.7	-5.9	-6.8	-2.9
1972-73	-2.9	-1.1	-9.1	-3.0
1973-74	1.3	.4	3.0	3.1
Average	-2.7	-3.1	-2.8	-.5

Source: Computed from Table 2.5.

TABLE 2.8

Monthly Employment in Agriculture;
Canada and Regions, 1974

Month	Total	Atlantic	Quebec	Ontario	Prairie	British Columbia
			Estimates In Thousands			
January	386	17	66	104	185	14
February	400	17	67	110	189	17
March	424	19	74	115	196	20
April	465	19	79	128	216	22
May	499	21	89	128	239	22
June	534	24	95	129	262	24
July	566	27	111	137	260	31
August	542	27	103	136	255	20
September	517	23	88	126	256	23
October	504	26	86	114	258	19
November	431	21	82	106	204	18
December	409	18	75	110	190	16

Source: Statistics Canada, Labour Force Survey, Catalogue No. 71-001, monthly, Ottawa, Information Canada, December, 1974.

levels of employment continue in August, then decline rapidly through September and October. November and December are months of less rapid decline. Of course, the weather in any particular year or region can alter this normal cycle significantly.

The seasonal variation by labour component is shown in Table 2.9. As would be expected, operator labour varies little within a year. Any variation that does occur could be a result of multiple job holding. A person with an off-farm job who also runs a farm may classify himself as a farmer during the summer months and as an industrial worker the rest of the time. Variation in unpaid family labour employment can be explained by the fact that: (1) the spouse often works on the farm only in the busy season and (2) the farm operator's children generally attend school or university and are only able to work on the farm in the summer months. Students also fill many of the seasonal hired farm labour positions although a study by Dawson and Freshwater[2] indicated that the number of students employed in agriculture has been declining throughout the 1970's. This same study estimated that seasonal farm labour accounted for 16 percent of total employment and 28 percent of hired employment on farms during 1973.[3] Regional estimates indicated a wide variation between regions which the authors felt reflected the differences in agricultural enterprise mix. In the Prairie region, seasonal labour accounted for 15 percent of total farm employment and 26 percent of hired farm employment.[4]

---

[2]D.A. Dawson and D. Freshwater, Hired Farm Labour in Canada, Ottawa; Food Prices Review Board, March, 1975, Table 5.

[3]Ibid.

[4]Ibid., Table 15.

TABLE 2.9

Monthly Employment in Agriculture
by Class of Worker;
Canada, 1974

Month	Total	Operator Labour	Unpaid Family Labour	Hired Labour
		Estimates In Thousands		
January	386	243	73	71
February	400	251	77	72
March	424	260	91	73
April	465	272	103	90
May	499	286	112	101
June	534	296	121	116
July	566	292	130	144
August	542	285	117	140
September	517	288	114	116
October	504	277	120	107
November	431	260	91	80
December	409	247	87	75

Source: Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, January to December, 1974.

The major implication to be drawn from the above review is that there are sizeable differences among regions and among labour components with regard to employment in agriculture. These differences could be a result of: (1) factors that determine the demand and supply of agricultural labour having more impact in some regions and component labour markets than in others; (2) different factors determining the demand and supply of agricultural labour in each region and component labour market; or (3) a combination of (1) and (2). Therefore, it is logical to examine each region and component labour market separately.

Economic Issues

The expenditures on hired farm labour expressed as a percent of farm operating and depreciation expenses have remained slightly greater than eight percent in Canada and somewhat less in the Prairie region for several years.[5] This stability is the net result of rapidly increasing farm wage rates and a declining level of farm employment. The average farm wage rate more than doubled during the 1961-1974 period causing the price of labour to increase relative to agricultural product prices and other farm inputs. However, farm wages appear to have followed the level of productivity in agriculture although wages out paced productivity in the 1970's as can be seen in Table 2.10.

Comparing the wage rate in agriculture to those of industry illustrates one of the major issues of the farm labour shortage problem. Table 2.11 shows the returns to employment in agriculture are much less

---

[5]D.A. Dawson and D. Freshwater, Hired Farm Labour in Canada, Ottawa; Food Prices Review Board, March, 1975, Table 5.

TABLE 2.10

Agricultural Price and Productivity Indices, Canada, for Selected Years, 1961-1974

Index	Year				
	1961[a]	1964	1967	1970	1974
Farm product price index (1)	100.0	101.3	116.0	116.0	223.3
Farm input price index (2)	100.0	108.6	121.5	131.2	194.8
Hired farm labour price index (3)	100.0	109.5	142.6	169.8	255.5
Agricultural productivity index (4)	100.0	133.9	144.5	175.1	190.4

[a] For all indices, 1961 is the base year.

Sources: Row (1) Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1961, 1964, 1967, 1970, and 1974.

Row (2) and (3) Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1961, 1964, 1967, 1970, and 1974.

Row (4) Statistics Canada, Aggregate Productivity Measures, Catalogue No. 14-201 annual, Ottawa, Information Canada, 1961, 1964, 1967, 1970, and 1974.

TABLE 2.11

Estimates of Average Wage Rates in Agriculture and Major Industries; Canada, for Selected Years 1961-1974

Year	Average Wage for Male Farm Help (Without Board)	Average Wage in the Service Industry	Average Wage in the Manufacturing Industry	Average Wage in the Construction Industry	Average Wage for Industry Composite
			Dollars Per Week		
(1)	(2)	(3)	(4)	(5)	(6)
1961	$38	$55	$81	$83	$78
1964	42	61	90	95	87
1967	52	75	107	131	103
1970	63	91	133	167	127
1974	93	126	186	250	178

Note: Column (2) was computed by taking an average of the daily wage paid to male farm help in January, May, and August and multiplying this average by five in order to arrive at a figure comparable to those presented in columns (3) to (6).

Source: Column (2) Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1961, 1964, 1967, 1970, and 1974.

Column (3) to (6) Statistics Canada, Employment Earnings and Hours, Catalogue No. 72-002 monthly, Ottawa, Information Canada, 1961, 1964, 1967, 1970, and 1974.

than returns to employment in industry. Farm operators argue that they are incapable of paying more until their own returns increase. Conversely potential farm employees, who consider their alternative employment opportunities, stay away from farm employment.

Poor working conditions on farms are as much a problem as low wages. A farm worker is often required to work long hours, especially on livestock enterprises where ten and twelve hour days are not uncommon. Six, and sometimes, seven day weeks are required in occupations such as dairy herdsmen. These highly demanding positions are very unattractive when industry requires, in general, eight hour days with weekends off while, at the same time, offering a higher rate of pay.

Another related issue is the problem of seasonality. Crop enterprises often require employees to work seven days a week throughout the daylight hours in order to plant or harvest the crop on time. However, during the growing season or the winter months little labour is needed and the workers are laid off. It is very difficult to maintain a reliable and experienced labour force on a seasonal basis. Students who supply a large portion of this seasonal type of labour present problems in many areas because they are unable to leave school early enough for seeding and must return to school before the end of the harvest season.

Employment of permanent or full-time workers is not much more stable than that of seasonal labour. The average permanent farm position has little of its industrial counterpart's security or promotion potential. A season of poor returns would likely force the farm operator to lay off any hired labour he had. A season of good returns could have the same effect with respect to hired labour if the farmer invested his returns in

labour-saving equipment. Moreover, the worker who is able to hold on to his job has little, if any, chance to advance past employment as a "hired hand." The typical farm unit is too small to have any middle management positions that an employee could expect to occupy some day. When a farm operator retires either a relative will take over operation of the farm or the farm will be sold. In either case, the hired farm worker has no chance of advancing his career in agriculture. Related to this problem of limited upward job mobility is the problem of low status with respect to the farming occupation. The general image of farm employment is one of arduous, dirty, and unskilled tasks. This image often stops young people from pursuing a farming occupation. On many farms, new farming techniques have made this description invalid, although the social stigma will remain for years to come.

The lack of fringe benefits available to farm labour is another reason why potential farm workers seek nonfarm employment. In most cases, agricultural workers do not have private group medical plans, disability insurance, retirement pensions, etc., because of the small number of people employed on any one farm and the seasonal nature of the work. Also government insurance programs, such as the Canadian Unemployment Insurance Act are often disincentives to accepting seasonal employment.[6]

Finally, there are the differences in living conditions associated with agricultural and industrial occupations. Although farm workers may be provided with acceptable accommodations over and above the wages

---

[6]Canadian Federation of Agriculture, "Farm Labour Problems," Project No. 412010, a paper presented at the Canadian Federation of Agriculture Dairy Farmers of Canada Seminar, Ottawa; February, 1974, section 7.

received, they are generally isolated from the social amenities of urban living. For example, schools, medical facilities, and entertainment services are usually inferior and at a greater distance from home than similar services in an urban centre. In recent years, society has placed a greater importance on the convenience of city living than on the benefits of rural living. If the noise, air pollution and crowding of our cities continue, however, there may be a shift back to the country and the agricultural labour force may gradually increase, assuming farm wages and working conditions can be improved.

Government Involvement

The present study is not an attempt to evaluate the impact of government involvement within the agricultural labour force. However, an examination of recent government activity in this area points up the extent to which government is concerned with the farm labour shortage problem and indicates the approaches taken to alleviate the problem.

Several provincial governments are investigating the impact of applying current labour legislation to the agricultural sector which at present is exempt from most labour laws.[7] These laws ensure a high standard of working conditions in industry and probably serve to attract workers to the industrial sector as much as the higher wages relative to agriculture. Table 2.12 lists the fringe benefits most workers now take for granted and indicates the benefits from which agriculture is exempt.

---

[7]Saskatchewan, Ontario, Quebec, and Prince Edward Island Agricultural Manpower Committees, "unpublished reports to the Canada Agricultural Manpower Committee annual meeting," Montreal; September 9-11, 1975.

TABLE 2.12

Labour Standards; Legislative Coverage, by Province, of Agricultural Workers: June 1974

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.
Obligated to keep records	E	E	E	E	C	E	E	E	E	E
Wage protection	E	E	C	E	C	N	E	C	E	C
Employment termination	N	E	E	E	C	C	N	E	E	C
Holidays with pay	E	E	E	E	E	N	E	E	E	N
Vacations with pay	E	E	E	E	E	E	E	E	E	C
Hours of work	E	E	E	E	E	E	E	E	E	E
Minimum wage	E	E	E	E	E	E	E	E	E	C
Overtime pay	E	E	E	E	E	E	E	E	E	E
Equal pay for equal work	C	C	E	E	C	E	C	C	C	C
Pregnancy leave	E	N	E	E	E	N	E	C	N	N
Workmen's Compensation	V	V	V	V	C	E	V	V	V	E

Note: N = None, E = Exempt, C = Covered, V = Voluntary

Source: Canadian Federation of Agriculture, "Labour Standards", an unpublished mimeograph, Ottawa, July, 1974.

The western provinces have lagged behind the eastern provinces, especially Ontario and Newfoundland, in the application of labour standards to agriculture. For example, in Newfoundland farm workers are covered by minimum wage, vacations with pay and employment termination legislation while similar workers in the Prairie region have no such protection. The seasonal nature of the agricultural industry plus the lack of a strong agricultural labour union have combined to create this inequality between industry and agriculture. Although the recent provincial government activity is encouraging, it will no doubt take several years before legislative changes will enforce fringe benefits for agricultural workers equal to those found in industry.

In Chapter I it was stated that government programs aimed at improving the supply of hired farm labour have been implemented. The Manpower and Immigration Department provides employer and employee listing referrals, placement, and training services through the Canada Manpower Centres. The Agriculture for Young Canadians program attempts to meet some of the special needs of the provinces by encouraging young workers to gain experience in agriculture while simultaneously meeting some of the needs of farmers.

The Canadian Farm Labour Pool system, established in 1974 and operated by the Federal Department of Manpower and Immigration, has probably been the most beneficial program to farmers. By December 1974, 35 Pools were set up throughout Canada to organize the supply of seasonal and permanent farm workers and match this supply to the needs of farmers. The Department of Manpower and Immigration also operates several foreign worker programs such as the Caribbean Seasonal Workers Program, the

Mexican Seasonal Agricultural Workers Program, the United States-Canada Harvest Worker Exchange, and the International Student and Youth Exchange Programs. Table 2.13 indicates the number of farm workers supplied to Canadian farm operators through the efforts of individual Department of Manpower and Immigration programs. The Canada Manpower Centres are spread throughout the nation and, theoretically, are best capable of organizing the farm work force. However, many farm operators hold a low opinion of these centres because of the low quality, completely unqualified employees that the Centres have sent out to farm operators in their attempt to fill vacant positions.[8] The problem was one of insufficient skilled farm labour and a misunderstanding on the part of the Centres as to the needs of the farm operator. As a result, farmers lost faith in the Canada Manpower Centres and the new Canada Farm Labour Pools were established in the hope that these specialized labour pools could better serve the needs of farmers. The Pools appear to be very successful and will likely become the major program, in terms of organizing farm labour, within three or four years.

It would appear from Table 2.13 that these programs supplied all of the hired farm labour employed in 1974 (99 thousand persons). This is most definitely not the actual case. Many of the positions vacant would have been filled several times within a year or a season. For example, a farm operator may require a hired worker for a six month seasonal position. In the six month period, the farm operator may have to hire

---

[8]See for example: Canadian Federation of Agriculture, "Farm Labour Problems," op. cit.

TABLE 2.13

Employees Supplied to Canadian Agriculture by Various Government Programs; Canada, 1974

Program	Employees Supplied
Canada Manpower Centres	75,031
Canadian Farm Labour Pools	16,826
Caribbean Seasonal Worker Program	5,342
International Student and Youth Exchange	1,713
United States - Canada Worker Exchange	350
Mexican Seasonal Worker Program	195

Source: Manpower Employer Services Branch, "Agricultural Manpower Programs, Department of Manpower and Immigration, 1974 Highlights", Report to the Canadian Agricultural Manpower Committee, unpublished mimeograph, Ottawa, Department of Manpower and Immigration, September, 1975.

three or more workers as each worker tires of the hard work and low wages and leaves the farm. Such rapid turnover is very common in agriculture and the resultant multiple hiring for one position causes the figures in Table 2.13 to somewhat exaggerate the importance of the Department of Manpower and Immigration programs in the hired farm labour market. A large number of positions are filled through personal recruitment in local newpapers and by word of mouth. Rapid turnover is not a problem in the Caribbean, Mexican or Exchange programs because the students and workers are carefully selected and in the case of the Caribbean and Mexican Programs the workers are under contract, but these programs provided less than eight percent of hired farm labour employment in 1974. Moreover, most of this labour is concentrated in Ontario and, therefore, does little to alleviate the farm labour problems of the Prairie region.

Table 2.14 presents summary data on full-time agricultural courses for Canada and the three Prairie provinces. In general, the types of courses offered have increased but the total number of training days, the estimated total cost and the number of clients referred to agricultural courses has decreased considerably. Although these data refer primarily to the training of farm operators, there are a number of farm workers that are sent on such courses either by their employer or by the Department of Manpower and Immigration. At a time when many farmers want to expand their operations and the maintenance of modern farm equipment is becoming quite complex, it would appear, from Table 2.14, that the mechanism needed to develop a more skilled labour force is being restricted.

TABLE 2.14

Summary of Full-Time Agricultural Courses, Canada and the Prairie Provinces, for Selected Years, 1969-70, 1970-71, 1971-72, 1972-73, 1973-74, and 1974-75

Summary Statistic		Year					
		1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
Types of courses offered -	Canada	86	130	177	166	223	175
	Manitoba	5	7	6	7	8	10
	Saskatchewan	3	6	5	10	10	10
	Alberta	9	11	10	14	14	10
Total training days -	Canada	364,287	468,260	820,328	597,352	465,127	329,459
	Manitoba	40,114	45,750	43,822	47,088	22,710	25,913
	Saskatchewan	11,952	48,415	58,214	54,282	40,422	32,531
	Alberta	8,282	41,640	65,977	43,929	41,080	19,627
Estimated total cost ($) -	Canada (,000)	5,426	8,017	11,418	11,017	9,618	6,661
	Manitoba	585,296	812,869	521,400	755,588	320,364	319,825
	Saskatchewan	194,457	860,218	827,427	986,969	589,996	258,230
	Alberta	338,701	691,870	891,764	793,971	597,671	265,964
Clients referred to agricultural courses -	Canada	..[a]	..	18,691	21,007	15,186	12,359
	Manitoba	..	..	864	924	786	603
	Saskatchewan	..	..	1,333	1,564	1,059	1,010
	Alberta	..	..	1,251	1,215	1,259	686

[a] Figures not provided by the report cited.

Source: Manpower Training Branch, "Agricultural Training Under the Canada Manpower Training Program 1969-70 to 1974-75", unpublished mimeograph, Ottawa, Department of Manpower and Immigration, July, 1975.

ANALYSIS OF AGRICULTURAL EMPLOYMENT IN THE PRAIRIE REGION[9]

In each Prairie province approximately one-third of all census farms reported employment of paid labour in 1971. Less than five percent of the farms employed permanent labour. Table 2.15 indicates that it is the larger farms that hire most of the labour as 56 percent of the Prairie farms with sales over $10,000 reported hired labour compared to 28 percent with sales between $2,500-$9,999 and 13 percent with sales up to $2,500. In addition, 79 percent of all the weeks of paid labour were on the farms with sales over $10,000.

To better understand the farm labour problems of the Prairie provinces it is helpful to examine the agricultural enterprise mix in the region. Table 2.16 presents the number and percent of farms by enterprise specialization. Grain farming combined with cattle, sheep, and hogs account for 93 percent of the Prairie farms with sales in excess of $2,500. Provincially, Saskatchewan is the dominant province with respect to grain farming while Alberta is the dominant province in livestock operations.

In all three provinces, there are farmers unable to hire the labour they need including both farmers who now employ some labour and

---

[9]This part of Chapter II draws extensively on the following report: Canadian Federation of Agriculture, "Farm Labour Problems," Project No. 412010, a paper presented at the Canadian Federation of Agriculture - Dairy Farmers of Canada Seminar, Ottawa; February, 1974, section 6(C).

TABLE 2.15

Farms Reporting Paid Labour by Size of Farm; Prairie Region, 1971

Farm Size	Farms		Farms Reporting Paid Labour	
	Number	Percent	Number	Percent
Farms with sales up to $2,500	39,372	23	5,290	13
Farms with sales between $2,500-9,999	80,743	46	22,554	28
Farms with sales over $10,000	54,056	31	30,478	56

Source: Canadian Federation of Agriculture, "Farm Labour Problems", Project No. 412010, an unpublished working paper for the Canadian Federation of Agriculture - Dairy Farmers of Canada Seminar on Farm Labour, Ottawa, Canadian Federation of Agriculture, December, 1973.

TABLE 2.16

Farm Enterprise Specialization;
Prairie Region, 1971

Product Type	Farms	
	Number	Percent
Wheat, small grains and other field crops	68,579	51
Cattle, sheep, hogs, (excluding dairy)	56,884	42
Dairy	4,805	4
Poultry	1,142	1
Fruit and Vegetables	119	..[a]
Forestry	47	..
Miscellaneous specialty	657	..
Other combinations	2,566	2

[a] Fruit and vegetables, forestry, and miscellaneous speciality represent less than one percent.

Source: Canadian Federation of Agriculture, "Farm Labour Problems", Project No. 412010, an unpublished working paper for the Canadian Federation of Agriculture - Dairy Farmers of Canada Seminar on Farm Labour, Ottawa, Canadian Federation of Agriculture, December, 1973.

farmers who cannot find, or afford, any of the labour they require. The economic issues mentioned in the previous section apply to the Prairie region for the most part. The most serious farm labour problems of the Prairie provinces are now presented in more detail below.

An average grain farmer needs workers capable of operating and repairing the equipment used on the farm. His needs are for seasonal, mechanically skilled labour. The average livestock owner requires permanent labour, skilled and unskilled, willing to work under the working conditions associated with ranching and feedlots. Many hog farmers operate without any hired labour but would employ a person permanently if they could find someone with experience or training. Dairy farmers require permanent labour for the twice daily milking chore. This is a seven day-a-week task which attracts few workers. The specialized skills required of a dairy herdsman make it difficult for dairy farmers to meet their labour requirements. The Labour Pools are attempting to ease the situation by providing a relief milking service so that herdsmen can have a weekend off or take a short holiday. The production of vegetables and sugar beets presents a different labour problem. Unskilled, manual labour is generally acceptable but most operators can only afford to pay very low wages. Native Indians have been used on many farms although this solution is far from satisfactory. Problems of exploitation of the Indians with low rates of pay, inadequate housing, etc., are contentious social issues.

In summary, farmers in the Prairie region require skilled agricultural labour for permanent employment especially for livestock

enterprises, experienced, seasonal labour for the crop season, and unskilled labour to do the various manual tasks involved in the production and marketing of vegetables and sugar beets but find it difficult to attract such labour because of certain factors which this study will attempt to identify.

REVIEW OF FARM LABOUR EMPLOYMENT IN 1975 AND 1976[10]

Thus far, the background analysis has covered the period 1954 to 1974 in-depth because it is this period to which the present study is addressed. A brief description of the farm labour situation in the years 1975 and 1976 will complete the analysis. Revisions to the Labour Force Survey in 1975 make comparisons of actual employment levels with earlier years invalid but it is possible to discuss employment in relative terms.[11]

Continued expansion of the Canada Farm Labour Pool system along with increased emphasis on foreign seasonal worker programs, labour mobility programs, and programs to improve housing for seasonal workers helped to increase hired labour employment in 1975. In the same year, the general economic recession and increasing unemployment in Canadian

---

[10] For more detail see R.S. Rust and W.D. Jones, "Agricultural Labour," Canadian Farm Economics, Vol. 10, No. 6, 1975, pp. 46-54 and R.S. Rust and W.D. Jones, "Farm Labour," Canadian Farm Economics, Vol. 11, No. 6, 1976, pp. 41-49.

[11] Revisions to the Labour Force Survey include a larger sample size which altered the population estimate results and minor definitional changes which shifted some farm managers from farm operators into the hired labour class and reduced the hours of work requirement for the unpaid family labour class.

industry temporarily stopped many farm operators and their families from leaving agriculture. Employment of both farm operators and unpaid family labour declined in 1975 but at a slower rate than in earlier years.

In 1976, employment of hired farm labour again increased but at a slower rate than in the previous year. Farm incomes decreased in 1976, restricting the farmer's ability to increase farm wages sufficiently to attract significant additional labour. Farm wages increased by about 11 percent compared with increases of nearly 20 percent in 1974 and 1975. In addition, continued adoption of various mechanical harvesters and "U-Pick" harvesting methods reduced the labour demand for some crops in 1976. The number of unpaid family workers and farm operators both decreased in 1976 with the decline in farm operators the largest since 1968. This significant reduction in the number of farm operators was believed partially due to the departure of operators who had delayed leaving the farm during the previous three years because of the higher than normal farm incomes for that period. The Prairie region continued to have the largest annual reduction in the number of persons employed on farms during the years 1975 and 1976, however, the region continued to represent more than one-half of total agricultural employment in Canada.

CHAPTER III

THE CONCEPTUAL FRAMEWORK

The purpose of this chapter is to develop the conceptual models that provide the framework within which the empirical analysis of the market for agricultural labour is performed. The chapter is separated into two parts. The first specifies the economic theory used to explain the supply of and demand for labour in agriculture. The second postulates an economic model consisting of a demand equation, a supply equation, and a market clearing identity for each component of the agricultural labour force.

THE ECONOMIC THEORY

In this section, the theoretical framework or working hypothesis is discussed in terms of the demand for labour, technological change, supply of labour, labour component interdependencies, secular influences in the labour force, and the lagged response to economic stimuli. Where necessary, pure economic theories are modified to suit the particular nature of farm labour markets based on prior knowledge of the agricultural sector.

The Demand for Labour

In economic theory, labour is viewed as a factor of production. The demand for a factor of production is a derived demand arising from the demand for the final product. The price of the factor, the prices of other input factors, and the price of the final product determine

this derived demand, given the state of technology. Marginal productivity theory provides a useful analytical tool for the development of this concept.[1]

Marginal productivity theory can be analyzed assuming perfectly competitive input and output markets when determining a firm's demand for labour curve. This framework is appropriate when explaining the demand for labour in the agricultural sector because the individual farm unit can be considered too small to affect equilibrium price levels in either input or output markets. Similarly, agricultural labour is not represented by powerful labour organizations which create imperfections in the labour market.

Assuming perfect competition and working from the premise that entrepreneurs seek to maximize profits, early labour economists deduced two propositions which form the basis of marginal productivity theory:[2]

1. The outlay for a factor of production will not be more than that factor adds to the firm's revenue.

2. Due to the forces of competition, the outlay tends to equal the value of that factor's contribution to the firm's revenue.

Thus in terms of the value of the marginal product of a variable input (its marginal product multiplied by the market price of the product), a profit maximizing entrepreneur will add additional units of an input until the value of its marginal product just equals the price of the input.

---

[1]For a discussion on marginal productivity theory, see J.R. Hicks, The Theory of Wages, 2nd ed., Toronto; Macmillan and Co., Ltd., 1963, pp. 1-20 or H.H. Liebhafsky, The Nature of Price Theory, Homewood; The Dorsey Press, Inc., 1963, pp. 303-332.

[2]Bloom and Northrup, Economics of Labor Relations, 5th ed., Homewood; Richard D. Irwin, Inc., 1965, pp. 349-350.

When a production process requires only one variable input, the value of the marginal product curve of the input is in fact the firm's demand curve for the input.[3] This curve will be negatively sloped due to the law of diminishing returns whereby the marginal physical product decreases as the quantity of a variable input increases (other inputs held constant). If the price of the final product remains constant the resulting value of the marginal product from each additional unit of the input will decrease.

If several variable inputs are employed, the marginal product value curve of an input ceases to represent the firm's demand curve for that input due to input interdependencies.[4] A change in the price of one input can have three distinct effects which are described below.

Assume a production process requires only two variable inputs; capital and labour. At equilibrium, a given quantity of output will be produced using the least cost combination of capital and labour. If the price of labour (wage rate) decreases, a new input price ratio exists which may cause a substitution effect, an output effect, and a maximizing effect. The substitution effect is a substitution of labour units for capital units because of the decrease in the relative price of labour. If output was kept constant the result would be a reduction in the cost of inputs. However, the lower price of labour allows the entrepreneur to purchase more inputs for a given input expenditure. The increase in

---

[3] C.E. Ferguson, Microeconomic Theory, Homewood; Richard D. Irwin, Inc., 1969, p. 365.

[4] Ibid., p. 365.

output due to the increased use of inputs represents the output effect. Finally, the decline in the price of labour increases the optimum (profit maximizing) level of output because the marginal cost of production has declined. The profit maximizing entrepreneur will increase output to the new optimum level. This shift is called the maximizing effect. At the new equilibrium position, the value of the marginal product for all variable inputs is equal and the price of each input is equal to the marginal revenue of producing one more unit of output.

The substitution of labour for capital decreases the marginal product of labour because there are less capital units (the other required input) to combine with the increased number of labour units. Conversely, the output and maximizing effects cause more of both variable inputs to be used which increases the marginal product of labour. The total effect is an increase in the marginal product of labour and in the value of the marginal product of labour.[5] This implies a shift to the right of the value of the marginal product curve when the price of labour declines. Moreover, points of intersection between the value of marginal product curve and the supply curve for labour indicate points of the demand for labour curve. Therefore the demand curve for an input, when several variable inputs are used, must have a negative slope (as in the case of one variable input) because a decrease in the price of an input shifts the value of marginal product curve to the right.

---

[5]C.E. Ferguson, Microeconomic Theory, Homewood; Richard D. Irwin, Inc., 1969, p. 368.

Thus marginal productivity theory implies an increase in the price of labour will reduce the quantity of labour demanded, assuming the variable factors need not be used in fixed proportions. An increase in the price of other inputs such as machinery will have the opposite effect.

The price of the final product has a positive relationship with the quantity of labour demanded. If the final product price increases, the demand of all inputs should increase as the firm attempts to increase output and vice versa. The assumption of a given level of technology, mentioned at the outset of this subsection, is discussed in a separate subsection below.

Technological Change

The demand for an input is affected by changes in the level of technology applied to the production process in which that input is used. Technological change may be defined as any shift of the production function that enables a higher level of output to be produced from the same level of inputs. It may be capital-using, neutral, or labour using as measured by the marginal rate of technical substitution of capital for labour which is the ratio of the marginal product of labour to that of capital.[6] According to a study by Yeh and Li, technological change in Canadian agriculture was neutral for the period 1946-1965.[7] This implies

---

[6] C.E. Ferguson, Microeconomic Theory, Homewood; Richard D. Irwin, Inc., 1969, pp. 385-388.

[7] M.H. Yeh and L. Li, Technological Change in Canadian Agriculture, Research Report No. 15, Faculty of Agriculture and Home Economics, University of Manitoba, November, 1968, pp. 50-52.

that technological progress in agriculture shifts the value of the marginal product of both labour and capital to the right. Consequently, the demand for both these factors of production should increase as the level of technology increases, other factors remaining constant. However, if the increase in output resulting from new technology reduces prices, the net effect of an increase in the level of technology may be a decrease in the demand for labour.

In addition, the level of technology is only part of a more general measure, the level of productivity. Technological change combined with capital intensification (increasing the quantity of capital used in production) determine labour productivity. As the capital per man employed increases, there is movement along the production function and output increases. Again, the net result may be a reduction in the demand for labour if the higher output reduces prices.

It was noted in Chapter I that the dramatic increase in agricultural output due to increased productivity resulted in depressed product prices which reduced the demand for labour. Therefore, in terms of the derived demand equations for labour, it is logical to account for the level of productivity rather than just the level of technology because the level of productivity measures technical change and capital intensification, both of which may affect the level of demand. This study explicitly introduces the level of productivity per man employed into each demand function.

The Supply of Labour

The supply of labour can be discussed at four levels: labour available to an individual firm, labour available to an industry or sector, labour available to a particular locality, or labour available in the economy as a whole.[8] The supply of labour in the economy as a whole represents the total labour force and is usually taken to be dependent upon (1) the size of the population; (2) the sex composition of the population; (3) the age distribution within the population; and (4) the attitude of the population towards work. In the present study, the size of the total labour force is considered given because the problem we wish to examine here is what quantity of labour will be supplied to a given sector, specifically the agricultural sector. The size of the total labour force is assumed exogenous and is taken to be one of the factors that determine the supply of agricultural labour.

The quantity of labour supplied to any particular sector depends upon: (1) the size of the total labour force; (2) the labour force's preference for that type of work; (3) mobility of the labour force; and (4) returns available in alternative employments. In the short-run the first three factors are held constant while relative returns to labour are assumed to be a function of the wage rate. Thus the short-run supply curve of labour relates units of labour to the wage rate. An increase in the wage rate will increase the quantity of labour supplied and

---

[8] Bloom and Northrup, Economics of Labor Relations, 5th ed., Homewood; Richard D. Irwin, Inc., 1965, pp. 320-321.

vice versa. Changes in the size of the labour force, its work preferences or its ability to shift from one job to another when returns available in alternative employments increase involve a shift of the labour supply curve.

Economic theory states that the supply curve of labour is positively sloped.[9] If each supplier of labour was identical (uniform employment preferences and equal ability) and perfectly mobile, the supply curve would be perfectly elastic. In this situation an industry that raised its wage rates relative to other industries could expect all workers to migrate to that industry. However workers are neither homogeneous nor perfectly mobile.

For example, many workers would not have sufficient training to accept a position in the higher return industry and may prefer not to acquire new skills. Of those qualified, many may not even be aware of the existing opportunity. Mobility is hampered by the cost of relocation and a desire to remain in familiar surroundings. In view of these circumstances the supply curve is not perfectly elastic but positively sloped. The higher an industry can raise its relative wage rate, the larger the number of workers that will offer their labour services to that industry. The wage rate which reflects the returns available in alternate employments has the opposite effect. If wages in the rest of the economy increase, the influence on the supply of labour to the sector under study would be negative.

---

[9] H.H. Liebhafsky, The Nature of Price Theory, Homewood; The Dorsey Press, Inc., 1963, pp. 333-340.

The size of the total labour force has a positive relationship with the quantity of labour supplied to a sector. That is, an increase in the total labour force tends to increase the labour available to each sector of the economy. Unless, of course, none of the new entrants selected employment in the sector under study. Such a case is unlikely, even in the agricultural sector where wages are low relative to industry, special skills are required, and the cost of entry is high.[10]

The level of employment in the economy has particular significance to the agricultural sector where there is an excess demand for labour at present. A high rate of unemployment suggests few employment opportunities and strong competition for vacancies that do exist. The effect is two fold. Out-migration from agriculture is reduced due to a lack of alternate employment, and the workers, unable to find employment in industry, may offer their services to agriculture. Therefore, a positive relationship exists between the level of employment in the economy and the supply of labour to agriculture. In terms of mobility, the agricultural labour force becomes less mobile while the industrial labour force (those who are unemployed) becomes more mobile if the rate of unemployment increases.

---

[10]The cost of entry refers to the investment in capital required to being farming and only applies to farm operator labour.

Labour Component Interdependencies

As stated previously, the agricultural labour force consists of the three components; hired labour, operator labour, and unpaid family labour. To the extent that each possesses the same skills, the components can be considered substitutes. The demand for operator labour in agriculture may be influenced by the number of hired labourers. The supply of unpaid family labour may be influenced by the number of farm operators. The demand for hired workers may be influenced by the number of unpaid family workers and so on. For example, operators and unpaid family labour may offer their services as hired farm labour if the hired farm wage rate increases substantially. Similarly, if the demand for hired labour decreased many of these workers could return to the family farm as unpaid family labour.

The interdependence between labour components is difficult to establish prior to applying statistical tests to a hypothesized model.[11] For the most part, hired and unpaid family labourers are required to do the same work on the farm and can therefore be labelled substitutes. However, the interdependence between operator labour and the two substitute components is not so clear. Farm operators often work at the same tasks as hired and unpaid family labour but they also must play the additional role of farm manager. This role of manager has become more

[11] When testing for a substitution effect in a demand or supply equation, the price of the substitute commodity is usually used as an explanatory variable. However in this case, the price of operator and unpaid family labour is difficult to estimate so the quantities of the hypothesized substitute labour components are used instead.

prominent over the years as the size and complexity of farms increased. For example, on several of the larger farm operations, the operator acts mainly as the manager or co-ordinator leaving most of the normal farm work to his employees. On this basis, then, a farm operation demands both management and worker labour. However, the two types of labour are not so specialized that workers and managers do not substitute roles when conditions warrant such a move. Further complications arise when it is realized that operator and unpaid family labour are related through family ties. This family relationship may cause a high correlation between movements of the two components. When a farm operator leaves agriculture, for example, the unpaid labour his family supplied would likely also leave.

In order to test for interdependencies within the Canadian agricultural labour market conventional economic theory, outlined above, is extended to account for supplementary, and possibly, complementary relationships between labour components. The nature of the relationships is hypothesized in the sections dealing with specific component labour markets which appear in the second part of this chapter.

Secular Influences in the Labour Force

There are secular shifts in the demand for and supply of labour which are not explicitly taken account of by the economic variables discussed above. The demand for labour will change as the quality of the labour force, in terms of education and experience, changes over time. An employer's preference for input mixes and changes in the total economy may also be secular in nature. Institutional factors such as government policies and laws can also cause secular influences on the demand for labour.

The supply of labour to agriculture has been continuously declining for many years. Gradual changes in the tastes and preferences of the labour force toward the urban way of life is cited as one factor behind this secular movement. Better education, communication, and transportation in rural areas are others.

Under conditions such as these a trend variable is added to the demand and supply equations to account for changes highly correlated with time and not explained by the economic variables. This makes possible a testing procedure to check the significance of these factors.

Lagged Response to Economic Stimuli

A lagged response model is used to take account of the fact that a person's response to economic stimuli is not instantaneous but distributed over time. The reasons for expecting a lag in demand response differ from those of supply.[12]

Lags occur in supply response for several reasons. There is uncertainty as to whether the changes are permanent or just temporary. Limited education and a desire to remain in familiar surroundings often restrict a worker's mobility. The unpaid family labour on the farm may have no other alternatives in terms of employment or may not be informed of existing opportunities.

Lags occur in demand response because present economic patterns may have become habit or the new situation may appear temporary. Also

---

[12] Marc Nerlove, "Distributed Lags and Estimations of Long-Run Supply and Demand Elasticities: Theoretical Considerations," Journal of Farm Economics, Vol. 40, No. 3, 1958, pp. 301-311.

certain agricultural resources are both durable and complementary with other durable resources making some instant responses inefficient. New economic patterns take time to establish if new knowledge and resources must be acquired or if old contracts must be fulfilled.

In this study Nerlove's distributed lag model is used as it has the additional capability of being able to provide estimates of short-run and long-run elasticities. The short-run elasticity is a measure of response to economic stimuli within a given time period. The long-run elasticity is a measure of the total response and is believed to be larger than the short-run response because it indicates the complete adjustment to economic stimuli. The difference between the short-run and long-run elasticities is due to the lagged response.

The process developed by Nerlove estimates this lag and separates the short-run and long-run elasticities. Specifically, the dependent variable (quantity demanded or supplied) is lagged one time period and is added to each demand and supply equation as an explanatory variable. From the estimated coefficient of the lagged dependent variable the coefficient or elasticity of adjustment is calculated and the short-run and long-run elasticities are determined. This technique is further described in Chapter IV under "The Estimation Procedure."

The trend variable, introduced above for theoretical reasons is also valuable on statistical grounds when a distributed lag model is used.[13] If important variables are omitted from the model the lagged

---

[13] G.E. Schuh, Distributed Lags as a Technique for Obtaining Long- and Short-Run Elasticities, Production Economics Paper No. 6213, Purdue University, July, 1962, p. 9.

dependent variable will tend to pick up their effects, especially if the omitted variables are correlated with time. In this situation the coefficient of the lagged variable will be over-estimated resulting in an under-estimated coefficient or elasticity of adjustment. The calculated long-run elasticities would then be over-estimated. A trend variable isolates the effects of omitted variables that are correlated with time thereby improving the elasticity estimates.

THE ECONOMIC MODEL

The Market for Hired Labour in Agriculture

The economic theory of the demand for and supply of labour, as outlined above, is likely most applicable to the market for hired labour. Farm operators must pay directly for hired labour services, as opposed to using their own services or those of the family, thus making such employment decisions more visibly economic in nature. The hired labourer, on the other hand, may not have the family ties of operator and unpaid family labour or the financial ties of farm operators. Therefore he may be more free to decide whether or not to supply his services to agriculture.

Demand. The demand relationship for hired labour is specified as:

$$Y_1^D = f\ (X_1, X_2, X_3, X_7, X_{11}, X_{12}, Y_2\ v) \qquad (3.1)$$

where:

Y_1^D = hired labour demanded by agriculture

X_1 = real farm price index

X_2 = index of productivity

X_3 = trend

X_7 = hired labour lagged one year

X_{11} = operator labour employed in agriculture

X_{12} = unpaid family labour employed in agriculture

Y_2 = price of hired labour index

v = random error

Hired labour employed in agriculture is used as a measure of hired labour demanded.

The real farm price index is a ratio of the prices received by farmers for their products to the prices paid by farmers for inputs. The index reflects the "real" price of the final product. The relationship between the quantity of labour demanded and real farm prices is expected to be positive to reflect the derived demand for a factor of production.

The index of productivity reflects both capital intensity and technological change. Increasing use of capital and neutral technological progress is expected to reduce the demand for labour. The hypothesized relationship between the labour demanded and productivity is therefore negative.

The relationship between the demand for labour and trend reflects secular influences on demand not accounted for by the economic variables. No *a priori* relationship is hypothesized.

The lagged dependent variable must have a positive relationship with quantity demanded to verify the distributed lag hypothesis. This point is covered further in the following chapter.

It is hypothesized that the number of operators in agriculture is negatively related to the demand for hired labour. As the number of farm operators decrease, more hired labour will be required due to a substitution effect. Demand for hired labour should increase. The recent trend to fewer farms of larger average size, for example, is expected to result in a higher demand for hired labour on these larger farm units. Other more complex factors related to farm operators, such as a shift in production emphasis to labour intensive crops, might cloud the observed relationship between hired and operator labour but only a test of the substitution hypothesis is within the scope of this study.

Hired labour and unpaid family labour are also considered substitute labour components. When the number of unpaid family labour employed rises the demand for hired labour will fall and vice versa. The hypothesized relationship is therefore negative.

A negative relationship between the quantity of hired labour demanded and the price of hired labour is hypothesized.

The random error term is included to account for random disturbances in the demand for hired labour not accounted for by the specified independent variables. Droughts, storms and strikes are examples of random disturbances.

<u>Supply</u>. The supply relationship for hired labour is specified as:

$$Y_1^S = f\ (X_4,\ X_5,\ X_3,\ X_7,\ X_{11},\ X_{12},\ Y_2,\ w) \qquad (3.2)$$

where:

Y_1^S = hired labour supplied to agriculture

X_4 = adjusted nonfarm wage rate index

X_5 = size of the labour force

X_3 = trend

X_7 = hired labour lagged one year

X_{11} = operator labour employed in agriculture

X_{12} = unpaid family labour employed in agriculture

Y_2 = price of hired labour index

w = random error

Hired labour employed in agriculture is used as a measure of hired labour supplied.

The hypothesized relationship between the supply of hired labour and the adjusted nonfarm wage rate is negative. The adjusted nonfarm wage rate is a measure of the returns available to farm labour if they leave farming. The nonfarm wage rate is adjusted by the current rate of unemployment to reflect the availability of nonfarm employment.[14]

The relationship between the supply of labour to agriculture and the size of the labour force is expected to be positive, indicating that an increase in the labour force will shift the labour supply curve to the right. Three alternative measures of the labour force will be considered in this analysis: (1) the total civilian labour force;

---

[14]As the level of unemployment in the economy increases and the availability of nonfarm employment is reduced, the supply of labour to agriculture may increase. This unemployment effect can be accounted for by adjusting the nonfarm wage rate downwards by the unemployment rate. The method of adjustment is discussed in Chapter IV.

(2) the male civilian labour force; and (3) the agricultural labour force. The total civilian labour force will be tested as an explanatory variable as it represents the total quantity of labour available, a fraction of which will be supplied to agriculture. The male civilian labour force is tried because the proportion of females in agriculture is quite small, particularly in the operator and hired labour components. Finally, the agricultural labour force will be tested because the labour supplied to each component farm labour market represents a part of the total agricultural labour force. Also, because the special skills required for agricultural employment are somewhat different from the typical skills required in other occupations, many persons in the general labour force may not see the agricultural sector as a possible place of employment.

The trend variable is again included to account for secular influences not accounted for by the economic variables.

The lagged variable and the random error term are also included in the supply function for the same reasons as those given for their inclusion in the demand function.

The hypothesized relationship between the supply of hired labour and operator labour employed is negative. A small proportion of the decline of hired labour may be due to hired labour starting up their own farm enterprise. Conversely farmers selling their own farms because of excessive debts, old age or a variety of other reasons may stay on in the rural community and offer their services as hired labour.

As the quantity of unpaid family labour decreases, the supply of hired labour is expected to increase. It is hypothesized that some of

the individuals who cease to be unpaid family labour (perhaps because their services are no longer required on the family farm) will offer their services in the hired labour market. Conversely, if individuals in the hired labour market return to the family farm as unpaid family labour, the supply of hired labour will be reduced.

Supply of hired labour and price of hired labour are expected to be positively related.

The economic model for the hired farm labour market is concluded with a market clearing identity which, for a given time period, equates the demand for and supply of hired farm labour:

$$Y_1^D = Y_1^S \tag{3.3}$$

The Market for Operator Labour in Agriculture

Operator labour is the most complex labour component in agriculture in terms of postulating an economic model. As discussed above, the farm operator performs two distinct functions which must be identified and kept separate.

In his role of farm manager, he seeks to maximize profits by efficient allocation of resources to his operation. If the price of one input increases relative to the others, he will demand less of that input. In his second role as that of a supplier of labour, he seeks to maximize his income by offering his services to the industry or occupation which provides him with the highest returns.

One difficulty relates to the price of operator labour which is his net income after all expenses and depreciation. The wages paid to hired labour were a cost to the operator and were negatively related to

demand. In this case however, it would appear that the farm operator would demand more of his own services as the return to them increased. This implies a positive sloped demand curve. The apparent economic discrepancy is a result of the two roles played by the farm operator.

As a manager he will choose the least cost combination of resources to produce his product. If his own labour is more expensive than the other labour components, he will hire labour. As a labourer he will offer his services to the activity where he stands to reap the highest financial gains. However this second phenomenon is a supply response not a demand response.

A second issue relates to the capital investment in farming as it affects the supply of farm operators. It can be argued that the slow migration of farm operators out of agriculture despite the low relative incomes is, in part, due to the sizeable capital investment required of farmers. The operator usually owns land and other capital resources so that the returns to these factors of production go to him as do the returns to his labour. Therefore operators consider all these returns when deciding to stay or leave the industry. Since most agricultural farm inputs (tractors, combines, barns, land) cannot be transferred to other industries, farmers may remain in agriculture to obtain the return on their capital assets even though returns to labour are higher in other industries. Consequently, it is hypothesized that the higher the equity of a farm operator, the less likely he will leave agriculture and the supply of operator labour would have a positive relationship with the level of owner's equity. This hypothesis is tested by introducing a variable indicating the equity position of farm operators into the farm operator supply equation.

Demand. In this study the demand relationship for operator labour is specified as:

$$Y_3^D = f\ (X_1,\ X_2,\ X_3,\ X_8,\ X_{10},\ X_{12},\ Y_4,\ m) \qquad (3.4)$$

where:

Y_3^D = operator labour demanded by agriculture

X_1 = real farm price index

X_2 = index of productivity

X_3 = trend

X_8 = operator labour lagged one year

X_{10} = hired labour employed in agriculture

X_{12} = unpaid family labour employed in agriculture

Y_4 = net farm income per farm

m = random error

Operator labour employed in agriculture is used as a measure of operator labour demanded.

Real farm prices, productivity, trend, the lagged term and the error term are treated the same in the demand for operator labour function as they were in the demand for hired labour function.

The hypothesized relationship between the demand for operator labour and hired labour employment is negative as was the relationship between the demand for hired labour and farm operator employment.

If the quantity of hired labour employed declines, farm operators would demand more of their own services; whereas if the quantity of

hired labour employed increased, farm operators would demand less of their own services.

The demand for operator labour is also hypothesized to be negatively related to the quantity of unpaid family labour employed, because farm operators would have to substitute their own labour for family labour if it decreased, and vice versa.

Net farm income per farm is used as a proxy for the price of operator labour. It represents the residual to a farmer after all costs have been incurred. The expected relationship is negative with respect to the demand for operator labour.

Supply. The supply relationship for operator labour is specified as:

$$Y_3^S = f\ (X_4,\ X_5,\ X_3,\ X_6,\ X_8,\ X_{10},\ X_{12},\ Y_4,\ n) \qquad (3.5)$$

where:

Y_3^S = operator labour supplied to agriculture

X_4 = adjusted nonfarm wage rate index

X_5 = size of the labour force

X_3 = trend

X_6 = owner's equity per farm

X_8 = operator labour lagged one year

X_{10} = hired labour employed in agriculture

X_{12} = unpaid family labour employed in agriculture

Y_4 = net farm income per farm

n = random error

Operator labour employed in agriculture is used as the measure of operator labour supplied.

The adjusted nonfarm wage rate, size of the labour force, trend, the lagged term and the error term are treated the same as in the hired labour supply equation.

Owner's equity is expected to have a positive relationship with the supply of operator labour.

It is hypothesized that quantity of operator labour supplied and the quantity of hired labour employed have a negative relationship due to the possibility of hired labour leaving the hired labour force and becoming farm operators and vice versa.

The same negative relationship is hypothesized to exist between the supply of operator labour and the quantity of unpaid family labour employed again because of the possibility of labourers shifting from one class of worker to another.

Net income is expected to have a positive relationship with the supply of operator labour.

The economic model for the farm operator labour market is concluded with a market clearing identity which, for a given time period, equates the demand for and supply of farm operator labour:

$$Y_3^D = Y_3^S \tag{3.6}$$

The Market for Unpaid Family Labour in Agriculture

Unpaid family labour generally consists of the farm operator's wife and children. These individuals offer their services without direct pay because of family relationship. Such arrangements are not strictly

economic in nature, thus causing problems when developing an economic model. However, only the variables that can be derived from economic theory are examined in this study. No attempt is made to measure the significance of the social factors.

In the present study, the wage rate for hired agricultural labour will be used as a proxy in the absence of a "price" for unpaid family labour. It is assumed that the farm operator would use the current wage rate as the opportunity cost of his family labour while the family, on the other hand, would view the current wage rate as an indication of the returns to working on the family farm.

The supply of hired labour was in part explained by the size of the labour force. This measure may or may not be relevant when discussing unpaid family labour. All three alternate measures of the labour force (total civilian, male civilian, and agricultural) will be tested to determine if they are shifters of the unpaid family labour supply curve.

Demand. The demand relationship for unpaid family labour is specified as:

$$Y_5^D = f\ (X_1, X_2, X_3, X_9, X_{10}, X_{11}, Y_6, r) \qquad (3.7)$$

where:

Y_5^D = unpaid family labour demanded by agriculture

X_1 = real farm price index

X_2 = index of productivity

X_3 = trend

X_9 = unpaid family labour lagged one year

X_{10} = hired labour employed in agriculture

X_{11} = operator labour employed in agriculture

Y_6 = "price" of unpaid family labour

r = random error

Unpaid family labour employed in agriculture is used as the measure of unpaid labour demanded.

Real farm prices, productivity, trend, the lagged term, and the error term are treated the same as in the demand equations for hired labour and operator labour.

It is hypothesized that the relationship between the demand for unpaid family labour and the quantity of hired labour employed is negative because of the substitution effect. A decrease in hired labour employment will increase the demand for unpaid family labour and vice versa.

Similarly, a decrease in the quantity operator labour employed will increase the demand for unpaid family labour and vice versa. The hypothesized relationship between the demand for unpaid family labour and the quantity of hired labour employed is, therefore, also negative.

<u>Supply</u>. The supply relationship for unpaid family labour is specified as:

$$Y_5^S = f\ (X_4,\ X_5,\ X_3,\ X_9,\ X_{10},\ X_{11},\ Y_6,\ s) \qquad (3.8)$$

where:

Y_5^S = unpaid family labour supplied to agriculture

X_4 = adjusted nonfarm wage rate

X_5 = size of the labour force

X_3 = trend

X_9 = unpaid family labour lagged one year

X_{10} = hired labour employed in agriculture

X_{11} = operator labour employed in agriculture

Y_6 = "price" of unpaid family labour

s = random error

Unpaid family labour employed in agriculture is used as the measure of unpaid family labour supplied.

The adjusted nonfarm wage rate, size of the labour force, trend, lagged term, and error term are treated the same as in the supply equations for hired and operator labour.

A decrease in hired labour employment should increase the supply of unpaid family labour and vise versa, as some workers return to the family farm. Therefore, a negative relationship is hypothesized.

A negative relationship is also expected between the supply of unpaid family labour and the quantity of operator labour employed although the probability of farm operators offering their services as unpaid family labour is very small.

The economic model for the unpaid family labour market is concluded with a market clearing identity which, for a given time period, equates the demand for and supply of unpaid family labour:

$$Y_5^D = Y_5^S \tag{3.9}$$

CHAPTER IV

THE EMPIRICAL FRAMEWORK

The purpose of this chapter is threefold. First, the statistical models, their identifying power, and the *a priori* constraints placed on the coefficients are presented. Following this is a discussion of the procedure used in estimating the structural demand and supply relationships. The final part of this chapter deals with the data problems encountered and the way in which they were handled.

THE STATISTICAL MODELS

A prerequisite for the estimation of parameters of structural relationships is that the model in question must be identifed. For a model to be identified, each structural function in that model must have a unique statistical form such that no other function, or combination of functions, contains the same variables as the function being considered.

A model will fall into one of three categories:[1]

1. Underidentified
2. Identified
   (a) Just Identified
   (b) Overidentified

[1] M.J. Brennan, *Preface to Econometrics*, South-Western Publishing Company, Cincinnati, Ohio, 1965, pp. 386-387.

If any one equation of a model is underidentified, the model is considered underidentified. Conversely if any one equation is overidentified, the model is considered overidentified. Underidentified models are unable to statistically estimate the structural parameters. If the model is overidentified the parameters may be statistically estimated by various econometric techniques. Two-stage least squares is one such method.

The structural equations of a model must meet necessary (order) conditions and necessary and sufficient (rank) conditions to be identified. The order condition may be expressed symbolically as:

$$N - N^* \geq G - 1$$

where:

N = total number of variables in the model

N^* = number of variables in the equation being considered

G = total number of endogenous variables.

The rank condition for identification states that there must exist at least one non-zero matrix, of parameters of all the variables excluded from the equation being considered, with order $(G - 1)$.[2]

Each structural relationship specified in this chapter is examined with respect to these two conditions. It should be noted that the market clearing identity of quantity demanded equals quantity supplied was included in each labour component market. This equation is a

---

[2]This condition is called the rank condition because the rank of a matrix is the order of the largest non-zero determinant derived from the matrix.

statement of equilibrium for which no problems of identification or estimation arise.[3]

The Market for Hired Labour in Agriculture

The variables are defined the same as in Chapter III. Statistical estimates of the structural demand and supply relationships for hired labour were obtained using the following model.[4]

Demand.

$$Y_1^D = a_1 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_7 + b_5 X_{11} + b_6 X_{12} + b_7 Y_2 + v \qquad (4.1)$$

The *a priori* constraints on the parameter estimates are $b_1 > 0$, $b_2 < 0$, $0 < b_4 < 1$, $b_5 < 0$, $b_6 < 0$, $b_7 < 0$.

Supply.

$$Y_1^S = a_2 + b_8 X_4 + b_9 X_5 + b_{10} X_3 + b_{11} X_7 + b_{12} X_{11} + b_{13} X_{12} + b_{14} Y_2 + w \qquad (4.2)$$

---

[3] J. Johnston, Econometric Methods, 2nd Ed., McGraw-Hill Book Company, New York, 1960, pp. 370-372.

[4] It should be noted that each model was estimated in both static and dynamic form. When specified as a dynamic model; $b_1 = b_1^*\gamma$, $b_2 = b_2^*\gamma$, etc. where γ is the coefficient of adjustment expressing the proportion of disequilibrium removed in one time period. The coefficients with asterisks refer to the coefficients of the static form of the equation. The coefficient of the lagged variable is equal to $(1 - \gamma)$. Model identification is not altered by the addition or deletion of the lagged term.

The *a priori* constraints on the parameter estimates are $b_8 < 0$, $b_9 > 0$, $0 < b_{11} < 1$, $b_{12} < 0$, $b_{13} < 0$, $b_{14} > 0$.

There are no *a priori* constraints placed on the coefficients of the trend variable (b_3 and b_{10}).

This statistical model for the hired farm labour market is over-identified. Both the demand and supply equations exceed the necessary (order) and necessary and sufficient (rank) conditions previously discussed. The model will be just identified as long as the coefficient of at least one identifiying variable in each equation (b_1 or b_2 for demand; b_8 or b_9 for supply) is statistically significant from zero.

The Market For Operator Labour in Agriculture

The variables are defined the same as in Chapter III. Statistical estimates of the structural demand and supply relationships for operator labour were obtained using the following model.

Demand.

$$Y_3^D = a_3 + b_{15} X_1 + b_{16} X_2 + b_{17} X_3 + b_{18} X_8 + b_{19} X_{10} + b_{20} X_{12} + b_{21} Y_4 + m \tag{4.3}$$

The *a priori* constraints on the parameter estimates are $b_{15} > 0$, $b_{16} < 0$, $0 < b_{18} < 1$, $b_{19} < 0$, $b_{20} < 0$, $b_{21} < 0$.

Supply.

$$Y_3^S = a_4 + b_{22} X_4 + b_{23} X_5 + b_{24} X_3 + b_{25} X_6 + b_{26} X_8 + b_{27} X_{10} + b_{28} X_{12} + b_{29} Y_4 + n \tag{4.4}$$

The a priori constraints on the parameter estimates are $b_{22} < 0$, $b_{23} > 0$, $b_{25} > 0$, $0 < b_{26} < 1$, $b_{27} < 0$, $b_{28} < 0$, $b_{29} > 0$.

There are no a priori constraints placed on the coefficients of the trend variable (b_{17} and b_{24}).

The statistical model for the farm operator labour market is also overidentified. There are two variables (X_1 and X_2) that appear in the demand function but not in the supply function. Three variables (X_4, X_5, and X_6) appear only in the supply function. As long as at least one of these variables in each function has coefficients statistically significant (b_{15} or b_{16} for demand; b_{22}, b_{23}, or b_{25} for supply) the model will be identified.

The Market For Unpaid Family Labour in Agriculture

The variables are defined the same as in Chapter III. Statistical estimates of the structural demand and supply relationships for unpaid family labour were obtained using the following model.

Demand.

$$Y_5^D = a_5 + b_{30} X_1 + b_{31} X_2 + b_{32} X_3 + b_{34} X_9 + b_{35} X_{10} + b_{36} X_{11} + b_{37} Y_6 + r \qquad (4.5)$$

The a priori constraints on the parameter estimates are $b_{30} > 0$, $b_{31} < 0$, $0 < b_{34} < 1$, $b_{35} < 0$, $b_{36} < 0$, $b_{37} < 0$.

Supply.

$$Y_5^S = a_6 + b_{37} X_4 + b_{38} X_5 + b_{39} X_3 + b_{40} X_9 + b_{41} X_{10} + b_{42} X_{11} + b_{43} Y_6 + s \quad (4.6)$$

The *a priori* constraints on the parameter estimates are $b_{37} < 0$, $b_{38} > 0$, $0 < b_{40} < 1$, $b_{41} < 0$, $b_{42} < 0$, $b_{43} > 0$.

There are no *a priori* constraints placed on the coefficients of the trend variable (b_{32} and b_{39}).

The statistical model for the unpaid family labour market is over-identified as are the hired and operator labour market models. The model for unpaid family labour will be identified as long as one of the identifying demand coefficients (b_{30} or b_{31}) and one of the identifying supply coefficients (b_{37} or b_{38}) are statistically significant from zero.

THE ESTIMATION PROCEDURE

As outlined in the section entitled "Procedure" in Chapter I, this study attempted to obtain statistical estimates of the demand and supply relations for each component of the farm labour force by applying the same three models to five different farm labour markets: (1) the Canadian national market; (2) the Prairie region market; (3) the Alberta market; (4) the Saskatchewan market; and (5) the Manitoba market.

At all geographic levels, the market for each labour component was considered independently using time series data. At the national level data from 1947 to 1973 were used. For the regional and provincial models, due to the difficulty of obtaining some data series, data from

1954 to 1973 were used. The basic models postulated were two-equation demand and supply models with the market clearing identify of quantity demanded equal to quantity supplied assumed. It was assumed that the price and quantity of each of the components are jointly determined, subject to a set of exogenous variables. This required the use of systems of equations estimating procedures.

The Two-Stage Least Squares econometric technique developed by Theil and Basmann was used.[5] This technique consists of the application of ordinary least squares in two stages. In the first stage ordinary least squares is applied to the reduced form equations in order to obtain estimated values for each independent endogenous variable in the structural model. The second stage uses these values to estimate the structural equations, again using ordinary least squares.

For example, the structural equations of the hired farm labour market (3.1 and 3.2) were defined as:

$$Y_1^D = f\ (X_1, X_2, X_3, X_7, X_{11}, X_{12}, Y_2, v)$$

$$Y_1^S = f\ (X_4, X_5, X_3, X_7, X_{11}, X_{12}, Y_2, w)$$

where Y_2 (hired farm wage rate) is an independent endogenous variable. The reduced form equation used to obtain estimated values ($\hat{Y}_2$) of Y_2 is defined as:

---

[5]See H. Theil, "Estimation and Simultaneous Correlations in Complete Equation System," Central Planning Bureau, The Hague, a mimeograph, June 23, 1953; and R.L. Basmann, "A Generalized Classical Method of Linear Estimation of Coefficients in a Structural Equation," Econometrica, Vol. XXV, January, 1957, pp. 77-84.

$$Y_2 = f\ (X_1,\ X_2,\ X_3,\ X_4,\ X_5,\ X_7,\ X_{11},\ X_{12},\ u) \qquad (4.1)$$

The $\hat{Y}_2$ values replace the endogenous variables Y_2 in the right-hand side of equations 3.1 and 3.2. The transformed original equations are then used to obtain estimates of the structural parameters.

Several dimensions of the postulated model were examined. A step-wise regression approach towards the model specified in this chapter was carried out so that the explanatory power of certain variables could be ascertained.[6] As mentioned above the model was specified in both static and dynamic form, in order to evaluate the need for a dynamic model. Using the dynamic model also made it possible to separate the short-run and long-run elasticities. The final part of this section discusses this technique in detail. Also statistical estimates of the model parameters were made with the data in both linear and logarithmic form to further test the model.

The Calculation of Short-run and Long-run Elasticities

In Chapter III the section "Lagged Response to Economic Stimuli" presented arguments for the use of a dynamic model on the basis of an expected lagged response to economic stimuli. It was stated that the Nerlove distributed lag model would be used in the estimation of the response lag because this particular formulation of lagged models also allows one to estimate short-run and long-run elasticities.

---

[6] Experiments were carried out on three preliminary models. These models are described in Chapter V. All three preliminary models are overidentified as determined by the order and rank conditions discussed in this chapter.

In this study a calendar year was considered to be one time period and can be called the short-run. The short-run is defined as a length of time too short to allow a farm operator to vary all of his inputs, or to allow a farm labourer to completely adjust, in response to a change in economic conditions. Conversely, in the long-run all inputs are permitted to vary and complete adjustments to the changed conditions occur, other factors remaining constant.

Nerlove[7] pointed out that, without a means by which short-run and long-run elasticities can be separated, the estimated elasticities are a combination of both short and long-run responses, telling us nothing about either one specifically. Consequently he developed a procedure to separate the short-run and long-run elasticities obtained from a distributed lag model.

The model is based on the assumption that if the independent variables affecting the quantity supplied (or demanded) remain unchanged, the quantity supplied (or demanded) moves toward the long-run equilibrium position in such a way as to reduce the gap between equilibrium and the quantity supplied (or demanded) by a constant proportion in each time period until no such gap remains. The constant proportion of disequilibrium removed (γ) in each time period is called the coefficient of adjustment.

Operationally, when quantity demanded or supplied is the dependent variable, the dynamic model is formed by adding the dependent variable, lagged one time period, to the original demand or supply equation

---

[7]Marc Nerlove, "Distributed Lags and Estimation of Long-run Supply and Demand Elasticities: Theoretical Consideration," Journal of Farm Economics, Vol. 50, May 1958, pp. 301-311.

as another independent variable. The coefficients obtained from this type of estimating equation can be used to calculate the short-run elasticities. The coefficient of adjustment (γ) obtained by subtracting the coefficient of the lagged term from one, can be used to determine the length of time necessary to reach long-run equilibrium assuming no other changes take place.

If the data is specified in logarithmic form the coefficients of the estimating equation are direct estimates of the short-run elasticities. The coefficient of adjustment becomes an elasticity of adjustment (still referred to as γ) and the long-run elasticities are determined when the coefficients of the estimating equation are divided by γ.

In a distributed lag model the coefficient of adjustment, γ, is constrained as follows: $0 < \gamma < 1$. The coefficient of the lagged dependent variable, b_i, equals $1 - \gamma$. In order to accept the distributed lag hypothesis, b_i must be significantly greater than zero and significantly less than one. If $b_i = 0$, then $\gamma = 1$ and all adjustment to a new equilibrium occurs within the current period. If $b_i = 1$, then $\gamma = 0$ and there is no adjustment during the time period.

For example, if the coefficient of the lagged dependent variable, in a demand equation b_i, is estimated to be .40 with the data in logarithmic form then the elasticity of adjustment, γ, is estimated as $1 - .40 = .60$. This value for the elasticity of adjustment implies that 60 percent of the adjustment in quantity demanded to an economic stimulus occurs in the first time period. Under the assumption that a constant proportion of disequilibrium is removed each time period,

84 percent of the adjustment would occur by the end of the second time period and 93.6 percent would occur by the end of the third time period, if the other variables affecting demand did not change. In this example the coefficients of the estimating equation would be estimates of the short-run elasticities. The long-run elasticities would be estimated by dividing the coefficients by .60.

DATA PROBLEMS

The data required for this study came from Statistics Canada publications although in some instances a particular time series was transformed for economic or statistical reasons. In this section the data used and the adjustments made to them are discussed. The actual data series used in this study are too numerous to list within the chapter but are presented in Appendix B for the interested reader.

Farm Employment

Farm employment was estimated in terms of the average number of persons employed annually on farms. The data were not transformed into year-equivalents because it was believed that statistical results pertaining to the number of persons employed in agriculture would be more interpretable and therefore more valuable for policy implications than results pertaining to an ambiguous year-equivalent index. Furthermore, there was no satisfactory adjustment mechanism available to convert the labour characteristics of age, sex, and seasonality into a meaningful year-equivalent value.

Farm Wages

An annual income concept was not used for hired or unpaid family labour because much of this labour is employed only on a short term basis. Furthermore, a time series that would be compatible to the wage statistics provided for industry was necessary. An index for farm wages based on reported hourly, daily and monthly farm wage rates is available from Statistics Canada at the national level. This index was used in the national models and a similar index was developed by the author for the Prairie region and provinces.

It should be noted at this point that in all cases where a data series was estimated in index form, the base year for the index was 1961. In some instances, index numbers for the early years had to be converted from a 1935-39 base year to the 1961 base year. This was done by dividing the index numbers of the years to be converted by the index number for 1961 (in the 1935-39 base) and multiplying the result by 100.

Furthermore, all data series that were a measure of dollar values were deflated to reflect constant 1961 dollars. The Consumer Price Index was used to deflate most data series although the Farm Input Price Index was used to deflate farm prices and the farm operator's equity. The deflation process involves dividing the data series by the appropriate price index.

For each Prairie province hourly, daily, and monthly wage rates were available on an annual basis for the months of January, May, and August. The wage rates for these months were averaged to provide annual rates on a hourly, daily, and monthly basis which were then converted to an index form. After weighting the annual hourly, daily, and

monthly wage rate indexes to reflect the proportion of the farm labour force that was paid on each basis (hourly basis .23, daily basis .18, monthly basis .59), the separate indexes were summed to form a single farm wage index for each province. The provincial farm wage indexes were then deflated by the Consumer Price Index corresponding to the major cities of the province in question. An average of the Prairie province indexes was calculated for the Prairie region models.

Farm wage rate data were available both with board and without board. Only the without board data were used in this study to avoid the problems of quality differences that are inherent in the with board farm wage rate estimates as is done by Statistics Canada for the hired farm labour component of the Farm Input Price Index.[8]

In the case of operator labour an annual net income estimate was used as the measure of wages by calculating the annual net income per farm and deflating this figure by the Consumer Price Index. Although this net income per farm is actually a measure of the returns to management and the family farm labour force it was felt to reflect the price of operator labour more accurately than the farm wage rate indexes. There is no market in which the price of operator labour can be observed. The return to the operator's labour is determined jointly with the return to the inputs used in production. The net income per farm measure is a better proxy for the operator's return than is the farm wage rate because it reflects the residual return to labour along with the return to the other inputs.

---

[8]For a detailed explanation see, Statistics Canada, Farm Input Price Indexes 1961-1971, Cat. No. 62-534 occasional, Ottawa, Information Canada, 1971, p. 10.

Real Farm Prices

As indicated in Chapter III, the demand for labour was partially dependent on the price of the final product and the price of other inputs. It was decided to aggregate these two factors into one index primarily on statistical grounds. The price of the final products and the price of inputs are, in general, highly correlated over time. If these factors were kept separate in the demand equations and they were highly correlated, then multicollinearity problems may have occurred. Consequently, Statistics Canada's Farm Product Price Index was deflated by the Farm Input Price Index to avoid multicollinearity problems and to provide a measure of the real change in farm product prices.

The Farm Product Price Index was available at the provincial level but the Farm Input Price Index was only disaggregated for Western and Eastern Canada. Using a Western Canada input index was not deemed to be a major inconsistency in the provincial models because in some cases farm inputs are purchased from outside the province and because the variation in the price of major inputs, such as farm machinery, is not significant among the Western provinces.

Agricultural Productivity

Statistics Canada calculates an annual index of productivity per person employed in agriculture by dividing the real domestic product of the agricultural sector by the number of persons employed in agriculture. This index was believed to be the best available measure of agricultural productivity although some of the variation in the index is due to differences in weather conditions between crop seasons.

Such an index was not available at the Prairie region or provincial level. However, for each province, Statistics Canada did supply an annual index of physical production which was used as an indicator of productivity in each provincial model. An average of the three provincial output indexes was used in the Prairie region models. It was decided not to convert the output indexes to a per man basis in order to make it comparable with the national productivity index because the employment estimates at the provincial level were not as accurate as those at the national level.

Nonfarm Wage Rate

The nonfarm wage rate was used in the supply equations to indicate the returns to alternate forms of employment available to agricultural labourers. It was difficult to determine what would be an acceptable wage rate for alternate employment because of the large range of skills, education, age, and experience that exists in the agricultural labour force. For example, some farm operators may have the skills and education to qualify for management positions while unpaid family labour of school age may only qualify for minimum wage summer employment. It was believed that the majority of the agricultural labour force would seek relatively unskilled employment in industry. Therefore, the wage rate paid to wage earners as opposed to the somewhat higher salaries paid to management positions was deemed to be the more appropriate measure of returns to alternate employment. The wage rates paid to wage earners in the manufacturing industry was used because this data was available at the required level of disaggregation (provincial level) and it is fairly representative of the nonskilled and semiskilled wages available in industry.

In Chapter III it was stated that the nonfarm wage rate was adjusted for changes in the rate of unemployment in order to account for the availability of nonfarm employment.[9] This adjustment was calculated using the formula:

$$NFW_T \times (1 - U_T) = ANFW_T$$

where NFW_T was the nonfarm wage rate in year T, U_T was the rate of unemployment in the economy in year T, and $ANFW_T$ was the adjusted nonfarm wage rate in year T.

[9]Qualification of the nonfarm wage adjustment based on the unemployment rate was presented in Chapter III, pp. 53-54.

CHAPTER V

STATISTICAL RESULTS

This chapter consists of three main sections. The first section outlines the procedure used to evaluate the various models that were formulated. In the next section the preliminary experiments are summarized. The final section of this chapter summarizes the results of the theoretical model specified in Chapter III. A detailed accounting of the statistical results obtained from this model can be found in Appendix C.

PROCEDURE FOR MODEL EVALUATION

The ability of each regression model to identify the agricultural labour markets was judged on a combination of factors.

The overall significance of the regression equation was determined by Fisher's F test of the coefficient of determination. The coefficient of determination (R^2) indicates what percent of the variation in the dependent variable was explained by the independent variables. If R^2 is found to be statistically significant, this implies that there is a functional relationship between the independent variables and the dependent variable. Statistical significance at the one, five, or ten percent level was termed acceptable. Of course, the R^2 value (explanatory power) for a regression equation should be as high as possible. Generally, an R^2 value greater than .90 was considered a good result.

Regression coefficients were examined for consistency with economic theory by checking the sign of the coefficient (positive or negative).

Each coefficient was tested for statistical significance as determined by Student's t test. A ten percent or higher level of significance was considered acceptable. On all variables, except a trend variable, a one tailed t test was used. Since no a priori sign was hypothesized for the trend variable a two tailed t test was used instead.

In the dynamic models, two statistical texts were required to determine the significance of the lagged dependent variable. The reason for this procedure was stated in Chapter IV. A one tailed t test was used to determine if the coefficient of the lagged dependent variable was significantly different from zero. A 95 percent confidence interval around the value of the coefficient was used to determine if the coefficient was significantly less than one.

The simple correlation coefficient matrices were checked for the degree of correlation among explanatory variables. Strongly, linearly correlated regressors were taken as an indication of the presence of multicollinearity. The effects of multicollinearity were uncertain but evidence from economtric studies does imply that it gives rise to higher standard errors for estimated values.[1] If this occurs the calculated t values will be under-estimated which may cause statistically significant variables to appear non significant. Moreover, if explanatory variables are highly correlated the estimates of the coefficients may be indeterminate because the variables change together.[2] Under such conditions the sign

---

[1] A. Koutsoyiannis, Theory of Econometrics, London: The MacMillan Press Ltd., 1973, pp. 226-230.

[2] Ibid.

and values of the coefficients may be affected. In this study, if the regression coefficients had the theoretically correct sign and were statistically significant, it was assumed that multicollinearity was not a serious problem.

Finally, each regression equation was tested for the presence of autocorrelation or serial correlation in the calculated residuals. If the calculated residuals (error terms) are temporally dependent, that is, correlated with their own preceeding values, both the value and standard error of the estimated coefficients will be incorrect.[3] The extent of the error depends on the type and degree of autocorrelation.

In this study the Durbin-Watson test was used to test for autocorrelation because of its applicability to small samples. One weakness of this test is that it is less likely to detect the presence of autocorrelation if a lagged dependent variable appears in the set of explanatory variables. This bias is serious in models with only a lagged dependent variable as an explanatory variable. However, Malinvaud has shown that this bias is reduced as the number of explanatory variables is increased.[4] Consequently, the Durbin-Watson test as applied in this study was assumed to be relatively free from bias. The critical regions

---

[3] Ibid., pp. 202-205.

[4] E. Malinvaud, Stastical Methods in Econometrics, North-Holland, 1966, pp. 460-5.

and inconclusive regions were determined from Durbin-Watson d' statistic tables at the one percent level of significance.[5]

SUMMARY OF PRELIMINARY EXPERIMENTS

The preliminary experiments consisted of tests performed on three models closely related to the theoretical model hypothesized in Chapter III. Due to the considerable number of variations tested it is not practical to discuss all the results in this chapter. Alternatively, a brief summary is presented.

In model I the demand for hired, operator, and unpaid family labour was expressed as a function of real farm prices and the price of the labour component being demanded. The supply of each component was expressed as a function of the nonfarm wage rate, a measure of the labour force, and the price of that particular component. In addition, the supply of operator labour included owner's equity as an explanatory

---

[5]Tables presenting the critical regions and inconclusive regions for the Durbin-Watson test can only be used for regression equations with five or less explanatory variables. In this study some of the regression equations had six or more explanatory variables. For these equations, it was necessary to set up some acceptable criteria in order to test for autocorrelation. Since the theoretical value of the Durbin-Watson statistic (d') is two if there is no autocorrelation and the values of d' lie between zero and four; it was decided that, if an empirical value of d' fell within the range 1.90 and 2.10, it would be accepted that there was no autocorrelation. The inconclusive range, which increases with the number of explanatory variables, was conservatively set at .75 to 1.90 in accordance with the ranges presented in Durbin-Watson tables and with respect to the number of observations used in this study.

variable. For model II a trend variable was added to each supply and demand equation. The trend variable remained in each equation of model III and a measure of labour productivity was added to all demand equations.

Other experiments performed on the three models included the estimation of both dynamic (distributed lag) and static models and the testing of three alternative measures of the labour force: total civilian labour force, male civilian labour force and agricultural labour force. Experimentation was carried out for three levels of agricultural labour markets: The Canadian national market, the Prairie region market, and the Prairie region provincial markets. The data used at each level of analysis are presented in Appendix B.

Initially the equations were run in both linear and logarithmic forms. Specification in logarithmic form generally resulted in higher coefficients of determination, t values, and d statistic values. To keep the statistical results homogeneous it was decided to run all models with the data transformed to logarithms thereby making the estimated coefficients direct estimates of the elasticities. The estimated coefficient of the lagged term in the dynamic equations is used to estimate the elasticity of adjustment rather than the coefficient of adjustment.

In addition, initial computer results of the national model showed the size of the male civilian labour force variable (M.C.L.F.) to be a weak explanatory variable in the supply equation. The use of this variable resulted in lower R^2 values with the coefficient more often statistically nonsignificant relative to supply equations using the size of the agricultural (A.L.F.) or total civilian labour force (T.C.L.F.) variables. Based on the early lack of success with the M.C.L.F. variable, experimentation

with this variable was discontinued. Testing with the A.L.F. and T.C.L.F. variables continued throughout all model formulations.

Hired Labour Market

The preliminary experiments performed on the hired labour market were not encouraging. In most models the overall regression equations were statistically significant with acceptable R^2 values, which increased when the trend and productivity variables were added. However, the coefficients of the explanatory variables were often not statistically significant. Generally, the coefficients did, however, have the expected theoretical sign. One notable exception to this was the productivity variable in the demand equations which appeared with an unexpected positive coefficient in most models.

Based on the evaluation procedure outlined in the first section of this chapter, the T.C.L.F. variable was preferable to the A.L.F. variable in the supply equations except for the regional models where the A.L.F. variable worked better.

As expected the lagged dependent variable increased the R^2 value in the dynamic models, however, statistical significance of the coefficient presented a problem. In most of the national and regional models the coefficient was not significantly different from zero resulting in an elasticity of adjustment (γ) equal to one. This would indicate that no lag in the adjustment to economic stimuli exists in the hired labour market. The same coefficient was not significantly different from one in most of the provincial models which meant γ was equal to zero and that no adjustment took place in that time period.

In the demand equations, where statistical tests showed γ to be significantly greater than zero and significantly less than one, there was a moderate spread in the values obtained for γ. The elasticity of adjustment at the national level (model I) was .684 when the T.C.L.F. variable was used in the model and .695 when the A.L.F. variable was used. For Alberta (model I), the γ value was .541 when either the T.C.L.F. or A.L.F. variable was used in the model.

In only two supply equations did γ meet the statistical requirements. At the national level (model I) the γ value was .695 compared to a γ value of .672 for Manitoba (model I). The spread in the values obtained for γ were less in the supply equations than in the demand equations but in both cases the national models had a greater response to the economic stimuli than the provincial models. Model I, at the national level, indicated that with respect to economic stimuli the rate of adjustment was nearly equal for the demand for hired labour and the supply of hired labour.

Due to the high incidence of statistically nonsignificant coefficients and to a lesser extent theoretically incorrect signs on those coefficients, multicollinearity was considered a problem in these preliminary experiments. The simple correlation coefficient matrices, a sample of which is presented in Appendix D for the interested reader, indicated strong linear correlation among the explanatory variables. This correlation was commonly in the order of .8 or higher.

Serial correlation of the calculated residuals was deemed to be less of a problem. The models at the national and regional levels were relatively free of autocorrelation as were the dynamic provincial models. Tests for autocorrelation at the provincial level were generally inconclusive when the models were of the static form.

The national models were ranked slightly ahead of the regional and provincial models in terms of its explanatory power on the basis of the overall statistical results. All regression equations were statistically significant and had acceptable R^2 values. Autocorrelation was not a problem, most coefficients had the expected sign, and statistically significant coefficients were more common at the national level. Furthermore, it was only at the national level that both demand and supply equation were able to identify the adjustment mechanism.

Operator Labour Market

Tests performed on the operator labour market proved encouraging. All regression equations were statistically significant and R^2 values were quite high. The independent variables were capable of explaining 90 percent of the variation in the demand for and supply of farm operators, on average.

In most cases, the statistically significant coefficients of the explanatory variable had the expected signs. When the expected signs did not appear on the coefficients, the coefficients were generally not statistically significant. However, as with the hired labour market models, there were some cases where the coefficients had the correct theoretical sign but were not statistically significant. This latter situation was most common with the net farm income or price of operator labour variable in the supply equations. The trend variable, which generally had a negative coefficient when it was statistically significant, and the productivity variable both improved the R^2 values when they were included in the equations. The productivity variable worked better in

the operator labour market models than in the hired labour market models. At the provincial level, the coefficient had the expected negative sign whenever it was statistically significant.

Tests with the two labour force variables indicated that the A.L.F. variable worked marginally better than the T.C.L.F. variable. This result was the reverse of that for the hired labour market possibly indicating that the supply of farm operators depends on a smaller, more specialized labour force than the supply of hired farm labour.

Using a lagged dependent variable worked particularly well at the regional level where all three preliminary model formations were able to identify the adjustment mechanism. The results were less successful at the national and provincial levels where the coefficient of the lagged term was generally not significantly different from one. This implied that γ was equal to zero and that no adjustment took place in that time period. Specifically, the elasticity of adjustment (γ) was found to be significantly greater than zero and significantly less than one in the demand equations of the national (models I and II), regional (models I and III), Alberta (model II), and Manitoba (models I and II) models but only in the supply equations at the regional (models I, II and III) level.

Results of the demand equations (model I) indicate the γ values for the national, regional and Manitoba equations were .810, .547 and .302, respectively. These results are comparable to those of the hired labour market as in both cases the magnitude of the response was greater at the national level.

A similar comparison could not be made for the supply equations as γ values could only be calculated for the regional models. However,

at the regional level it was possible to compare demand elasticities of adjustment to supply elasticities of adjustment. Unlike the hired labour market, the γ values for the demand equations were not similar to the γ values for the supply equations. In all cases where a comparison was possible, the γ values were greater for the supply equations. For example, in model I when the γ value for the demand equation was .547, the γ value for the supply equation was .723. Similarly in model III the γ values were .495 and .643 for the demand and supply equations, respectively.

As with the hired labour market, the problem of multicollinearity was believed to be partially responsible for the theoretically incorrect signs and the lack of statistical significance of some coefficients. The reader is again referred to Appendix D which presents a sample of the simple correlation coefficient matrices and indicates the degree of linear correlation among the explanatory variables.

The presence of autocorrelation was only detected, by the Durbin-Watson test, in the static demand equations. In these equations positive autocorrelation was often present, particularly in models I and II. The Durbin-Watson test was unable to detect autocorrelation in the dynamic demand equations or the supply equations. Although a few of the test results were inconclusive, most indicated that autocorrelation was not a problem.

Comparing the national, regional and provincial models, there was little evidence to suggest one level of analysis was better than the other. At all three levels the regressions were statistically significant and the R^2 values were quite high. Each level had some equations with coefficients that did not have the expected sign or were not statistically

significant but these problems were of the same magnitude. The one distinguishing feature was the fact that the regional models were best able to identify the adjustment mechanism with the lagged dependent variable technique.

Unpaid Family Labour Market

The statistical results of the preliminary experiments on the unpaid family labour market were an improvement over the results for the hired labour market but were not as encouraging as the results for the operator labour market. The R^2 values were greater than .95 for the equations at the national level while at the regional and provincial level the R^2 values ranged from .80 to .90. All equations were statistically significant at the one percent level.

In most equations, the coefficients of the real farm price and productivity variables had the expected signs but neither variable was consistently statistically significant. The trend variable generally had a negative coefficient in the demand equations and a positive coefficient in the supply equations at all levels although it was only statistically significant at the national level. The farm wage rate variable worked well in the demand equations but the coefficient had a theoretically wrong sign and was statistically nonsignificant in the supply equations. Results of a similarly unfavourable nature were obtained for the nonfarm wage rate variable in the supply equations. These preliminary results indicated that the supply of unpaid family labour was not a function of either the prevailing farm wage or nonfarm wage rate.

Of the two labour force variables (T.C.L.F. and A.L.F.) tested, the A.L.F. variable appeared to have the most satisfactory results as it

did for the operator labour market. The coefficient of the A.L.F. variable consistently had an expected positive coefficient whereas the T.C.L.F. did not. However, statistical significance was still a problem. The choice of one variable over the other had little affect on the R^2 values.

The lagged dependent variable was unable to identify the adjustment mechanism. In most dynamic equations the coefficient was not significantly different from one which implies that γ was equal to zero and that no adjustment occurred in that period.

Only in the supply equation (model III) at the national level was the coefficient of the lagged term statistically significant from both zero and one. In this case the value of the elasticity of adjustment was .473 which implies 47.3 percent of the adjustment in supply to an economic stimuli takes places in the first time period. By the end of the third time period (three years in this study) about 85 percent of the adjustment in the supply of unpaid family labour due to the original stimuli would have occurred, assuming no other stimuli affected the market.

Multicollinearity was believed to be a problem in these models, especially with respect to the lagged term. The large standard errors spread out the confidence intervals (used to test the coefficients statistical significance from one) to the point where almost all values fell within the limits of the confidence interval. Statistical significance of the other variables were similarly affected. Appendix D presents a sample of the simple correlation coefficient matrices obtained from models of the unpaid labour market.

Serial correlation of the calculated residuals was a problem in the static models at the national and regional levels. Here positive

autocorrelation was present. However, the dynamic models were generally free from autocorrelation problems. The Durbin-Watson test, when applied to the provincial models, generally had inconclusive results in the static models but indicated few autocorrelation problems in the dynamic models.

Statistical results obtained at the national level were marginally superior to those at the regional or provincial level. This conclusion is based on the fact that, at the national level, the R^2 values were 5 to 10 percent higher, more of the coefficients were statistically significant, and only at this level was the adjustment mechanism identified.

RESULTS FROM MODEL IV

This analysis is based on the results obtained from the theoretical model set forth in Chapter III (model IV). Model IV was found to be superior to the preliminary models I through III in its ability to explain the variation in the demand for and supply of the three agricultural labour components. While the explanatory power of model IV, as expressed by the R^2 values, was only marginally acceptable for the hired labour component, it was quite satisfactory for the operator and unpaid family labour components. The regression equations for model IV were statistically significant at the 10 percent level or higher except for some hired labour equations (most noticeable were the static demand functions).

Although model IV was tested in both static and dynamic form, the following analysis concentrates on the dynamic equations. The statistical tests performed on the lagged variables provided only weak support for the distributed lag hypothesis, as is indicated by the results

in Appendix C, but the dynamic form of the model has other advantages which make it superior to the static form.

Firstly, the dynamic model has a solid theoretical basis. The underlying assumption that complete adjustment to economic stimuli does not take place in one time period is quite consistent with rational behaviour. Suppliers of labour can be expected to lag in their response because of such factors as a lack of job training, barriers to mobility or limited alternatives at a given time. Farm operators can be expected to lag in their demand for labour due to such factors as prior commitments and the complementarity of labour with other factors of production. Both supply and demand response are affected by a common lack of knowledge with respect to the occurrence and permanence of specific economic events. Lagged response seems especially appropriate in the agricultural labour markets where a large number of farm operators and a non-unionized labour force coexist in a relatively unregulated market.

Secondly, using Nerlove's distributed lag model made it possible to separate short-run and long-run elasticities and to determine the elasticity of adjustment. Elasticities are quite important in policy analysis because they estimate the magnitude of change in demand or supply resulting from some change in one of the factors that affect market structure. However, in static equations short-run and long-run elasticities can only be observed as a combined influence rather than two distinct adjustment periods.

The dynamic models had merit on statistical grounds as well as theoretical grounds. The R^2 values, which indicate the explanatory power of the model, were higher in the dynamic equations than in the static

equations. In general, the difference was most noticeable in the demand equations and for the hired labour components. The R^2 statistic alone does not provide strong support for acceptance of the distributed lag hypothesis because the inclusion of the lagged dependent variable as an explanantory variable will always increase the R^2 value if the economic variables are following a long-run trend.

Serial correlation of the calculated residual was also reduced in the dynamic equations. The Durbin-Watson test for autocorrelation indicated that the dynamic equations were more free from autocorrelation problems than the static equations. Moreover, the dynamic equations with inconclusive Durbin-Watson tests had d-statistic values closer to the upper limit of the inconclusive range than the d-statistic values for the static equations. The only time positive autocorrelation was detected, the equation was in the static form. As with the R^2 values, the Durbin-Watson test must be treated with caution in the dynamic equations. The lagged term may pick up the effects of omitted variables and thus remove the serial correlation from the error term. Although the improvement in Durbin-Watson test results may be partially due to this characteristic, the lagged term did not appear to be masking serious autocorrelation problems because even in the static equations the test was unable to detect autocorrelation.

Finally, the dynamic model was compared to the static model with respect to the affect of the lagged dependent variable on the other regression coefficients. The lagged term did not affect the signs or the statistical significance of the coefficients to any appreciable degree.

Slight improvements were noticeable in some cases such as the coefficient of the nonfarm wage variable which appeared with the expected sign with more consistency in the dynamic supply equations. On the basis of its affect on the regression coefficients, the lagged term could be considered superfluous and left out of the model. However, because this variable provides other advantages it is left in the demand and supply equations and the model remains dynamic in nature.

Each variable is discussed in terms of the sign and statistical significance of the regression coefficient along with the short-run elasticities obtained. Long-run elasticities are included in the discussion of the elasticity of adjustment. The statistical results are presented in Tables 5.1 through 5.10. Different levels of aggregation are discussed separately beginning at the national level followed by the regional and provincial levels.

National Model

The price of labour variable had a statistically significant negative coefficient in the operator and unpaid family labour demand equations. This implies an increase in the price of these components will result in a decrease in the quantity demanded. In the hired labour demand equation, the coefficient had a theoretically incorrect positive coefficient that was not statistically significant. The coefficient was also not statistically significant in the supply equations. However, it had the expected positive sign in the hired and unpaid family labour supply equations indicating an increase in the farm wage rate would increase the quantity of labour supplied to agriculture.

Table 5.1

Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Canada

	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Nonfarm Wage	X_5 Labour Force	X_6 Owner's Equity	X_7 Hired Labour Lagged	X_8 Operator Labour Lagged	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{y}^n_{2,}\hat{y}^n_{4,}\hat{y}^n_6$ Price Of Labour
Hired Labour													
Demand	-.087	-.234	-.064				.196				.131	-.146	.195
Constant=1.758	(.311)	(.211)	(.081)				(.307)				(.964)	(.213)	(.547)
R^2= .640**d'=1.58*													
Supply			-.033	-.045	3.068*		.134				-1.309*	-.829**	.357
Constant=-2.321			(.065)	(.594)	(.878)		(.209)				(.698)	(.247)	(.339)
R^2=.758**d'=1.62*													
Operator Labour													
Demand	1.271*	.687+	-.012					.596**		.348*		.176+	-.613*
Constant = .699	(.689)	(.452)	(.038)					(.126)		(.200)		(.125)	(.318)
R^2=.991**d'=2.00													
Supply			.019	-.401**	.883**	-.202**		-.200+		-.152*		-.120	-.031+
Constant=3.007			(.017)	(.148)	(.323)	(.069)		(.124)		(.065)		(.102)	(.020)
R^2=.998**d'=2.00													
Unpaid Family Labour													
Demand	.064	-.374**	.017						.938**	-.062	-1.396*		-.739*
Constant=6.161	(.214)	(.142)	(.069)						(.167)	(.164)	(.674)		(.403)
R^2=.984**d'=2.00													
Supply			-.039	-.119	2.566**				.208	-.376*	-1.275**		.211
Constant=-1.612			(.047)	(.432)	(.580)				(.179)	(.161)	(.425)		(.317)
R^2=.989**d'=1.67*													

NOTE: (1) A one-asterisk superscript indicates the regression coefficient is statistically significant at the five percent level, a two-asterisk superscript indicates significance at the one percent level, and + indicates statistical significance at the ten percent level.

(2) d' is the Durbin-Watson statistic for serial correlation among the calculated residuals. The presence of positive serial correlation is indicated by a two-asterisk superscript. One-asterisk indicates an inconclusive test. No superscript indicates no serial correlation among the residuals.

(3) X_5 represents the total civilian labour force rather than the agricultural labour force when the coefficient in the table has the superscript, 0.

(4) The price of labour coefficient represents the farm wage rate in the hired and unpaid family labour equations and represents net farm income in the operation labour equations.

Table 5.2

Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV - Canada

	Elasticity of Adjustment[a]	Price of Labour[b]	Real Farm Prices	Productivity	Non-farm Wage Rate	Labour Force	Owner's Equity	Trend	Hired Labour	Operator Labour	Unpaid Family Labour
Hired Labour - Demand											
Short-run		.195[c]	-.087[c]	-.234[c]				-.064[c]		.131[c]	.146
Long-run	1	.195	-.087	-.234				-.064		.131	.146
Hired Labour - Supply											
Short-run		.357[c]			-.045[c]	3.068		-.033		-1.309	-.829
Long-run		.357			-.045	3.068		-.033		-1.309	-.829
Operator Labour - Demand											
Short-run		-.613	1.271	.687				-.012	.348		.176
Long-run	0										
Operator Labour - Supply											
Short-run		-.031[c]			-.401	.883	-.202	.019[c]	-.152		-.120[c]
Long-run	1.200										
Unpaid Family Labour - Demand											
Short-run		-.739	.064	-.374				.017[c]	-.062[c]	-1.396	
Long-run	0										
Unpaid Family Labour - Supply											
Short-run		.211[c]			-.119[c]	2.566		-.039[c]	-.376	-1.275	
Long-run	1	.211			-.119	2.566		-.039	-.376	-1.275	

Note: The short-run elasticities were taken directly from the structural demand and supply equations. The long-run elasticities were calculated by dividing the short-run elasticities by the elasticity of adjustment. Long-run elasticities were not calculated if the elasticity of adjustment was found to be zero or greater than one. For the purpose of this discussion, the elasticities for all variables are presented, including those found not stastically significant.

[a] If the coefficient of the lagged dependent variable (b_i) was not significantly different from zero at the ten per cent level or higher, it was assumed that this coefficient was equal to zero and the elasticity of adjustment was equal to one ($1-b_i = \gamma$). If the coefficient was not significantly different from one, based on a 95 per cent confidence interval, the coefficient was assumed equal to one and the elasticity of adjustment was equal to zero.

[b] The price of labour coefficient represents the farm wage rate in the hired and unpaid family labour equations and represents net farm income in the operator labour equations.

[c] Computed from coefficients not statistically significant at the ten per cent level or higher.

[d] The total civilian labour force variable was used instead of the agricultural force variable in this supply equation.

Short-run responses were all inelastic with the supply of hired labour more responsive to farm wages than the quantity demanded. The opposite was true for the family labour components. Both operator and unpaid family labour demand was quite sensitive to changes in the price of labour relative to the supply of these components.

The demand for farm labour was expected to increase as real farm prices increased. This result was obtained for the family labour components but not for the hired labour component. Real farm prices had very little influence on the demand for hired or unpaid family labour with short-run elasticities of -.087 and .064, respectively and neither coefficient being statistically significant. In the operator labour demand function, the coefficient of the real farm price variable had a short-run elasticity of 1.271 which was statistically significant. A one percent increase in the real farm price would be expected to increase the quantity of operator labour demanded by 1.271 percent in the first year, other things remaining constant.

The productivity variable had the expected negative coefficient in the hired and unpaid family labour demand equations. The implication is that increased productivity will result in increased output which depresses product prices because supplies outpace demand. With a lower price for the final product, the derived demand for labour will decrease through this market effect. The positive and statistically significant coefficient in the operator labour demand equation may indicate that this market effect, created by increased productivity, affects the demand for operator labour in a different way. If increased productivity has a negative effect on the price of the final product, the returns to operator

labour and therefore the price of operator labour will decrease. As the price of this labour component declines the demand for operator labour would increase, assuming this decline in price more than offsets the decline in the price of the final product.

The short-run response to change in productivity was inelastic for all three farm labour components with the demand for operator labour about twice as responsive as the demand for hired or unpaid family labour.

The trend variable was introduced into each demand and supply equation to take account of changes in the component labour market that were highly correlated with time and not explained by the economic variables. Trend did not appear to be an important factor as the coefficient was not statistically significant and its magnitude was quite small. Moreover, the sign on the coefficient was not consistently positive or negative. Multicollinearity problems are believed to have caused the coefficient to become unstable and statistically non-significant because trend was highly correlated with the economic variables. If this is the case, secular influences not accounted for by the economic variables may be masked by the inability of the model to separate these influences so that they can be measured. Preliminary experiments showed the trend variable to have some merit on the grounds that it increased the overall explanatory power of the model particularly for the hired and unpaid family labour markets. In addition, the trend variable picked up some influences that might otherwise have been attributed to the lagged term thereby under-estimating the elasticity of adjustment.

Substitution variables were introduced into each equation to allow testing for interdependencies among the three components of the

agricultural labour force. It was hypothesized that the substitution variables would have a negative coefficient in both the demand and supply equations. A negative coefficient was obtained for all substitution variables in all the national supply equations and only one coefficient (quantity of unpaid family labour in the operator labour equation) was not statistically significant. This result implies that there is a certain amount of mobility among the three components. In the short-run, there would be very little change in the supply of operator labour due to changes in the quantity of hired or unpaid family labour as evidenced by short-run elasticities of -.152 and -.120, respectively. For example, few of the people leaving employment as hired labour or unpaid family labour would be expected to become farm operators. Conversely, the quantity of operator labour has a much greater effect on the supply of the other two components. A one percent increase in the quantity of operator labour will decrease the quantity of hired and unpaid family labour supplied by more than one percent, ceteris paribus. One interpretation of this result could be that farm operators tend to come exclusively from the ranks of experienced farm labour and the addition of a farm operator concommitantly reduces the supply of hired or unpaid family labour, ceteris paribus.

On the demand side, the substitution variables were less successful. Only in the unpaid family labour demand equation did both substitution variables have the theoretically correct sign on the coefficient and then only the coefficient for the quantity of operator labour was statistically significant at the ten percent level or higher. The quantity of unpaid family labour variable had the expected sign and was

statistically significant in the hired labour demand equation. In general, the short-run demand response to the substitution variables was less than the supply response. Some of the unfavourable results for the substitution variables in the demand equations may be due to the method of introducing the substitute components. Theoretically, it would have been preferrable to test for a substitution effect using the price of the substitute commodity rather than the quantity. However, accurate estimates of the price of operator and unpaid family labour were not available.

The nonfarm wage rate variable, adjusted for the level of unemployment, had the expected negative coefficient in all national supply equations although it was only statistically significant at the ten percent level in the operator labour supply equation. The negative coefficient implies that an increase in the wages outside the agricultural industry relative to farm wages and incomes would decrease the supply of all three farm labour components. It is interesting to note that the supply of operator labour was more responsive to the nonfarm wage rate than the supply of either hired or unpaid family labour. Operator labour was expected to be less responsive due to ties to the farming operation. Perhaps farm operators, on average, have more education and experience than the other components, thereby qualifying for more of the available nonfarm employment opportunities.

Hired labour and unpaid family labour were both more responsive to the farm wage rate than to the nonfarm wage rate; especially hired labour which had a short-run elasticity for farm wages of .357 compared to -.045 for nonfarm wages. A similar comparison could not be made for the operator labour component because the net farm income variable had a theoretically incorrect coefficient.

The labour force variable (agricultural labour force) worked well in all three supply equations with the coefficient having the expected positive sign and being statistically significant at the ten percent level or higher. The size of the labour force was a strong variable in determining the quantity of hired and unpaid family labour supplied. The short-run elasticity was greater than one for both components which means for a given percent increase/decrease in the size of the labour force, a greater percent increase/decrease will occur in the quantity of labour supplied, ceteris paribus. The short-run supply response for the operator labour component was inelastic.

Finally, the owner's equity variable in the operator labour supply equation was statistically significant but did not have the expected positive coefficient. It was hypothesized that farm operators may remain in agriculture despite higher returns to labour elsewhere in order to obtain the return on their capital assets. In this sense, the higher the farm equity, the less likely an operator will leave the farm thereby making the relationship between equity and supply of operator labour positive.

The negative coefficient may indicate an opposite relationship. The continuing decline in the number of farm operators is believed partly due to reduced entry into the industry. Greatly increased cost of entry or initial investment in a farm enterprise is generally given as one reason for the reduced number of entrants. If this is the case, the owner's equity variable may be measuring the steadily increasing investment required to begin farming. Under these assumptions, the negative coefficient on the equity variable could be given the following

interpretation. As the capital investment required to farm increases, fewer persons will attempt to enter the industry either to replace someone leaving the industry or to begin a new operation.

Theoretically, the elasticity of adjustment should have a value between zero and one. The adjustment coefficient had a value of one in the hired labour demand equation implying that all adjustment takes place in one time period. Therefore, the long-run elasticities are the same as the short-run elasticities. The same result was obtained for the hired and unpaid family supply equations. In the operator and unpaid family labour demand equations, the adjustment coefficient was zero. This implies no adjustment to economic stimuli in the first time period. The results indicate that rapid adjustments are made in the demand for hired labour as economic conditions change but the demand for operator and unpaid family labour (the components that do not receive a direct wage payment) adjusts more slowly.

On the supply side, the hired and unpaid family labour components both adjust rapidly to changing conditions. Both components likely face similar alternatives to agricultural employment and neither have a strong financial commitment to the farm enterprise. The supply of operator labour equation has an elasticity of adjustment greater than one which indicates an over adjustment to economic stimuli. In this case the distributed lag hypothesis may be in error. For example, the time period in which adjustments are measured may need to be shortened to a quarterly rather than a yearly basis in order to observe adjustments in the supply of the operator's own labour.

Regional Model

The statistical results improved somewhat in the regional models in terms of theoretically consistent signs. The price of labour variable had a coefficient with the expected negative sign in all demand equations and was statistically significant at the 5 percent level or higher in the operator and unpaid family labour equations. A theoretically consistent positive coefficient, statistically significant at the 5 percent level or higher, was obtained for the labour force variable in each supply equation. The real farm price variable had the expected positive sign in all demand equations but was only statistically significant in the operator labour equation. Owner's equity appeared with the hypothesized positive coefficient in the operator labour supply equation and was statistically significant at the ten percent level. The trend variable was statistically significant at the ten percent level or higher and had a positive coefficient in all supply equations.

Two interpretations of this positive influence on the supply of farm labour can be advanced. First, gradual improvements in the working and living conditions available to people employed in agriculture combined with the increasing disadvantages of urban living (overcrowding, crime, pollution) may be changing the attitude of some people towards farm employment. Secondly, the trend variable may be picking up a consistent error in the measurement of the specified economic variables. Whatever the cause of this influence, its magnitude is relatively small as all coefficients for the trend variable were less than .150.

The nonfarm wage rate variable did not work as well in the regional supply equations as the coefficient had a theoretically inconsistent sign in the hired and unpaid family labour equations. However,

Table 5.3

Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Prairie Region

	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Nonfarm Wage	X_5C Labour Force	X_6 Owner's Equity	X_7 Hired Labour Lagged	X_8 Operator Labour Lagged	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\bar{y}_2, \bar{y}_4, \bar{y}_6$ Price of Labour
Hired Labour													
Demand	.113	-.032	.040				.164				.422	-.032	-.036
Constant=.435	(.312)	(.151)	(.062)				(.292)				(.636)	(.134)	(.761)
R^2=.215d'=1.94													
Supply			.104+	.048	6.011*		.052				-4.384*	-.665	-.329
Constant=1.525			(.052)	(1.270)	(2.603)		(.205)				(1.952)	(.170)	(1.924)
R^2=.724*d'=2.08													
Operator Labour													
Demand	1.144**	1.006**	.003					.481**		.031		.087**	-.590**
Constant=.907	(.179)	(.145)	(.014)					(.090)		(.062)		(.016)	(.085)
R^2=.978**d'1.41*													
Supply			.019**	-.115*	1.316**	.058+		-.026		-.098**		-.129**	-.001
Constant= -.564			(.006)	(.052)	(.080)	(.034)		(.066)		(.031)		(.014)	(.007)
R^2=.997**d'=2.82*													
Unpaid Family Labour													
Demand	.083	-.170	.024						.199	-.307	-1.719		-3.407*
Constant = 13.001	(.630)	(.338)	(.137)						(.351)	(.717)	(1.277)		(1.650)
R^2=.908**d'=2.19													
Supply			.145**	1.344	8.004**				-.373	-.770**	-5.961**		-3.381
Constant= 3.908			(.042)	(1.723)	(1.444)				(.281)	(.214)	(1.261)		(2.965)
R^2=.993**d'=2.24													

NOTE: See Table 5.1 for footnotes.

Table 5.4

Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Prairie Region

	Elasticity of Adjustment[a]	Price of Labour[b]	Real Farm Prices	Productivity	Nonfarm Wage Rate	Labour Force	Owner's Equity	Trend	Hired Labour	Operator Labour	Unpaid Family Labour
Hired Labour - Demand											
Short-run		-.036[c]	.113[c]	-.032[c]				.040[c]		.422[c]	-.032[c]
Long-run	1	-.036	.113	-.032				.040		.422	-.032
Hired Labour - Supply											
Short-run		-.329			.048[c]	6.011		.104		-4.384	-.665
Long-run	1	-.329			.048	6.011		.104		-4.384	-.665
Operator Labour - Demand											
Short-run		-.590	1.144	1.006				.003[c]	.031[c]		.087
Long-run	.519	-1.137	2.204	1.938				.006	.060		.168
Operator Labour - Supply											
Short-run		-.001[c]			-.115	1.316	.058	.019	-.098		-.129
Long-run	1	-.001			-.115	1.316	.058	.019	-.098		-.129
Unpaid Family Labour - Demand											
Short-run		-3.407	.803[c]	-.170[c]				-.024[c]	.307[c]	-1.719[c]	
Long-run	1	-3.407	.803	-.170				-.024	-.307	-1.719	
Unpaid Family Labour - Supply											
Short-run		-3.381[c]			1.344[c]	8.044		.145	-.770	-5.961	
Long-run	1	-3.381			1.344	8.044		.145	-.770	-5.961	

See Table 5.2 for footnotes.

in the operator labour equation the coefficient had the expected positive sign and was statistically significant at the 5 percent level.

The short-run elasticities were often higher in the regional equations compared to the equivalent national equations. Although the results were not conclusive, it would appear that demand and supply were more responsive in the short-run in the prairie region than for the nation as a whole. This hypothesis was strengthened by the values for the elasticity of adjustment. Whereas in the national demand equations for operator and unpaid family labour the elasticity of adjustment was zero, it was .519 and one, respectively, at the regional level. In all other equations at the regional level, the elasticity of adjustment was one implying complete adjustment in one time period.

The elasticity of adjustment of .519 in the operator labour demand equation implies that about 52 percent of the total adjustment to a change in economic conditions occurs in the first time period. By the end of the second time period 77 percent of the disequilibrium will be removed and 89 percent will be removed by the end of the third period, assuming no other shocks affect the system.

Provincial Models

The statistical results, in terms of statistical significance at the ten percent level, were much less favourable in the Alberta models compared to the regional and national models, slightly less favourable in the Manitoba models, and more or less the same in the Saskatchewan models. This is due, in part, to the indirect way in which data had to be estimated at the provincial level. The estimation procedure causes

the data to be less precise in the measurement of the specified economic variables.

The price of labour variable continued the same pattern in each provincial model that appeared in the regional model. That is, the coefficient had the expected sign in the demand equations but a theoretically inconsistent sign in the supply equations. The coefficient was often not statistically significant at the ten percent level. One explanation of the lack of importance of the price of labour in determining the labour supply may be that employment in agriculture, for many people, is a last resort situation with farm work accepted only when nothing else is available. In such a case, the wage rate is of little importance. Farm operators may remain in agriculture because of their heavy financial commitment or because they enjoy the life style. They may pay little attention to the returns to their labour in relation to some monetary opportunity cost.

A second interpretation, at least for the supply of hired and unpaid family labour, could be that the returns for farm work are very close to the returns for nonfarm work when all factors are considered (free board on the farm, low returns for unskilled nonfarm work). If monetary returns are equitable and tend to remain so, it may be the non-precuniary differences that are of most importance. The long hours and isolation from public services associated with some farm jobs, for example, may be of more significance than wage rates.

This premise was given further support by the nonfarm wage rate variable which was generally not statistically significant in the supply equations. The variable did, however, have the expected negative coefficient in the hired and operator labour equations.

Table 5.5

Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Alberta

	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Nonfarm Wage	X_5 Labour Force	X_6 Owner's Equity	X_7 Hired Labour Lagged	X_8 Operator Labour Lagged	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$y^n_{2,}y^n_{4,}y^n_6$ Price Of Labour
Hired Labour													
Demand	.085	-.137	.069				.537*				.261	-.103	-.332
Constant=1.267	(.204)	(.226)	(.055)				(.259)				(.676)	(.087)	(.571)
R^2=.460d'=1.49*													
Supply			-.090	-1.777+	2.690*°		.346				.329	-.034	-.558
Constant = 5.225			(.075)	(.503)	(1.270)		(1.444)				(.685)	(.117)	(2.038)
R^2=.619+d'=1.56*													
Operator Labour													
Demand	.378	.159	-.034					.435*		.138		.091*	-.147
Constant = .969	(.864)	(.624)	(.029)					(.164)		(.131)		(.044)	(.375)
R^2=.992**d'=2.33*													
Supply			-.038*	-.296	.767	-.177**		-.428*		-.036		.020*	-.035
Constant = 1.579			(.016)	(.369)	(.830)	(.111)		(.234)		(.114)		(.033)	(.033)
R^2=.988**d'=1.91													
Unpaid Family Labour													
Demand	-.158	-.688	.117						.083	-.969	2.177		-.814
Constant= 1.197	(.662)	(.661)	(.166)						(.374)	(.843)	(2.112)		(2.317)
R^2=.903**d'=2.11*													
Supply			.281	5.292	-1.239°				-.564	-.420	3.555+		-7.045
Constant = 11.775			(.398)	(4.602)	(11.794)				(1.866)	(1.262)	(2.506)		(18.036)
R^2=.905**d'=2.12*													

NOTE: See Table 5.1 for footnotes.

Table 5.6

Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Alberta

	Elasticity of Adjustment[a]	Price of Labour[b]	Real Farm Prices	Productivity	Nonfarm Wage Rate	Labour Force	Owner's Equity	Trend	Hired Labour	Operator Labour	Unpaid Family Labour
Hired Labour - Demand											
Short-run		-.332[c]	.085[c]	-.137[c]				.069[c]		-.261[c]	-.103[c]
Long-run	0										
Hired Labour - Supply											
Short-run		-.558[c]			-1.777	2.690[c,d]		-.090[c]		.329[c]	-.034[c]
Long-run	1	-.558			-1.777	2.690		-.090		.329	-.034
Operator Labour - Demand											
Short-run		-.147[c]	.378[c]	.159[c]				-.034[c]	.138[c]		.091
Long-run	.565	-.206	.669	.281				-.060	.244		.161
Operator Labour - Supply											
Short-run		-.035[c]			-.296[c]	.767[c]	-.177	-.038	-.036[c]		.020[c]
Long-run	1.428										
Unpaid Family Labour - Demand											
Short-run		-.814[c]	-.158[c]	-.688[c]				.177[c]	-.969[c]	2.177[c]	
Long-run	1	-.814	-.158	-.688				.177	-.969	2.177	
Unpaid Family Labour - Supply											
Short-run		-7.045[c]			5.292[c]	-1.239[c,d]		.281[c]	-.420[c]	3.555	
Long-run	1	-7.045			5.292	-1.239		.281	-.420	3.555	

See Table 5.2 for footnotes.

Table 5.7

Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Saskatchewan

	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Nonfarm Wage	X_5 Labour Force	X_6 Owner's Equity	X_7 Hired Labour Lagged	X_8 Operator Labour Lagged	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\bar{y}_2, \bar{y}_4, \bar{y}_6$ Price Of Labour
Hired Labour													
Demand	.142	.007	.003				.727**				.384**	-.258**	-.614
Constant = 1.083	(.136)	(.061)	(.044)				(.134)				(.601)	(.080)	(.492)
R^2=.904**d'=2.06													
Supply			.033	-.627	-.003°		.603**				.213	-.222*	-.081
Constant = .615			(.044)	(.922)	(2.805)		(.157)				(.544)	(.091)	(.679)
R^2= .905**d'=1.98													
Operator Labour													
Demand	.506*	.441*	-.022					.340*		.128+		.125**	-.310*
Constant = 1.079	(.252)	(.245)	(.020)					(.144)		(.074)		(.040)	(.158)
R^2=.985**d'=2.15*													
Supply			.026	-.238	.504+	-.264*		-.269		.263+		.104**	-.040**
Constant = 1.553			(.038)	(.313)	(.328)	(.144)		(.206)		(.170)		(.033)	(.014)
R^2= .992**d'=2.06													
Unpaid Family Labour													
Demand	-.270	.079	.110						-.519+	-1.547**	3.297**		-1.969
Constant = 1.000	(.368)	(.163)	(.116)						(.378)	(.445)	(1.441)		(2.061)
R^2=.945**d'=1.85*													
Supply			-.001	2.669+	-.973				-.975*	-1.359**	3.432**		-5.985*
Constant = 10.712			(.185)	(1.932)	(1.709)				(.454)	(.491)	(1.205)		(3.070)
R^2=.952**d'=2.20*													

NOTE: See Table 5.1 for footnotes.

Table 5.8

Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Saskatchewan

	Elasticity of Adjustment[a]	Price of Labour[b]	Real Farm Prices	Productivity	Nonfarm Wage Rate	Labour Force	Owner's Equity	Trend	Hired Labour	Operator Labour	Unpaid Family Labour
Hired Labour - Demand											
Short-run		-.614[c]	.142[c]	.007[c]				.033[c]		.384	-.258
Long-run	0										
Hired Labour - Supply											
Short-run		-.081[c]			-.627[c]	.003[c]		.033[c]		.213[c]	-.222
Long-run	.397	-.204			-1.579	.008		.083		.537	-.560
Operator Labour - Demand											
Short-run		-.310	.506	.441				.022[c]	.128		.125
Long-run	.660	-.470	.767	.668				.033	.194		.189
Operator Labour - Supply											
Short-run		-.040			-.238[c]	.504	-.264	.026[c]	.263		.104
Long-run	1	-.040			-.238	.504	-.264	.026	.263		.104
Unpaid Family Labour - Demand											
Short-run		-1.969[c]	-.270[c]	.079[c]				.110[c]	-1.547	3.297	
Long-run	1.519										
Unpaid Family Labour - Supply											
Short-run		-5.985			2.669	-.973[c]		-.001[c]	-1.359	3.432	
Long-run	1.975										

See Table 5.2 for footnotes.

Table 5.9

Estimates of Structural Demand and Supply Relationships for Agricultural Labour from Dynamic Model IV--Manitoba

	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Nonfarm Wage	X_5 Labour Force	X_6 Owner's Equity	X_7 Hired Labour Lagged	X_8 Operator Labour Lagged	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\bar{y}_2, \bar{y}_4, \bar{y}_6$ Price of Labour
Hired Labour													
Demand	.020	.018	-.010				.421*				.080*	-.177*	-.506*
Constant = 1.505	(.033)	(.092)	(.033)				(.209)				(.036)	(.080)	(.261)
R^2=.681*d'=2.13*													
Supply			.010	-.401	.023°		.392*				.059	-.130	.013
Constant = .569			(.032)	(.774)	(.033)		(.214)				(.059)	(.133)	(1.029)
R^2=.684*d'=2.05													
Operator Labour													
Demand	-.025	-.622*	-.025					.334+		.159		.069**	.257+
Constant = 1.365	(.025)	(.338)	(.026)					(.195)		(.136)		(.026)	(.155)
R^2=.981**d'=2.27*													
Supply			-.094*	-.844*	.034°	-.017		-.195		-.390+		.038+	-.035
Constant = 2.506			(.033)	(.381)	(.029)	(.019)		(.388)		(.219)		(.023)	(.029)
R^2=.983**d'=2.21*													
Unpaid Family Labour													
Demand	.065	-.252	-.117						.402	-1.526	.163+		-.826
Constant = 3.847	(.136)	(.353)	(.137)						(.619)	(1.187)	(.092)		(2.651)
R^2=.932**d'=2.18*													
Supply			.078	2.795	3.903				.037	-1.298	.125+		-2.293
Constant = -1.155			(.149)	(2.253)	(3.780)				(.797)	(1.472)	(.092)		(5.055)
R^2=.937**d'=2.30*													

NOTE: See Table 5.1 for footnotes.

Table 5.10

Estimates of Elasticities of Adjustment, and Short-Run and Long-Run Elasticities Derived from Dynamic Model IV--Manitoba

	Elasticity of Adjustment[a]	Price of Labour[b]	Real Farm Prices	Productivity	Nonfarm Wage Rate	Labour Force	Owner's Equity	Trend	Hired Labour	Operator Labour	Unpaid Family Labour
Hired Labour - Demand											
Short-run		-.506	.020[c]	.018[c]				-.010[c]		.080	-.177
Long-run	.579	-.874	.035	.031				-.017		.138	-.306
Hired Labour - Supply											
Short-run		.013[c]			-.401[c]	.023[c,d]		-.010[c]		.059[c]	-.130[c]
Long-run	.608	.021			-.660	.038		-.016		.097	-.214
Operator Labour - Demand											
Short-run		.257	-.025[c]	-.622				-.025[c]	.159[c]		.069
Long-run	.666	.386	-.038	-.934				-.038	.239		.104
Operator Labour - Supply											
Short-run		-.035[c]			-.844	.034[c,d]	-.017[c]	-.094	-.390		.088
Long-run	1	-.035			-.844	.034	-.017	-.094	-.390		.088
Unpaid Family Labour - Demand											
Short-run		-.826[c]	.065[c]	-.252[c]				-.117[c]	-1.526[c]	.163	
Long-run	1	-.826	.065	-.252				-.117	-1.526	.163	
Unpaid Family Labour - Supply											
Short-run		-2.293[c]			2.795[c]	3.903		.078[c]	-1.298[c]	.125	
Long-run	1	-2.293			2.795	3.903		.078	-1.298	.125	

See Table 5.2 for footnotes.

The real farm price variable did not work as well in the provincial unpaid family labour demand equations with the coefficient not statistically significant at the ten percent level and not having the expected positive sign in the Alberta or Saskatchewan equations. Where the coefficient had the expected sign, the short-run response was inelastic with the elasticity higher in Saskatchewan than in Alberta or Manitoba.

The trend variable was only statistically significant in the operator labour supply equations where the coefficient generally had a negative sign.

The Saskatchewan demand equations were the only ones where the productivity variable did not appear with the expected negative coefficient for any of the three components. The Manitoba operator labour and unpaid family labour demand equations and the Alberta hired labour and unpaid family labour demand equations had the expected negative coefficient for the productivity variable.

Other noticeable differences between the provincial models and the national and regional models include the labour force variable in the supply equations. The total civilian labour force, as compared to the agricultural labour force, was a more important variable in determining the supply of hired labour in Alberta and Manitoba. This could be due to improved communication and transportation between rural and urban areas allowing urban dwellers to apply for farm employment.

The owner's equity variable had a negative coefficient in all three provincial supply equations for operator labour just as it did in the equivalent national equation. Moreover the coefficient was

statistically significant at the ten percent level or higher in both the Alberta and Saskatchewan supply equations. In all cases the short-run response was inelastic with Saskatchewan supply (-.264) more responsive than Alberta (-.177) or Manitoba (-.017).

Although problems of statistical significance were present with the substitution variables, the signs on the coefficients were very similar to those of the national and regional models thereby developing an interesting pattern. With few exceptions, the pattern is consistent. It appears as if hired labour is a substitute for unpaid family labour and vice versa. This relationship holds true in both the supply and demand equations. However, hired labour and unpaid family labour are not substitutes for operator labour. There could be a complementary relationship between operator labour and the other components in some instances. For example, as the number of farm operators increase the demand for hired labour would increase. Similarly, as the number of farm operators increase the supply of unpaid family labour would increase because the unpaid family labour force would increase due to the family relationship of the two components.

The substitution variables in the hired and operator labour equations had inelastic coefficients in the short-run while in the unpaid family labour equations the demand and supply responses were often greater than one. This implies that the demand for and supply of unpaid family labour is strongly influenced by changes in the other labour components.

The elasticity of adjustment calculations were more successful in the provincial models as evidenced by the number of values that fell between zero and one. Of particular interest were the operator labour

demand equations where the elasticities of adjustment were .565, .660 and .666 for Alberta, Saskatchewan and Manitoba, respectively. This implies that the farm operators respond similarly in all three provinces with respect to the use of their own labour on the farm. It would take about three years for 90 percent of the adjustment to an economic stimuli to occur, ceteris paribus.

In the Manitoba hired labour model, the elasticity of adjustment was .579 in the demand equation and .608 in the supply equation. This would indicate that both the demand for and supply of hired labour in Manitoba adjust to changing economic conditions at about the same rate.

The other elasticities of adjustment, that were theoretically consistent, were generally equal to one indicating a very rapid adjustment to economic change.

MULTICOLLINEARITY PROBLEMS[6]

The term "multicollinearity" refers to the presence of linear or near linear relationships among explanatory variables. It exists to some degree in most economic functions. Multicollinearity is known to cause instability of the parameter estimates and to increase the standard errors of these estimates. Both these symptoms were present in the models tested for this study. As a result, variables that had highly linear relationships with other explanatory variables often appeared

---

[6] A. Koutsoyiannis, Theory of Econometrics, The MacMillan Press Ltd., London, 1973, pp. 225-249.

with theoretically inconsistent signs and non-statistically significant coefficients.

A good example is the trend variable. Reference to Appendix D illustrates the linear relationship of this variable (X_3) to the other explanatory variables. The simple correlation coefficients of the trend variable were seldom less than .7 and often greater than .9. Hired labour was about the only time series not highly related to time as accounted for by the trend variable. Model experimentation indicated that the coefficient of the trend variable did not appear with a consistent positive or negative sign and was often not statistically significant.

Closer examination of Appendix D indicates that multicollinearity was a major problem with some of the variables under study. It is believed that multicollinearity was the cause, at least in part, of the theoretically inconsistent signs and lack of statistical significance dispersed throughout the results presented in Chapter V. The presence of multicollinearity can be explained by the fact that economic variables, such as nonfarm wage rates and farm wage rates, tend to move in the same direction over time because they are influenced by the same factors. When two or more explanatory variables move in almost the same way, it is difficult to separate each factor's influence on the dependent variable and multicollinearity problems arise.

It is difficult to find a solution to this problem. Larger samples of data or the use of cross-section samples might reduce the problem but such data is not presently available. Exclusion of the variables most affected by multicollinearity provides another partial

solution although the model may then become mis-specified. Other corrective solutions of a more sophisticated nature such as the introduction of additional equations in the model are outside the scope of this study.

On a more positive side, the coefficient estimates of the most important variables such as real farm prices, farm wage rates and nonfarm wage rates are fairly stable and reliable. These coefficients can be used to arrive at some general policy implications. Moreover, there is little reason to doubt the continuance of the same multicollinearity patterns in the near future which implies the model can be used for a certain amount of forecasting work.

UNDERIDENTIFICATION PROBLEMS[7]

Underidentification of a model is closely related to the problem of multicollinearity in the sense that the presence of either condition creates estimation problems. The model developed for this study was correctly identified as shown in Chapter IV. However, problems arise when one or more of the explanatory variables are found not to be statistically significant. This implies the coefficient is no different from zero and the originally identified model may become underidentified. In an underidentified model, estimates of structural parameters may relate to the model in question, some other model, or a mixture of models. An underidentified model does not have a unique statistical form.

It should be noted at this point that multicollinearity and underidentification create estimation problems but do not invalidate

---

[7]Ibid., pp. 336-358.

the economic theory presented in Chapter III. A model is theoretically sound so long as the specification of the variables and mathematical form of the model is accurate despite any difficulties in obtaining numerical values for the parameters from sample data. The statistical results of the hypothesized model were interpreted as far as possible without taking steps to investigate possible underidentification problems.

COMPARISON WITH AN EARLIER STUDY

The author knows of no other study in which the three components of agricultural labour have been studies independently in the Canadian context. However, it is possible to make some comparisons with a study done by Yeh and Li in 1966.[8]

Yeh and Li investigated the demand for and supply of hired and family (operator and unpaid family) farm labour in Canada and the five Canadian regions for the years 1946 to 1962. The demand for farm labour was expressed as a function of the farm wage rate, real farm prices, quantity of farm machinery, and the index of productivity or a time-trend variable. Variables used in the supply function were the farm wage rate, the adjusted nonfarm wage rate and trend. A lagged dependent variable was introduced into both the demand and supply functions. The statistical results of the variables common to both studies for Canada and the Prairie region are presented, along with the comparable results of Model IV from this study, in Table 5.11.

---

[8] M.H. Yeh and L.K. Li, "A Regional Analysis of the Supply and Demand of Farm Labour in Canada," Canadian Journal of Agricultural Economics, XIV, No. 2, 1966, pp. 15-31.

Table 5.11

Comparison of Short-Run Elasticities and Adjustment Mechanism from Both Studies[a]

Variable		Hired Labour		Family Labour[b]	
		Canada	Prairie Region	Canada	Prairie Region
Real Farm Prices	(1)	.575	.765	.104	.009
	(2)	-.087	.113	1.271[d] .064	1.144[d] .083
Productivity	(1)	.312	.104		
	(2)	-.234	-.032	.687[d] -.374[d]	1.006[d] -.170
Trend (Demand)	(1)			.109[d]	-.004
	(2)	-.064	.048	-.012 .017	.033 -.024
Trend (Supply)	(1)	-.153	-.070	-.089	.034
	(2)	-.033	.104[d]	.019 -.039	.019[d] .145[d]
Farm Wage Rate[c] (Demand)	(1)	.843	.308	-.089[d]	-.002
	(2)	.195	-.036	-.613[d] -.739[d]	-.590[d] -3.407[d]
Farm Wage Rate[c] (Supply)	(1)	.646	1.416	.004	-.011
	(2)	.357	-.329[d]	-.031 .211	-.001 -3.381
Nonfarm Wage Rate	(1)	-.255	-.901	-.130	-.165
	(2)	-.045	.048	-.401[d] -.119	-.115[d] 1.344
Adjustment Coefficient (Demand)	(1)	.768	.819	.338[d]	.092[d]
	(2)	1	1	0 0	.519[d] 1
Adjustment Coefficient (Supply)	(1)	.860	.690	.278[d]	.036[d]
	(2)	1	1	e 1	1 1

a Rows (1) and (2) refer to Yeh and Li's study and this study, respectively.

b The two figures presented for this study with respect to family labour represent operator and unpaid family labour, respectively.

c Net farm income was used instead of farm wage rate for operator labour in this study.

d Coefficient statistically significant at the ten per cent level or higher.

e The elasticity of adjustment is theoretically inconsistent with the distributed lag theory.

Looking at the hired farm labour market first, the R^2 values for Canada were .640 (demand) and .758 (supply) in this study compared to .575 (demand) and .465 (supply) in Yeh and Li's study. For the Prairie region the R^2 values were .215 (demand) and .724 (supply) in this study compared to .648 (demand) and .565 (supply) in Yeh and Li's study. By disaggregating to the provincial level in the present study, the R^2 values were increased to a high of .904 (Saskatchewan demand) and .905 (Saskatchewan supply). The significance of the coefficients in this study were detailed in the previous chapter. In the Yeh and Li study no coefficients were significant at the ten percent level. Both studies ran into theoretically inconsistent signs on the farm wage rate coefficient in the demand equations and the nonfarm wage rate in the supply equations. In the present study, the productivity variable had the expected negative coefficient in the hired labour demand equations at the national and regional level while the coefficient was positive in the Yeh and Li study. The other common variables generally had the same sign in both studies.

Generally, the short-run demand and supply elasticities for hired labour with respect to the studied variables were inelastic in both studies although the magnitudes were quite different. The elasticities in the Yeh and Li study were consistently higher. In both studies, the adjustment coefficients were quite high indicating rapid adjustments to economic stimuli.

Turning to the family farm labour component, the R^2 values increased to over .90 in all cases and the statistical significance of the regression coefficients improved in both studies. Yeh and Li used

the farm wage rate in the family labour model whereas this study used net farm income for operator labour. Both variables appeared with a theoretically inconsistent negative sign in some of the supply equations in the respective studies. The remaining common variables generally appeared with the expected sign on the coefficients in both studies.

Again the short-run demand and supply elasticities were inelastic in the Yeh and Li study. However, in the present study the real farm price variable in the operator demand equation and the farm wage rate variable and nonfarm wage rate variables in the unpaid family labour equations all had short-run elasticities greater than one. There were large differences in the magnitude of other coefficients as well. For example, the farm wage rate variable in the demand equation had a short-run elasticity of -.089 (Canada) and -.034 (Prairie region) in Yeh and Li's study compared to -.613 (Canada, operator labour), -.739 (Canada, unpaid family labour), -.590 (Prairie region, operator labour), and -3.407 (Prairie region, unpaid family labour) in the present study. In both studies, there was evidence of smaller adjustment coefficients in the demand equations for the family labour components than was the case for the hired labour demand equations. This evidence supports the hypothesis that adjustments in the use of hired labour occur faster than adjustments in the use of family labour components.

Differences in the two studies could be the result of several factors: (1) The studies encompass different time periods. The present study includes additional observations from 1963 to 1973; (2) Common variables were not all measured in the same manner. For example, the productivity index used in the Yeh and Li study had a 1935-39 base

whereas in this study the base was 1961; (3) Each study had variables not found in the other study. The present study included substitution variables, a labour force variable, and an owner's equity variable. Yeh and Li experimented with the quantity of farm machinery as a substitute for labour. (Their statistical results for this variable were unfavourable.); (4) Yeh and Li estimated the equations in linear form while in this study all equations were estimated in logarithmic form; (5) Yeh and Li combined family farm labour into one component. The present study separated family labour into farm operator labour and unpaid family labour.

CHAPTER VI

SUMMARY AND IMPLICATIONS

The object of the present study was to increase information about the market structure for agricultural labour at the provincial, regional and national level with a view toward pointing out policy implications for solving some agricultural labour problems. The study provides statistical estimates of the demand for and supply of hired, unpaid family, and operator labour while testing the ability of a specific theoretical framework to describe the agricultural labour markets. In this chapter, the study results are summarized followed by a simple test of the predictive power of the econometric model. The chapter is concluded with two sections dealing with policy implications and suggestions for further research, respectively.

SUMMARY OF THE STUDY

As the first attempt to quantitatively analyze the three components of the Canadian agricultural labour force individually, the present study was moderately successful. Problems with theoretically inconsistent and statistically insignificant coefficients were encountered by the overall results compare favourably with an earlier Canadian study as demonstrated in Chapter V. The explanatory powers of the models were quite high thereby suggesting the models may be useful for short-term forecasting work. Such powers are examined in the next section of this chapter. In addition, provincial short-run and long-run

elasticities were obtained, labour component interdependencies were identified and response lags were measured. Some general comments on the economic implications of these findings for the Prairie Provinces follow, based on the provincial model results (see Tables 5.5 to 5.10 in the previous chapter).

1. It is possible from the estimated coefficients, statistical tests and derived elasticities to draw some implications about the wage and employment characteristics of the Prairie Provinces. The farm wage rate and net farm income appear to have a negative influence on the demand for farm labour with the exception of the hired labour component. Thus an increase in the price of farm labour would be expected to decrease the quantity demanded. Nonfarm wages appear to have a positive affect on the supply of farm labour but only with respect to hired and operator labour. An increase in the nonfarm wage rate, other things remaining equal, would work to reduce the quantity of labour supplied to agriculture by these two components. Neither real farm prices or labour productivity, as measured in this study, were found to significantly affect the demand for farm labour in the Prairie Provinces. The trend variable was only statistically significant in the operator supply equations where the estimated coefficient was negative. This negative sign would be consistent with a number of time-correlated trends affecting the supply of operator labour such as; increasing preference for nonfarm work, increasing rural education and increasing off-farm job opportunities. The size of the labour force was one of the more important variables in the supply equations with an increase in the labour force increasing the quantity of labour supplied, ceteris paribus. Finally, the owner's equity variable

had a theoretically inconsistent negative coefficient in all provincial operator supply equations (as well as the national operator supply equation) and was generally statistically significant. One interpretation of this negative sign could be that equity per farm serves as a proxy indicator of the "entry cost" to agriculture in the sense that a certain level of investment is required before an individual may begin operating a farm. Thus as the equity per farm increases, the number of individuals selecting employment as farm operators will decrease.

2. In almost all cases, the short-run and long-run demand and supply responses are inelastic which implies that a given adjustment in one of the explanatory variables would result in a less than proportional adjustment in the quantity of labour demanded or supplied. A shift in one of the demand or supply curves would have a greater impact on the new equilibrium level of the price of labour than on the quantity of labour because the curves are inelastic.

Comparing the influence of the nonfarm wage rate on the supply of hired labour with operator labour, the estimated short-run elasticities indicate that operator labour is generally less responsive to changes in nonfarm wages than is hired labour. A similar situation exists with respect to the farm wage rate and net farm income in the demand equations for hired labour and operator labour. The demand for hired labour is more responsive to changes in the farm wage rate relative to the demand for operator labour in relation to changes in net farm income.

3. Provincial differences in the estimated coefficients provided strong evidence that disaggregation to the provincial level was a useful exercise. The labour force coefficient, for example, was .003 in the

Saskatchewan hired labour supply equation, .023 in Manitoba and 2.690 in Alberta. Moreover, experimentation showed that while the total civilian labour force variable worked well in the Alberta and Manitoba models, better statistical results were obtained in the Saskatchewan models if the agricultural labour force variable was used. Provincial differences in demand and supply responses were common to each estimated coefficient.

4. Testing for the interdependencies among the three components of the agricultural labour force met with partial success. Hired labour and unpaid family labour appeared to be substitute components. An increase in the quantity of unpaid family labour would result in a decrease in the demand for hired labour and vice versa. On the supply side, the two components displayed mobility characteristics. An increase in the quantity of unpaid family labour would result in a decrease in the supply of hired labour and vice versa.

There appeared to be a positive relationship between the operator and unpaid family labour components indicating a complimentary form of interdependency. An increase in the quantity of one component was associated with an increase in the demand for and supply of the other component. This relationship could be due to the family ties between the two components. For example if a number of farm operators with families moved out of agriculture, the supply of unpaid family labour would decrease.

A relationship between hired labour and operator labour could not be identified from the results of this study.

5. Although not conclusive, the calculated elasticities of adjustment suggest that, at least for hired and operator labour, there is a lag

in response to changes in the economic conditions. In general, the demand for components of the labour force would adjust more rapidly to economic stimuli than would the supply. There was evidence that the demand and supply of operator labour would take longer to adjust compared with the hired and unpaid family labour components possibly because farm operators tend to make more long-term commitments. The adjustment coefficients of .565, .660 and .666 obtained for the operator demand equations for Alberta, Saskatchewan and Manitoba, respectively, suggests that the lag in response is similar among the three Prairie Provinces.

THE PREDICTIVE POWER OF THE MODEL

In 1974, an interesting reversal of trends occurred. The number of persons employed in agriculture increased for each farm labour component whereas the trends for the last several years have been for the number employed in each class to drop. This section was included in the text as a simple test of model IV to predict these trend reversals. Actually, the procedure used does not provide a true test of the predictive power of the model for two reasons. First, actual 1974 data was obtained for the explanatory variables whereas a true prediction would require the forecaster to make estimates of these values. Second, all explanatory variables specified in the model were employed regardless of whether or not they were found statistically significant or theoretically consistent. The exercise does, however, provide some indication of the relative importance of the variables in the equations.

Data for all the variables used in model IV were collected for the calendar year 1974 with all monetary series deflated to 1961 constant

dollars. Using the reduced form equations and the structural demand and supply equations obtained from the national dynamic model, estimates of price, demand and supply levels in 1974 were calculated for each farm labour component. These estimates were then compared to the actual figures for 1974. Prediction was performed at the national level only. Table 6.1 presents the actual figures for 1973 and 1974.

Table 6.2 presents the actual and estimated price, demand and supply levels for 1974. Despite the trend reversals in 1974 (employment of all components increased) the dynamic models correctly predicted the change in the employment trend. Two exceptions were the operator labour supply estimate and the unpaid family labour demand estimate. In these cases, the estimated value indicated a decrease in employment which did not actually occur.

The magnitude of the difference between the estimated and actual employment levels varied from a low of 1.2 thousand persons (1.2 percent) in the hired labour demand equation to a high of 37.0 thousand persons (13.6 percent) in the dynamic operator labour supply equation. With the exception of the latter figure, all employment predictions for 1974 were within nine percent of the actual employment level.

By examining the direction of change in the explanatory variables (Table 6.1) and the sign and magnitude of the regression coefficients (Table 5.1, Chapter V), it is possible to determine which variables were most influential to the predicted level of employment. In the hired labour and unpaid family labour supply equations, the size of the agricultural labour force and the farm wage rate were important to the predicted positive increment contrary to past trends. Both of these variables

Table 6.1

Comparison of Data for National Farm Labour
Model IV - 1973 and 1974

Item	1973	1974
Hired farm labour employed (no.)	96,400	98,800
Operator labour employed (no.)	269,800	271,400
Unpaid family labour employed (no.)	100,300	102,900
Hired farm wage rate index (1961=100)	216.1	248.1
Net farm income per farm ($)	8,235	8,369
Real farm price index (1961=100)	1.8	1.14
Productivity index (1961=100)	207.4	190.4
Adjusted nonfarm wage rate index (1961=100)	128.9	128.4
Total civilian labour force (no.)	9,279	9,662
Agricultural labour force (no.)	476	484
Farm owner's equity per farm ($)	64,200	68,286

had theoretically consistent positive coefficients. The increase in farm owner's equity per farm combined with the large, theoretically inconsistent negative coefficient for the owner's equity variable were, in part, responsible for the operator supply equation not predicting the increase in operator labour.

The productivity variable with its theoretically consistent negative coefficient and the observed decline in productivity in 1974 relative to 1973 were important to the increase in hired labour predicted by the hired labour demand equation. The substitution variables were generally important to the predicted levels of employment in both demand and supply equations. For example, unpaid family labour was a significant variable in the hired labour demand and supply equations. The reverse was also true. Both unpaid family labour in the hired labour equations and hired labour in the unpaid family labour equations had the expected negative coefficients.

Predicting the price of labour, using the reduced farm price equations was similarly accurate. Despite the historically sharp increase in the price of hired and unpaid labour and the absence of any significant change in the price of operator labour in 1974 (two uncommon phenomenon), the range in the error of the prediction had a low of 7.3 percent and a high of 15.9 percent (see Table 6.2). The average error of the prediction compared to the actual data was about 9.9 percent.

In general, the predictions were fairly accurate. The majority were within ten percent of the actual figure with rounding errors obtained when coverting from logarithms accounting for some of this variation.

Table 6.2

Actual and Predicted Levels of Price, Demand and Supply for Each Farm Labour Component - Canada, 1974

		Actual	Estimated	%Difference
	Price (index)	248.3	223.9	- 9.8
Hired labour	demand (number)	98,800	100,000	+ 1.2
dynamic	supply (number)	98,800	104,000	+ 5.6
	price (dollars)	8,369	7,762[a]	- 7.3
operator labour	demand (number)	271,400	281,800	+ 3.7
dynamic	supply (number)	271,400	234,400[a]	-13.6
unpaid	price (index)	248.3	208.9[a]	-15.9
family labour	demand (number)	102,900	95,500[a]	- 7.2
dynamic	supply (number)	102,900	112,200	+ 8.8

[a]The estimated values indicate a decline while the actual values indicate an increase over the 1973 values.

POLICY IMPLICATIONS

In the first chapter of this study several policy-related questions were raised.[1] This section refers back to those comments and attempts to shed some light on the issues, based on the statistical results of the present study. It is necessary to preface the following remarks with the note that the statistical results obtained in this study were not always consistent thus permitting only guarded suggestions with respect to policy implications. To the extent that the results could be improved through further research, this section provides an indication of the potential usefulness of agricultural labour market analysis.

Various provinces are looking at the idea of removing the exemption of agricultural labour from the minimum wage laws. It is felt that such a move would bring agricultural wages more in line with the wages paid to similar skills in the nonfarm sector thereby attracting more hired labour into agriculture. Assuming the equilibrium level of farm wages is below the current minimum wage rate, the proposed change is expected to result in a decrease in the quantity of hired labour demanded and an increase in the quantity supplied.

The regression results for Manitoba (Tables 5.9 and 5.10 in Chapter V) can be used to evaluate this proposal. The results indicate that such a policy would have very little, if any, impact on the quantity of hired labour supplied. The farm wage variable had a coefficient of

---

[1]See Chapter I, pp. 7-8.

.013 and was not statistically significant in the hired labour supply equation. However, the variable had a statistically significant coefficient of -.506 in the hired labour demand equation. These results imply that removal of the minimum wage exemption for agriculture would reduce the employment opportunities for labour currently seeking employment in agriculture at the present wage rate but would not have the desired effect of attracting more hired labour into agriculture. Moreover, the demand effect would increase in the long-run relative to any supply effect, ceteris paribus, as shown in Table 5.10.

In view of the detrimental effect such a policy would have on the hired farm labour market, it may be more beneficial to concentrate on other ways of increasing the availability of farm labour. Improvements in working conditions, agricultural training courses, and job security are possible alternative areas of investigation.

Another issue confronting policy-makers is the low income of hired farm labour relative to hired labour in other industries. The findings of this study indicate the supply and demand curves for hired farm labour are generally inelastic which implies a shift in either curve will have a strong influence on the price of labour relative to the influence on the quantity of labour. A program or set of programs that caused the supply curve for hired farm labour to shift to the left would significantly increase the farm wage rate while marginally decreasing, the quantity of hired labour employed. Any curtailment of the foreign agricultural worker programs or of the government sponsored mobility programs, for example, could effect such a change because the size of the agricultural labour force would be reduced. If the demand curve for

hired labour shifted to the right, farm wages would also increase significantly with hired labour employment increasing less than proportionately.

Given the current situation of inadequate hired farm labour incomes and an undersupply of hired farm labour, it would seem desirable to implement policies that would shift the labour demand curve to the right because such policies would serve to increase farm wages without reducing the supply of hired labour. Policies that worked to increase the real prices received by farmers for their products might achieve this effect. In the present study the real farm price variable was not statistically significant at the ten percent level, but the coefficients did appear with the expected positive signs in the regional and provincial hired labour demand equations. Based on the regression results at the provincial level (Tables 5.5, 5.7 and 5.9 in Chapter V), policies designed to increase real farm prices would have the greatest effect on the demand for hired labour in Saskatchewan followed by Alberta and Manitoba, respectively.

Policy-makers have also expressed concern over the decline of the unpaid family labour force. It is felt that as this source of labour diminishes, the demand for hired farm labour (which is already a scarce input) will increase. Concern over this phenomenon is justified because hired labour receives a direct payment from farm operators while unpaid family labour receives only indirect payment. The end result could be a combined problem of reduced productive capacity due to the lack of farm labour and increased labour input costs to the farm operator.

The study findings indicate that there is a substitution relationship between the hired and unpaid family labour components. The number of unpaid family workers had its strongest influence on hired labour demand in the province of Saskatchewan, a somewhat lesser influence in Manitoba and the smallest influence in Alberta. These results indicate that the migration of unpaid family labour out of agriculture may be expected to create the most problems, in terms of increased demand for hired labour, in Saskatchewan.

Policy-makers attempting to reduce this problem have taken steps to encourage the farm population to remain on the farm by improving the social services (hospitals, schools) in farm communities.

Conversely, some agriculturalists believe there are too many farm operators in the industry and that a fewer number of larger farms would create a more efficient system. If this belief were to be translated into policy, the farm operator supply curve would need to shift to the left which would increase the returns to a smaller number of operators. In order to do this, programs to improve the availability and profitability of nonfarm employment for farm operators would be required. The federal Small Farm Development Program is already working in this area by assisting farmers on non-viable farms to leave the industry while providing extension services for those farmers attempting to expand their farm size.

However, a certain lack of co-ordination among agricultural programs may work to defeat this objective. Alongside the Small Farm program which should shift the farm operator supply curve to the left are policies such as Manitoba's "Stay Option" and tax incentives for part-time farming which are expected to have the opposite effect by encouraging individuals to remain in or enter the agricultural industry.

Moreover the programs designed to shift farm operators out of agriculture are inconsistent with the objective of keeping unpaid family labour on the farm. This is evident from the results of this study which indicate that there is a complementary relationship between farm operators and unpaid family labour. It would appear that a new agricultural development strategy is required to aim all on-going agricultural policies and programs toward a common set of objectives.

Policy-makers could also benefit through this study by recognizing the lagged adjustment in the labour market to economic change. This lagged effect was most noticeable in the operator labour markets of the Prairie provinces. Only about 60 percent of an adjustment to the demand for operator labour, brought about by some shock to the market, would occur in the first year. It would take three or four years for the full adjustment to take place. Therefore, factors that change the demand for operator labour such as changes in net farm income and real farm prices will only have their full effect after a lag of several years and then only if no other shocks affect the market.

SUGGESTIONS FOR FURTHER RESEARCH

One of the major problems in this study was the lack of statistical significance and theoretical inconsistency of the economic variables. Although the results of this study appear to be an improvement over earlier studies, the statistical results are still weak. Some of these problems may be overcome by searching out better methods of measuring the explanatory variables. Two new data sources are now available that could provide time-series and cross-section information on agricultural

labour. The first source is the data collected by the Canadian Farm Labour Pool System which records the type of labour demanded by farm operators and the supply of labour available for hired. The second source is the match of 1966 Census of Agriculture farms to 1971 Census of Agriculture farms. (Eventually 1976 census farm will also be matched.) The census match data would help in the study of the operator labour market. This new data source may provide more accurate information about the farm labour markets and further research in the farm labour area should begin by investigating these possibilities.

The agricultural labour force is made up of an extremely diverse collection of workers. This is particularly true of the hired and unpaid family labour components. Workers may be full-time, seasonal, or peak-period (seeding and harvest) employees. They may be highly trained, semi-skilled, or unskilled. In addition, the farm on which they work could be producing crops, livestock, dairy products, or special crops. Farm labour of a certain type may have little in common with labour of another type and the factors affecting the demand for and supply of each type may vary considerably. For example, the market for unskilled labour to tend the sugar beet crops bears little relationship to the market for labour, trained in animal husbandry, to manage a large dairy enterprise. There is a need to identify these altogether different labour markets within the agricultural industry. When more detailed data becomes available, researchers should attempt to recognize the heterogeneity of farm labour.

Finally, the work of the present study could be extended to the other regions and provinces of Canada. More studies of a similar nature would provide further tests of the theoretical framework and empirical procedures developed for this study. In addition, such studies could be used to make inter-regional comparisons of Canada's agricultural labour markets.

B I B L I O G R A P H Y

I. BOOKS

Bloom, G.F. and Northrup, H.R. Economics of Labor Relations, 5th ed., Homewood, Richard D. Irwin, Inc., 1965.

Brennan, M.J. Preface to Econometrics, Cincinnati, South-Western Publishing Company, 1965.

Ferguson, C.E. Microeconomic Theory, Homewood, Richard D. Irwin, Inc., 1969.

Hicks, J.R. The Theory of Wages, 2nd ed., Toronto, MacMillan and Co., Ltd., 1963.

Johnston, J. Econometric Methods, 2nd ed., New York, McGraw-Hill Book Company, 1960.

Koutsoyiannis, A. Theory of Econometrics, London, The MacMillan Press Ltd., 1973.

Liebhafsky, H.H. The Nature of Price Theory, Homewood, The Dorsey Press, Inc., 1963.

Snedecor, G.W. and Cochran, W.G. Statistical Methods, 6th ed., Ames, Iowa State University Press, 1967.

II. JOURNAL ARTICLES

Auer, L. "Labour Productivity in Agriculture, A Canadian-U.S. Comparison," Canadian Journal of Agricultural Economics, Vol. 18, No. 3, 1971, pp. 43-55.

_____. "Labor Productivity in Agriculture, A Conceptual Analysis," Canadian Journal of Agricultural Economics, Vol. 14, No. 1, 1966, pp. 29-39.

Basmann, R.L. "A Generalized Classical Method of Linear Estimation of Coefficients in a Structural Equation," Econometrica, Vol. XXV, January, 1957, pp. 77-84.

Furniss, I.F. "The Importance of Agriculture to the Canadian Economy," Canadian Farm Economics, Vol. 4, No. 4, 1969, pp. 1-8.

Fitzpatrick, J.M. and Parker, C.V. "Distribution of Income in Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. 13, No. 2, 1965, pp. 47-64.

Galloway, L.E. "Geographic Flows of Hired Agricultural Labour 1957-60," American Journal of Agricultural Economics, Vol. 50, No. 2, 1968, pp. 199-212.

_____. "Mobility of Hired Agricultural Labour 1957-1960," American Journal of Agricultural Economics, Vol. 49, No. 1, 1967, pp. 32-52.

Gilcrist, V. "A Pilot Study of Income Alternatives Affecting the Movement of Farm Operatives Out of Agriculture," Canadian Journal of Agricultural Economics, Vol. 11, No. 1, 1963, pp. 9-21.

Gisser, M. "Needed Adjustments in the Supply of Farm Labour," Journal of Farm Economics, Vol. 49, No. 4, 1964, pp. 806-815.

Hathaway, D.E. and Perkins, B.B. "Farm Labour Mobility, Migration, and Income Distribution," American Journal of Agricultural Economics, Vol. 50, No. 2, 1968, pp. 342-352.

Holt, J.S. "Impact of the Industrialization of the Hired Farm Work Force Upon the Agricultural Economy," American Journal of Agricultural Economics, Vol. 52, No. 5, 1970, pp. 780-786.

Kulshrestha, S.N. "Age and Efficiency in Public Agricultural Policy: The Case of Ontario," Canadian Journal of Agricultural Economics, Vol. 17, No. 2, 1969, pp. 85-91.

_____. "Measuring the Relative Income of Farm Labourers 1941-1961," Canadian Journal of Agricultural Economics, Vol. 15, No. 1, 1967, pp. 28-43.

Lianos, T.P. "Impact of Minimum Wages Upon the Level and Composition of Agricultural Employment," American Journal of Agricultural Economics, Vol. 54, No. 3, 1972, pp. 477-484.

_____. "Labour Mobility and Market Imperfections," Canadian Journal of Agricultural Economics, Vol. 18, No. 3, 1970, pp. 97-108.

Lerohl, M.L. and MacEachern, G.A. "Factor Shares in Agriculture: The Canada-U.S. Experience," Canadian Journal of Agricultural Economics, Vol. 15, No. 1, 1967, pp. 1-20.

MacMillan J.A. and Tulloch, J.R. "A Micro-Analytic Model of Migration Behaviour," Regional Science Perspective, Vol. 3, 1972, pp. 105-126.

MacMillan, J.A., Tulloch, J.R. and Tung, F.L. "Migration Analysis and Farm Number Projection Models: A Synthesis," American Journal of Agricultural Economics, Vol. 56, No. 2, 1974.

Madden, I.P. "Social Change and Public Policy in Rural America: Data and Research Needs of the 1970's," American Journal of Agricultural Economics, Vol. 52, No. 2, 1970.

Menzies, M.W. "Philosophical Dimensions of Rural Poverty in Canada," Canadian Journal of Agricultural Economics, Vol. 16, No. 3, 1968.

Nerlove, M. "Distributed Lags and Estimates of Long-Run Supply and Demand Elasticities: Theoretical Considerations," Journal of Farm Economics, Vol. 40, No. 3, 1958, pp. 301-311.

Plaunt, D. "Economic Guidelines for Mobilizing Labour and Management in Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. 17, No. 3, 1969, pp. 20-33.

Purnell, G.R. and Heighton, V.H. "The Agricultural Situation in Canada," Canadian Farm Economics, Vol. 5, No. 5, 1970, pp. 1-15.

Rust, R.S. and Jones, W.D. "Agricultural Labor," Canadian Farm Economics, Vol. 10, No. 6, 1975.

_____. "Farm Labour," Canadian Farm Economics, Vol. 11, No. 6, 1975.

Rust, R.S. and Stone, P.M. "Agricultural Manpower," Canadian Farm Economics, Vol. 10, No. 1, 1975, pp. 6-12.

Schuh, G.E. and Tyrchniewicz, E.W. "Behavioural Equations and Equilibrium in the Agricultural Labour Market," Journal of Farm Economics, Vol. 48, No. 5, 1966, pp. 1222-1226.

Tyrchniewicz, E.W. and Schuh, G.E. "Econometric Analysis of the Agricultural Labour Market," American Journal of Agricultural Economics, Vol. 15, No. 4, 1969, pp. 770-787.

_____. "Regional Supply of Hired Labour to Agriculture," Journal of Farm Economics, Vol. 48, No. 3, 1966, pp. 537-556.

Whyte, D.R. "Social Determinants of Inter-Community Mobility: An Inventory of Findings," Canadian Review of Sociology and Anthropology, Vol. 4, No. 1, 1967, pp. 1-23.

Yeh, M.H. and Li, L.K. "A Regional Analysis of the Supply and Demand of Farm Labour in Canada," Canadian Journal of Agricultural Economics, Vol. 14, No. 2, 1966, pp. 15-31.

Yeh, M.H. "The Labour Market with Particular Reference to Canadian Agriculture," Journal of Farm Economics, Vol. 49, No. 5, 1967, pp. 1257-1267.

III. UNIVERSITY STUDIES

Balch, B.W. "Migration-Inducing and Income-Equilibrating Factors Involved in Reconstructing the Alabama Farm Labor Force 1950-67: A Multivariate Analysis," Unpublished Ph.D. Dissertation, University of Alabama, 1968.

Buckmire, G.E. Occupational Mobility of Farm People in the Bonnyville District--A Low Income Area, University of Alberta, 1966.

Connor, D.M. "Rural Anti-Poverty Policy for the Future," Canadian Journal of Agricultural Economics, Vol. 16, No. 3, 1968.

Cowling, K. and Metcalf, D. Labour Transfer from Agriculture: A Regional Analysis, Manchester School of Economics and Social Studies, March, 1968.

Lane, S.H. and Campbell, D.R. Farm Labour in Ontario, Department of Agricultural Economics, Ontario Agricultural College, 1954.

MacMillan, J.A. An Information Base for Formulation of Effective Regional Employment Policy, Research Bulletin No. 71-1, Department of Agricultural Economics and Farm Management, University of Manitoba, 1971.

MacMillan, J.A., Bernat, L.A., and Flagler, J.J. Benefits and Costs of Manpower Services in the Interlake Rural Development Area, Research Bulletin No. 72-1, Department of Agricultural Economics and Farm Management, University of Manitoba, 1972.

MacMillan, J.A. and Bollman, R.D. Income Expenditure Relationship and Level of Living in the Interlake Area of Manitoba, Research Bulletin No. 72-2, Department of Agricultural Economics and Farm Management, University of Manitoba, 1972.

Maki, W.R. and MacMillan, J.A. Regional Systems for Development Planning in Manitoba, Research Bulletin No. 70-1, Department of Agricultural Economics and Farm Management, University of Manitoba, 1970.

Schuh, G.E. Distributed Lags as a Technique for Obtaining Long- and Short-Run Elasticities, Production Economics Paper No. 6213, Purdue University, July, 1962.

Tyrchniewicz, E.W. "An Econometric Study of the Agricultural Labour Market," Unpublished Ph.D. Dissertation, Purdue University, January, 1967.

Yeh, M.H. Application of Simple and Multiple Regression Analysis To Economic Problems, Technical Bulletin No. 4, Department of Agricultural Economics and Farm Management, University of Manitoba, June, 1962.

Yeh, M.H. and Li, L. Technological Change in Canadian Agriculture, Research Report No. 15, Department of Agricultural Economics and Farm Management, University of Manitoba, November, 1968.

IV. GOVERNMENT AND BUSINESS DOCUMENTS

Agriculture Canada. Selected Agricultural Statistics for Canada, Publication No. 75/10, Ottawa, Economics Branch Publication, June, 1975.

Andarawewa, A.B. The Structure of the Canadian Agricultural Labour Force, Publication No. 70/6, Ottawa, Economics Branch Publication, Agriculture Canada, April, 1970.

"1974-75 Annual Report of the Ontario Agricultural Manpower Committee to the Canada Agricultural Manpower Committee," Montreal, September, 1975 (mimeographed).

Canadian Federation of Agriculture. "Farm Labour Problems," Project No. 412010, a paper presented at the Canadian Federation of Agriculture--Dairy Farmers of Canada Seminar, Ottawa, February, 1974 (mimeographed).

_____. "Labour Standards," Ottawa, July, 1974 (mimeographed).

Dawson, D.A. and Freshwater, D. Hired Farm Labour in Canada, Ottawa, Food Prices Review Board, March, 1975.

Department of Manpower and Immigration. "Agricultural Manpower and Immigration, 1974 Highlights," Manpower Employer Services Branch, Ottawa, September, 1975 (mimeographed).

_____. "Agriculture Training Under the Canada Manpower Training Program 1969-70 to 1974-75," Manpower Training Branch, Ottawa, July, 1975 (mimeographed).

Foster, A. and Proud, B. "Report on Wages and Hours of Work in Canadian Agriculture," a research report prepared by Statistics Canada for the International Labour Organization, Ottawa, September, 1970 (mimeographed).

"Rapport du Quebec sur la Main-D'Oeuvre Agricole au Comite National de la Main-D'Oeuvre Agricole Reuni a Montreal," Montreal, September, 1975 (mimeographed).

"Report of the National Working Group on Agricultural Manpower," Ottawa, January, 1974 (mimeographed).

"Report of Prince Edward Island Agricultural Manpower Committee to the Canada Agricultural Manpower Committee," Montreal, September, 1975 (mimeographed).

"Saskatchewan Report to Canada Agricultural Manpower Committee," Montreal, September, 1975 (mimeographed).

Statistics Canada, Aggregate Productivity Measures, Catalogue No. 14-201 annual, Ottawa, Information Canada, various years.

_____. 1971 Census of Canada, Catalogue 96-701, 96-708, 96-709, and 96-710, Ottawa, Information Canada, 1973.

_____. Employment, Earnings and Hours, Catalogue No. 72-002, Monthly, Ottawa, Information Canada, various years.

_____. Prices and Price Indexes, Catalogue No. 62-002, Monthly, Ottawa, Information Canada, various years.

_____. Quarterly Bulletin of Agricultural Statistics, Catalogue No. 71-201, Annual, Ottawa, Information Canada, 1974.

_____. The Labour Force, Catalogue No. 71-001, Monthly, Ottawa, Information Canada, various years.

Theil, H. "Estimation and Simultaneous Correlations in Complete Equation Systems," Central Planning Bureau, The Hague, June, 1953 (mimeographed).

A P P E N D I C E S

APPENDIX A:

REVIEW OF LITERATURE

In Chapter I, two previous studies were summarized because they were similar in nature to the present study and served as an introduction to the theories and procedures which followed. However, the range of literature on the topic of farm labour consists of many informative articles that do not deal with the econometric structure of the labour market. This review attempts to provide additional background on farm labour by presenting a sample of such studies, with the emphasis on current, Canadian material. Most of these studies may be classified in one of three categories: (1) general overview, (2) migration, or (3) productivity. The present review follows this structure.

The first group generally describe the present situation, current trends, and possible future conditions. One such study was published by Furniss[1] in 1969. It dealt with the overall importance of the farm sector to the economic life of the nation. He estimated total investment in Canadian agriculture at $22.5 billion (1967) or about $41,000 per worker (excluding rented land and buildings). Since 1957, primary agriculture has contributed a stable 5-6 percent to the nation's Gross Domestic Product. The export trade in farm products contributed over $1 billion annually to the balance of payments.

With respect to labour, Furniss suggested the most important single change has been the continuing substitution of purchased capital

---

[1] I.F. Furniss, "The Importance of Agriculture to the Canadian Economy," Canadian Farm Economics, Vol. 4, No. 4, 1969, pp. 1-8.

inputs for farm labour. From 1948 to 1968, the farm labour force decreased by 50 percent, representing 7 percent of Canada's total labour force in 1968. He points out the structure of the agricultural work force has also changed with unpaid family workers declining and hired labour increasing, in percentage terms. The actual hired farm work force seemed stable at 100,000 workers, representing 18 percent of the total farm labour force. Productivity (net output per man) increased 6.5 percent per year since 1961. A farm worker, capable of producing food and fibre for 11 people in prewar years, was found to support 42 people.

In 1970, Purnell and Heighton[2] produced a similar study in which they discussed the nature of the farm problem in terms of low and unstable incomes, unequal distribution of income, resource immobility, and over capacity of production. One of their recommendations as a goal for Canadian agriculture was to obtain a living standard for farm workers comparable to the levels of nonfarm workers.

In the same year Andarawewa[3] produced a study specifically related to the Canadian agricultural labour force. Basically a compilation of labour data through 1968, it also projected future trends. In a summary of the data, he pointed out the problem of hired farm workers unable to form a homogeneous group due to personal qualification differences

---

[2]G.R. Purnell and V.H. Heighton, "The Agricultural Situation in Canada," Canadian Farm Economics, Vol. 5, No. 5, 1970, pp. 1-15.

[3]A.B. Andarawewa, The Structure of the Canadian Agricultural Labor Force, Research Division, Economics Branch, Canada Department of Agriculture, 1970.

and a widely dispersed labour force. Thus farm labour, without a pressure group, found itself excluded from several labour laws such as minimum wage legislation. This exemption from labour standards makes parity with nonfarm labour unlikely.

Another viewpoint was discussed by Holt.[4] He believed technical and managerial requirements of modern farming caused a separation of owner-management and labour. This relationship is becoming more formalized or industrialized due to several socio-economic forces. He mentioned increased mobility of the rural labour force, industrial growth of rural areas, increased rural awareness of opportunities, changing sets of life goals, and the changing legal structure as the main factors.

An earlier study, by Lerohl and MacEachern,[5] appeared in 1967. The study analyzed trends in the relative factor shares of national income in Canada and the United States, comparing them to factor shares in agriculture. They made the point that, in both countries, while the labour share of national income has risen, the farm labour share of gross agricultural output has declined (data to 1965). They explained this trend in terms of advancing technology creating substantial factor substitution. The problem was exaggerated because of disequilibrium in the farm labour market due, in part, to insufficient off-farm employment alternatives. The study concluded by predicting a continuous

---

[4] J.S. Holt, "Impact of the Industrialization of the Hired Farm Work Force Upon the Agricultural Economy," American Journal of Agricultural Economics, Vol. 52, No. 5, 1970, pp. 780-786.

[5] M.L. Lerohl and G.A. MacEachern, "Factor Shares in Agriculture: The Canada-U.S. Experience." Canadian Journal of Agricultural Economics, Vol. 15, No. 1, 1967, pp. 1-20.

decline of the labour share, the extent to be determined by changing input markets, technology, nonfarm opportunities, rural educational opportunities, and immigration policies.

Labour migration studies are quite numerous with many reaching the same conclusions. The ones presented here illustrate the range of topics often found in migration articles.

Whyte[6] and Buckmire[7] discussed the important, non-monetary factors of off-farm migration. Whyte declared that low education levels, lack of information, and strong parental influence hinder the movement of rural youth away from agriculture. Buckmire included lack of alternate job training, lack of job opportunities, and the security of staying on the farm as additional factors.

In a later study, Balch[8] recognized that variables relating to farm structure, technology and crop composition were also related to out-migration. He predicted a new farm work force, based on large, owner-operated and diversified farms, which was smaller but more fully committed to farming.

---

[6] D.R. Whyte, "Social Determinants of Inter-Community Mobility: An Inventory of Findings," Canadian Review of Sociology and Anthropology, Vol. 4, No. 1, 1967, pp. 1-23.

[7] G.E. Buckmire, Occupational Mobility of Farm People in the Bonnyville District--A Low Income Area. University of Alberta, Edmonton, 1966.

[8] B.W. Balch, "Migration - Inducing and Income - Equilibrating Factors Involved in Reconstructing the Alabama Farm Labor Force 1950-67: A Multivariate Analysis," unpublished Ph.D. Dissertation, University of Alabama, 1968.

Two studies done by Galloway examined the migration of hired agricultural labour in the United States. The first[9] presented the fact that despite sizeable out-migration of labour from the agricultural sector, the relative returns to labour in agriculture had not increased. He felt the total labour market was in dynamic equilibrium with the earnings differential, between farm and nonfarm sectors, a combination of economic costs (objective and subjective) and artificial barriers related to labour mobility. To alleviate this problem Galloway recommended pursuing measures to decrease the equilibrium wage differential between the sectors. However, no such measures were put forward.

His second article[10] looked for an explanation of the nature of interregional flows of hired agricultural labour. Hired workers were found responsive to regional earnings differentials as well as distance, age, age-group earnings, and, in some cases, the demand for agricultural labour, when moving between geographic regions. However, the data implied an existence of substantial noneconomic barriers to the regional mobility of hired agricultural labour such as formal seniority systems and restrictive hiring practices of trade unions. Galloway again concluded by saying these artificial and economic barriers are, in part, responsible for the low income levels among hired farm labour.

---

[9] L.E. Galloway, "Mobility of Hired Agricultural Labor 1957-1960," American Journal of Agricultural Economics, Vol. 50, No. 2, 1968, pp. 199-212.

[10] L.E. Galloway, "Geographic Flows of Hired Agricultural Labor 1957-60," American Journal of Agricultural Economics, Vol. 50, No. 2, 1968, pp. 199-212.

In 1963, Gilcrist[11] investigated the income alternatives affecting the decisions of current and potential farm operators on farming as an occupation. He approached the problem from the cost side by determining farm operator transfer income (the minimum income required to keep the operator on the farm). He found transfer incomes increase, although less than proportionally, with the increase in farm size (value of total output), but was cautious about the reliability of his data.

Plaunt[12] considered migration, income and price problems all part of the major "adjustment problem" of Canadian agriculture. He felt one must improve both the farmer's managerial skill and the environment within which the farmer must make decisions for adjustment toward improved net farm income to be possible. Poor off-farm skills and inadequate opportunity for training are just a couple of the barriers to adjustment, mentioned by Plaunt, that must be eliminated by new agricultural policy if the Canadian farmer is to improve his lot.

Hathaway and Perkins[13] critically examined the general model of farm-nonfarm labour mobility and came up with the following conclusions based on American data from 1955 through 1963: (1) many persons in agriculture could not expect to achieve higher earnings in the nonfarm

---

[11] V. Gilcrist, "A Pilot Study of Income Alternatives Affecting the Movement of Farm Operatives Out of Agriculture," Canadian Journal of Agricultural Economics, Vol. 11, No. 1, 1963, pp. 9-21.

[12] D. Plaunt, "Economic Guidelines for Mobilizing Labor and Management in Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. 17, No. 3, 1969, pp. 20-33.

[13] D.E. Hathaway and B.B. Perkins, "Farm Labor Mobility, Migration, and Income Distribution," American Journal of Agricultural Economics, Vol. 50, No. 2, 1968, pp. 342-352.

labour market; (2) mobility out of agriculture was a highly selective process with age, race, nonfarm job experience, farm earnings, and farm location all factors affecting movement incentive and success; (3) nonfarm unemployment and the lack of knowledge of nonfarm job opportunities were not severe barriers of migration to nonfarm work. However, full employment was a necessary condition for the off-farm movement to improve incomes of farm workers; (4) the existence of a local nonfarm labour market was crucial to off-farm mobility; (5) there did not seem to be a serious malallocation of labour between farm and nonfarm employment in the United States as is commonly assumed; (6) farm labour mobility and migration were less favourable to the solution of farm income problems than previously suggested.

Lianos,[14] in a study published in 1970, also found the unemployment rate as insignificant factor of migration although he notes this could be a result of a fairly consistent employment rate over the period analyzed. He suggested that further research should attempt to elaborate and quantify the psychic costs of migration as a barrier to mobility.

A regression analysis, done in the United Kingdom by Cowling and Metcalf,[15] found out-migration from agriculture significantly related to industrial employment. In areas with a high demand for labour, migration was very sensitive to variations in the local level of unemployment. In

---

[14] T.P. Lianos, "Labor Mobility and Market Imperfections," Canadian Journal of Agricultural Economics, Vol. 18, No. 3, 1970, pp. 97-108.

[15] K. Cowling and D. Metcalf, Labor Transfer from Agriculture A Regional Analysis. Manchester School of Economics and Social Studies, Manchester, 1968.

low labour demand areas, migration was less affected by local levels of unemployment. Changes in the national level of unemployment may have been of greater importance in these areas.

In a paper investigating the effects of minimum wage on agricultural employment Lianos[16] found that, in the southern U.S. at least, the introduction of minimum wages decreased the employment of hired and total labour. Lianos was uncertain as to the net welfare effect because, although the hired labour still in agriculture received a better wage, those who left agriculture might be worse off. The probability of this situation is increased if those who moved off the farm were the marginal workers (teenagers, old people, non-whites), least able to obtain a nonfarm job.

An attempt to estimate the annual shift of farm labour out of agriculture required to raise the farm wage rate parallel with the rise in nonfarm wages, was carried out by Gisser.[17] He felt once the desired shift and actual shift had been determined, government policy need only be concerned with making up the difference.

Recently Tulloch and MacMillan have done some important developmental work with migration models. "A Micro-Analytic Model of Migration Behaviour"[18] developed a framework in which to examine factors responsible

---

[16] T.P. Lianos, "Impact of Minimum Wages Upon the Level and Composition of Agricultural Employment," American Journal of Agricultural Economics, Vol. 54, No. 3, 1972, pp. 477-484.

[17] M. Gisser, "Needed Adjustments in the Supply of Farm Labor." Journal of Farm Economics, Vol. 49, No. 4, 1964, pp. 806-815.

[18] J.A. MacMillan and J.R. Tulloch, "A Micro-Analytic Model of Migration Behavior," Regional Science Perspective, Vol. 3, 1973, pp. 105-126.

for migration and migration patterns. The model was a multiple regression equation with the dependent variables: migration, multiple migration, short-distance migration, long-distance migration. These variables were represented by a comprehensive set of 0-1 independent variables including residence, age, sex, marital status, time in municipality, ethnic origin, education, type of employment, unemployment, income, and manpower service usage. Both the theoretical concepts and empirical model of migration behavior, used by the authors, would be relevant for a national or regional migration study in agriculture.

Their second and most recent analysis[19] was a synthesis of migration functions and a Markov Chain type, farm number projection model. They found this system more accurate than basic projection models with the added advantage that information regarding the impact of price changes and changes in factors of migration on farm operators is provided.

Productivity studies are generally of a quantitative nature often using farm records for data. Many articles use labour productivity indices to measure economic performance in terms of output per man.

In 1966, Auer[20] examined the functional relationship between changing resource use, technology and labour productivity. This paper was a conceptual exercise in labour productivity measurement techniques

---

[19] J.A. MacMillan, J.R. Tulloch, and F.L. Tung, Migration Analysis and Farm Number Projection Models: A Synthesis, University of Manitoba, Winnipeg, 1974.

[20] L. Auer, "Labour Productivity in Agriculture, A Conceptual Analysis," Canadian Journal of Agricultural Economics, Vol. 14, No. 1, 1966, pp. 29-39.

and was without empirical evaluation. He described productivity models for single-crop production at individual, regional and aggregate levels.

A later study by the same author[21] compared Canada and U.S. labour productivity in agriculture. He found that Canadian labour productivity lagged 7-10 years behind U.S. rates by 25 percent net and 35 percent gross. This implied a 25 percent-35 percent increase in Canadian productivity over the next decade. If domestic and export markets are not expanded, this increase in supply of farm products would result in lower farm incomes. Foreseeing a rise in agricultural labour productivity and a probable decline in farm incomes, Auer called for more research into a solution to the farm adjustment problem.

Kulshrestha[22] looked at the question of age and efficiency in agriculture with very interesting results. Using Ontario data for 1965, he found there is little if any basis for the common belief that older farmers tend to operate inefficient farm units. The implication, here, is that if these data represent the present situation, policies designed to move older farm operators out of agriculture could prove detrimental to the overall productivity of the sector and should be re-examined.

---

[21] L. Auer, "Labour Productivity in Agriculture, A Canadian-U.S. Comparison," Canadian Journal of Agricultural Economics, Vol. 18, No. 3, 1971, pp. 43-55.

[22] S.N. Kulshrestha, "Age and Efficiency in Public Agricultural Policy: The Case of Ontario," Canadian Journal of Agricultural Economics, Vol. 17, No. 2, 1969, pp. 85-91.

Another paper by Kulshrestha[23] and one by Fitzpatrick[24] examined farm income. Both concluded returns to the farm sector were well below those to the nonfarm sector. Although these articles were based on rather old data there is little reason to assume conditions have changed significantly.

It is very often a useful exercise to review literature of somewhat broader nature than the topic at hand. In the present case, studies on rural society, especially those of a detailed, regional nature, can provide valuable data and concepts for the solution of labour problems. MacMillan and several different co-authors for example, have set up an extensive data base and development plan for Manitoba's Interlake which deal with the regions' labour difficulties.[25] Studies in such areas as rural poverty and rural development also aid in

---

[23]S.N. Kulshrestha, "Measuring the Relative Income of Farm Labourers 1941-1961," Canadian Journal of Agricultural Economics, Vol. 15, No. 1, 1967, pp. 28-43.

[24]J.M. Fitzpatrick and C.V. Parker, "Distribution of Income in Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. 13, No. 2, 1965, pp. 47-64.

[25]See for example, J.A. MacMillan, An Information Base for Formulation of Effective Regional Employment Policy, Research Bulletin No. 71-1, Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Manitoba, Winnipeg, 1971; J.A. MacMillan and R.D. Bollman, Income Expenditure Relationship and Level of Living in the Interlake Area of Manitoba, Research Bulletin No. 72-2, Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Manitoba, Winnipeg, 1972; and J.A. MacMillan, L.A. Bernat, J.J. Flagler, Benefits and Costs of Manpower Services in the Interlake Rural Development Area, Research Bulletin No. 72-1, Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Manitoba, Winnipeg, 1972.

understanding agricultural manpower problems although not focusing soley on agriculture.[26]

---

[26]See for example, D.M. Connor, "Rural Anti-Poverty Policy for the Future," Canadian Journal of Agricultural Economics, Vol. 16, No. 3, 1968, pp. 18-31; M.W. Menzies, "Philosophical Dimensions of Rural Poverty in Canada," Canadian Journal of Agricultural Economics, Vol. 16, No. 3, 1968, pp. 18-31; J.P. Madden, "Social Change and Public Policy in Rural America: Data and Research Needs of the 1970's," American Journal of Agricultural Economics, Vol. 52, No. 2, 1970, pp. 308-314; and W.R. Maki and J.A. MacMillan, Regional Systems for Development Planning in Manitoba, Research Bulletin No. 70-1, Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Manitoba, Winnipeg, 1970.

APPENDIX B: DATA SERIES USED IN ESTIMATION

TABLE B.1

Data Series Used In Estimation of National Models

Year	Y_1 Hired Farm Labour (2)	Y_3 Farm Operator Labour (3)	Y_5 Unpaid Family Labour (4)	Y_2, Y_6 Farm Wage Index (5)	Y_4 Average Net Farm Income (6)	X_1 Real Farm Price Index (7)
	(000)	(000)	(000)	(1961=100)	(000)	
1947	119.5	664.3	337.8	60.3	2595	1.39
1948	133.0	668.5	294.5	65.6	3093	1.42
1949	142.5	663.0	273.3	66.0	2758	1.37
1950	110.8	628.3	279.3	65.1	2440	1.35
1951	99.3	598.0	243.0	73.6	3670	1.41
1952	108.0	549.0	213.2	78.7	3797	1.23
1953	112.8	550.8	194.8	79.3	3167	1.14
1954	120.0	568.8	184.3	78.0	1917	1.09
1955	105.8	500.2	169.8	77.7	2607	1.07
1956	101.4	511.7	160.3	83.1	2812	1.04
1957	95.6	497.8	151.8	88.6	2117	1.01
1958	96.9	468.6	146.9	90.7	2782	1.03
1959	109.2	450.8	132.5	95.1	2486	1.00
1960	110.7	442.1	126.3	98.1	2731	.98
1961	110.6	431.8	131.2	100.0	2134	1.00
1962	107.8	409.3	135.7	101.9	3687	.99
1963	101.0	400.7	139.8	105.3	3682	.95
1964	98.9	397.0	134.1	109.5	3106	.93
1965	105.3	362.6	126.0	118.5	4019	.96
1966	97.6	335.7	110.3	131.8	5206	.99
1967	99.1	337.6	122.2	142.6	3782	.95
1968	98.7	319.3	127.6	153.0	4464	.91
1969	95.5	314.8	124.7	161.8	3957	.89
1970	98.9	296.3	116.0	169.8	4028	.88
1971	101.6	291.0	117.5	178.2	4253	.85
1972	98.8	272.7	109.5	190.6	4838	.95
1973	96.4	269.8	100.3	216.1	8235	1.08

Continued

TABLE B.1 Continued

Year	X_2 Index of Productivity (8)	X_4 Adjusted Nonfarm Wage Index (9)	X_5 Total Civilian Labour Force (10)	X_5 Male Civilian Labour Force (11)	X_5 Agricultural Labour Force (12)	X_6 Average Farm Owner's Equity (13)
	(1961=100)		(000)	(000)	(000)	(000)
1947	53.6	69.0	4942	3869	1125	16038
1948	56.6	68.1	4988	3923	1100	15171
1949	54.0	70.4	5055	3969	1083	15631
1950	62.8	71.6	5163	4050	1023	17442
1951	77.7	73.4	5223	4076	943	19391
1952	100.3	77.9	5324	4144	895	20151
1953	95.2	82.0	5397	4206	862	21587
1954	71.5	81.9	5493	4263	884	20813
1955	94.6	84.7	5610	4341	825	24440
1956	106.0	88.6	5782	4439	781	23443
1957	92.9	88.2	6008	4573	751	24004
1958	107.7	86.2	6137	4641	725	27185
1959	107.3	90.5	6242	4687	703	28577
1960	115.1	90.7	6411	4754	689	29244
1961	100.0	92.9	6521	4782	691	30461
1962	125.9	95.9	6615	4819	667	31770
1963	143.7	98.0	6748	4879	655	33501
1964	133.9	101.2	6933	4961	641	36517
1965	146.3	104.5	7141	5193	601	42350
1966	182.6	106.5	7420	5326	551	47836
1967	144.5	108.1	7694	5329	565	51021
1968	157.2	110.8	7919	5443	556	56352
1969	169.7	114.0	8162	5560	545	57806
1970	175.1	116.6	8374	5684	524	67439
1971	203.9	122.7	8631	5800	523	60400
1972	194.8	127.3	8891	5938	491	65086
1973	207.4	128.9	9279	6127	476	64200

Sources: See footnotes on the following page.

Sources: Columns (2) to (4) Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1947-1973.

Column (5) Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1947-1973.

Column (6) Calculated by dividing net farm income, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1947-1973, by the number of farm operators and deflating with the Consumer Price Index, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1947-1973.

Column (7) Calculated by dividing the Farm Product Price Index, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1947-1973, by the Farm Input Price Index, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1947-1973.

Column (8) Statistics Canada, Aggregate Productivity Measures, Catalogue No. 14-201, Ottawa, Information Canada, 1947-1973.

Column (9) Calculated by deflating Average Weekly Wages in Manufacturing, obtained from Statistics Canada, Employment, Earnings, and Hours, Catalogue No. 72-002 monthly, Ottawa, Information Canada, 1947-1973, by the Consumer Price Index, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1947-1973. The series was converted into index form with 1961 the base year and multiplied by the annual rate of employment, obtained from Statistics Canada, Labour Force Survey, Catalogue No. 71-002 monthly, Ottawa, Information Canada, 1947-1973.

Columns (10) to (12) Statistics Canada, Historical Labour Force Statistics, Catalogue No. 71-201 annual, Ottawa, Information Canada, 1974.

Column (13) Calculated by dividing the Value of Farm Capital, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1947-1973, by the number of farm operators and deflating with the Farm Input Price Index, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1947-1973.

TABLE B.2

Data Series Used in Estimation of Prairie Region Models

Year (1)	Y_1 Hired Farm Labour (2)	Y_3 Farm Operator Labour (3)	Y_5 Unpaid Family Labour (4)	Y_2, Y_6 Farm Wage Index (5)	Y_4 Average Net Farm Income (6)	X_1 Real Farm Price Index (7)
	(000)	(000)	(000)	(1961=100)	(000)	
1954	34	240	64	89.8	1789	1.02
1955	31	235	65	88.0	2897	1.00
1956	33	232	59	93.2	3649	.98
1957	29	219	60	95.3	2000	.93
1958	28	213	59	95.6	2994	.96
1959	30	204	53	95.9	2751	.94
1960	33	203	49	99.5	3185	.93
1961	33	210	56	100.0	1682	1.00
1962	36	213	50	100.1	4225	.99
1963	31	213	56	101.7	4364	.94
1964	32	232	32	105.8	3072	.92
1965	36	213	22	110.0	4190	.91
1966	28	195	17	118.4	5156	.93
1967	29	191	23	125.3	3594	.91
1968	28	180	21	127.2	4570	.83
1969	29	191	23	128.9	3350	.78
1970	29	177	20	128.3	2541	.79
1971	30	175	26	132.1	4003	.76
1972	35	177	14	138.2	3750	.83
1973	31	170	15	147.6	8000	1.10

Continued

TABLE B.2 Continued

Year	X_2 Index of Productivity (8)	X_4 Adjusted Nonfarm Wage Index (9)	X_5 Total Civilian Labour Force (10)	X_6 Male Civilian Labour Force (11)	X_5 Agricultural Labour Force (12)	X_5 Average Farm Owner's Equity (13)
	(1961=100)		(000)	(000)	(000)	(000)
1954	101.1	1.52	949	771	340	24.8
1955	143.1	1.56	969	782	333	26.4
1956	164.5	1.63	998	788	324	26.3
1957	120.0	1.67	1019	803	307	27.5
1958	134.1	1.68	1055	811	299	29.9
1959	136.3	1.76	1084	826	286	31.3
1960	150.8	1.77	1115	841	282	32.4
1961	100.0	1.79	1154	853	295	32.1
1962	169.3	1.82	1175	858	296	30.9
1963	190.5	1.84	1181	862	298	32.9
1964	170.2	1.88	1199	869	298	33.6
1965	189.7	1.89	1228	879	272	39.8
1966	215.6	1.96	1248	881	241	46.3
1967	173.3	2.05	1268	888	245	52.4
1968	192.9	2.21	1318	912	231	57.3
1969	202.0	2.33	1351	927	245	51.4
1970	165.8	2.42	1380	939	229	55.0
1971	218.8	2.47	1401	952	234	53.5
1972	199.6	2.56	1436	968	228	51.4
1973	216.5	2.63	1484	985	218	55.1

Sources: See footnotes on the following page.

Source: Column (2) Calculated by subtracting the number of paid non-agricultural workers employed from the number of paid workers employed, both series obtained from Statistics Canada, Historical Labour Force Statistics, Catalogue No. 71-201 annual, Ottawa, Information Canada, 1974.

Column (3) The percent of workers employed in agriculture who were farm operators was calculated for the years 1956, 1961, 1966, and 1971 using the number of farm operators, obtained from Statistics Canada, Census of Agriculture, Catalogue Nos. 96-708, 96-709, and 96-710, Ottawa, Information Canada, 1973, and the number of workers employed in agriculture, obtained from Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1974. The percent estimates (1956-1961 average = 71.1 percent; 1966-1971 average = 78.5 percent were used to calculate the annual number of farm operators.

Column (4) Calculated by subtracting the number of paid agricultural workers employed and the number of farm operators from the total number of employed agricultural workers.

Column (5) For each Prairie province hourly, daily, and monthly hired farm wage rates for the months of January, May, and August, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, were used to obtain average annual hourly, daily, and monthly wage rates which were transformed into an index. A single, weighted average farm wage rate was calculated for each Prairie province from the hourly, daily, and monthly wage rate indexes using the weights (hourly .23, daily .18, monthly .59) used in the Farm Input Price Index. The provincial indexes were deflated by the Consumer Price Index of the major city(s) in each Prairie province (Winnipeg, Regina-Saskatoon, Calgary-Edmonton), obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973. The deflated provincial indexes were averaged to obtain a Prairie region farm wage rate index.

Column (6) Net farm income for each Prairie province, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, were summed and then divided by the number of farm operators in the Prairie region. The regional series was deflated by the Consumer Price Index, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973.

Column (7) A Farm Product Price Index for the Prairie region was calculated as the average of the Farm Product Price Index for each Prairie province, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973. This average index was divided by the Farm Input Price Index for Western Canada, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973.

Column (8) An average Prairie region Agricultural Output Index was calculated from the Agricultural Output Index of each Prairie province, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973.

Column (9) Average hourly earnings of hourly rated wage earners in manufacturing, obtained for each Prairie province from Statistics Canada, Employment, Earnings, and Hours, Catalogue No. 72-002 monthly, Ottawa, Information Canada, 1954-1973, were deflated by the Consumer Price Index of the major city(s) in each Prairie province (Winnipeg, Regina-Saskatoon, Calgary-Edmonton), obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973, and multiplied by the rate of employment in the Prairie region, obtained from Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1973. An average of the adjusted nonfarm wage rate index of each Prairie province was calculated.

Column (10) to (12) Statistics Canada, Labour Force Survey, Catalogue No. 71-001 monthly, Ottawa, Information Canada, 1954-1973.

Column (13) The value of farm capital for each Prairie province, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, was summed and divided by the number of farm operators. This series was deflated by the Farm Input Price Index for Western Canada, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973.

TABLE B.3

Data Series Used in Estimation of Models for Alberta

Year	Y_1 Hired Farm Labour	Y_3 Farm Operator Labour	Y_5 Unpaid Family Labour	Y_2, Y_6 Farm Wage Index	Y_4 Average Net Farm Income	X_1 Real Farm Price Index
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(000)	(000)	(000)	(1961=100)	(000)	
1954	17.5	79.6	20.4	90.3	2408	1.12
1955	15.4	71.0	21.6	89.0	2687	1.02
1956	14.8	73.7	20.0	93.2	3300	.99
1957	14.0	72.2	21.1	95.1	2174	.96
1958	14.1	68.9	21.1	93.8	3303	.99
1959	15.8	67.2	19.6	94.7	2919	.97
1960	15.9	66.3	18.3	100.5	2702	.93
1961	15.9	65.6	19.8	100.0	2760	1.00
1962	16.1	63.0	17.2	101.7	3840	1.01
1963	15.5	62.5	18.8	103.6	4031	.95
1964	15.6	62.3	10.6	106.9	3371	.92
1965	17.1	57.7	7.9	111.1	4188	.93
1966	16.3	54.0	6.7	119.3	5202	.96
1967	16.1	55.0	8.7	124.2	3715	.94
1968	15.6	52.7	8.3	125.9	4663	.87
1969	14.6	52.6	8.5	127.7	3517	.84
1970	14.7	50.1	7.7	129.1	3141	.84
1971	14.6	49.8	9.5	133.8	3445	.82
1972	14.2	47.2	5.1	136.9	4121	.89
1973	13.9	47.2	5.7	146.3	8533	1.15

Continued

TABLE B.3 Continued

Year	X_2 Index of Productivity (8)	X_4 Adjusted Nonfarm Wage Index (9)	X_5 Total Civilian Labour Force (10)	X_5 Male Civilian Labour Force (11)	X_5 Agricultural Labour Force (12)	X_6 Average Farm Owner's Equity (13)
	(1961=100)		(000)		(000)	(000)
1954	81.9	1.55	395		112	29.5
1955	99.0	1.60	409		111	29.9
1956	109.5	1.66	423		110	29.6
1957	88.0	1.71	436		108	30.1
1958	99.7	1.71	450		107	33.2
1959	104.2	1.78	464		106	34.1
1960	100.2	1.82	477		105	35.7
1961	100.0	1.87	491		104	37.1
1962	111.1	1.89	505		102	36.7
1963	128.2	1.91	519		100	38.7
1964	123.2	1.97	534		99	43.8
1965	132.7	2.01	548		97	47.5
1966	152.6	2.07	562		45	50.4
1967	128.0	2.14	578		93	56.8
1968	147.7	2.27	604		91	60.7
1969	144.2	2.43	628		90	60.7
1970	133.5	2.54	650		88	61.9
1971	141.4	2.59	664		86	61.1
1972	146.4	2.68	688		84	61.4
1973	154.7	2.79	718		82	64.8

Sources: See footnotes on the following page

Sources: Columns (2) to (3) The number of hired farm labour employed and the number of farm operators for Alberta and for Canada were obtained from Statistics Canada, Census of Agriculture, Ottawa, Information Canada, 1951, 1956, 1961, 1966 and 1971. The percent of hired farm labour employed and percent of farm operators in Canada, who were in Alberta, were calculated. The percent rates were used to estimate the annual number of hired farm labour employed and the number of farm operators in Alberta from the Canada totals.

Column (4) The percent of the Prairie region agricultural labour force that were unpaid family labour was calculated on an annual basis from the data series collected for the Prairie region model. These percent figures were used to estimate unpaid family labour from the Alberta agricultural labour force.

Column (5) For source and method of estimation see the footnote of Table B.2 referring to column (5).

Column (6) Net farm income for Alberta, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, was deflated by the Consumer Price Index for Calgary-Edmonton, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973, and divided by the number of farms in Alberta.

Column (7) The Farm Product Price Index for Alberta, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, was divided by the Farm Input Price Index for Western Canada, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973.

Column (8) The Agricultural Output Index of Alberta was obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973.

Column (9) For source and method of estimation see the footnote of Table B.2 referring to column (9).

Column (10) For the years 1954-1965, the series was an extrapolation of the total civilian labour force of Alberta for 1951 and 1961, obtained from Statistics Canada, Population Census, Ottawa, Information Canada, 1951 and 1961. For the years 1966-1973 annual estimates were used, obtained from Statistics Canada, Historical Labour Force Statistics, Catalogue No. 71-201 annual, Ottawa, Information Canada, 1974.

Column (11) Due to the lack of significance of this variable at the national and regional level, it was not tested at the provincial level.

Column (12) The series was an extrapolation of the agricultural labour force of Alberta in 1951, 1961 and 1971, obtained

from Statistics Canada, Population Census, Ottawa, Information Canada, 1951, 1961, and 1971.

Column (13) The value of farm capital for Alberta, obtained from Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue No. 21-003 quarterly, Ottawa, Information Canada, 1954-1973, was devided by the number of farms in Alberta and then deflated by the Farm Input Price Index for Western Canada, obtained from Statistics Canada, Prices and Price Indexes, Catalogue No. 62-002 monthly, Ottawa, Information Canada, 1954-1973.

TABLE B.4

Data Series Used in Estimation of Models for Saskatchewan

Year	Y_1 Hired Farm Labour	Y_2 Farm Operator Labour	Y_5 Unpaid Family Labour	Y_2, Y_6 Farm Wage Index	Y_4 Average Net Farm Income	X_1 Real Farm Price Index
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(000)	(000)	(000)	(1961=100)	(000)	
1954	16.7	105.2	24.4	89.6	1395	.97
1955	14.7	93.0	25.7	88.0	3397	.95
1956	14.1	96.2	23.5	90.6	4217	.94
1957	12.8	94.1	24.4	94.0	1862	.88
1958	12.3	89.5	23.8	94.3	2490	.91
1959	13.4	86.6	21.6	95.9	2395	.90
1960	13.1	85.8	19.8	99.1	3518	.90
1961	12.5	84.2	20.9	100.0	1054	1.00
1962	13.3	80.2	18.4	99.7	4962	.97
1963	13.4	78.9	20.3	100.5	5949	.93
1964	14.2	78.2	11.4	103.9	3708	.92
1965	16.2	71.8	8.6	109.0	5258	.89
1966	16.0	66.8	7.5	117.7	6278	.90
1967	15.1	67.9	9.8	127.0	3798	.88
1968	13.8	64.8	9.4	128.1	4854	.79
1969	12.3	64.8	9.6	128.2	4248	.71
1970	11.6	61.6	8.8	125.2	2452	.74
1971	10.7	61.1	11.1	130.6	5130	.71
1972	10.4	56.7	6.0	137.8	4197	.77
1973	10.1	55.6	6.8	147.5	9401	1.06

Continued

TABLE B.4 Continued

Year	X_2 Index of Productivity (8)	X_4 Adjusted Nonfarm Wage Index (9)	X_5 Total Civilian Labour Force (10)	X_5 Male Civilian Labour Force (11)	X_5 Agricultural Labour Force (12)	X_6 Average Farm Owner's Equity (13)
	(1961=100)		(000)		(000)	(000)
1954	115.1	1.55	310		134	23.3
1955	210.4	1.60	312		132	25.4
1956	232.7	1.66	315		129	25.5
1957	152.3	1.71	317		129	25.5
1958	127.0	1.74	320		121	27.0
1959	165.0	1.81	322		117	27.7
1960	206.9	1.84	325		114	29.1
1961	100.0	1.89	327		110	30.5
1962	220.6	1.89	328		109	30.6
1963	291.6	1.92	328		108	34.2
1964	201.0	1.96	329		107	38.8
1965	242.7	1.99	329		106	43.6
1966	310.1	2.07	330		105	47.5
1967	199.7	2.17	332		104	53.9
1968	225.4	2.43	342		103	56.0
1969	279.7	2.52	350		102	52.8
1970	198.1	2.57	350		101	53.2
1971	288.2	2.67	348		100	52.2
1972	245.6	2.74	352		99	51.4
1973	272.4	2.79	358		98	542

Sources: For sources and methods of estimation, see the footnotes of Table B.3.

TABLE B.5

Data Series Used in Estimation of Models for Manitoba

Year	Y_1 Hired Farm Labour	Y_3 Farm Operator Labour	Y_5 Unpaid Family Labour	Y_2, Y_6 Farm Wage Index	Y_4 Average Net Farm Income	X_1 Real Farm Price Index
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(000)	(000)	(000)	(1961=100)	(000)	
1954	7.9	48.9	12.7	89.5	1945	1.04
1955	7.4	43.0	13.3	86.9	1948	1.03
1956	7.1	44.5	12.2	95.8	2846	1.00
1957	6.6	43.8	12.9	96.9	1608	.96
1958	6.6	41.2	12.6	98.7	2869	.98
1959	7.2	40.1	11.7	97.1	2303	.96
1960	7.2	39.3	10.6	98.8	2477	.94
1961	7.1	38.9	11.4	100.0	1201	1.00
1962	7.3	36.8	10.0	98.9	3779	.99
1963	7.3	36.5	10.7	101.1	2576	.93
1964	7.4	36.1	6.0	106.6	3738	.90
1965	8.3	33.4	4.5	109.9	3951	.91
1966	8.1	30.9	3.8	118.1	3426	.92
1967	7.9	31.4	4.9	124.6	3514	.90
1968	7.6	30.0	4.6	127.7	3634	.84
1969	7.2	29.6	4.7	130.9	2534	.78
1970	7.1	28.1	4.2	130.7	2095	.78
1971	7.0	27.9	5.2	131.9	3800	.75
1972	6.8	26.5	2.8	139.8	4076	.82
1973	6.7	26.4	3.0	149.1	8097	1.09

Continued

TABLE B.5 Continued

Year	X_2 Index of Productivity (8)	X_4 Adjusted Nonfarm Wage Index (9)	X_5 Total Civilian Labour Force (10)	X_5 Male Civilian Labour Force (11)	X_5 Agricultural Labour Force (12)	X_6 Average Farm Owner's Equity (13)
	(1961=100)		(000)		(000)	(000)
1954	106.3	1.45	313		70	22.2
1955	119.8	1.47	317		68	22.9
1956	151.4	1.53	322		67	22.8
1957	119.7	1.54	326		66	22.5
1958	145.5	1.54	331		64	24.1
1959	139.6	1.63	335		63	24.0
1960	145.2	1.63	340		61	25.4
1961	100.0	1.64	344		60	26.7
1962	176.1	1.67	347		59	25.8
1963	151.6	1.70	349		57	27.2
1964	186.4	1.71	352		56	30.6
1965	192.4	1.69	354		55	33.0
1966	184.0	1.73	357		54	36.7
1967	192.2	1.83	358		52	41.6
1968	205.5	1.94	372		51	44.3
1969	182.0	2.04	373		50	43.6
1970	165.9	2.15	380		48	44.4
1971	226.9	2.17	390		47	43.0
1972	206.7	2.25	396		46	42.6
1973	222.3	2.34	408		44	45.1

Sources: For sources and methods of estimation, see the footnotes referring to Table B.3.

APPENDIX C: RESULTS FROM THE THEORETICAL MODEL

In this appendix the statistical results from the theoretical model described in Chapter III are presented. To continue the numerical sequence of the step-wise regression approach applied to the preliminary models, the model discussed herein is labelled model IV. Tables C.1-C.15 detail the results of model IV, specified in both static and dynamic form, for each labour component and each level of analysis.[1] A model is presented with either the total civilian labour force or the agricultural labour force depending upon which variable was in the "better" model. The selection of the "better" models was based on the factors outlined in the first part of Chapter V.

The Market for Hired Labour in Agriculture

Demand. As was expected from the preliminary experiments, the statistical results for hired farm labour were unfavourable. Looking at the demand functions first, the coefficient of determination (R^2) ranged from a low of .194 in the static demand function for the Prairie region to a high of .904 in the dynamic demand function for Saskatchewan. The latter figure implies that 90.4 percent of the variability in the demand

[1]Each equation has been numbered for each identification in the text. In the two digit code, the number refers to the table number. The letter refers to a specific equation. Demand - static, supply - static, demand - dynamic and supply - dynamic equations are always lettered A, B, C, and D, respectively.

Table C.1

Estimates of Structural Demand and Supply Relationships for Hired Labour--Canada, 1947-73, Regression Coefficients[a] and Standard Errors, Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Non Farm Wage	X_5[c] Labour Force	X_7 Hired Labour Lagged	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{Y}_2$ Farm Wage	R^2[a]	d'[b]
Demand Static 1-A	5.213	.090	- .348*	-.052				- .659	- .073	- .261	.636**	1.55*
		(.307)	(.169)	(.082)				(.893)	(.200)	(.551)		
Supply Static 1-B	-2.238			-.043	.015	3.284**		-1.468*	- .851**	.323	.752**	1.61*
				(.062)	(.592)	(.825)		(.633)	(.257)	(.381)		
Demand Dynamic 1-C	1.758	-.087	-.234	-.064			.196	.131	-.146	.195	.640**	1.58*
		(.311)	(.211)	(.081)	[illegible]		(.307)	(.964)	(.213)	(.547)		
Supply Dynamic 1-D	-2.321			-.033	-.045	3.068*	.134	-1.309*	-.829**	.357	.758**	1.62*
				(.065)	(.594)	(.878)	(.209)	(.698)	(.247)	(.339)		

a - A one-asterisk superscript indicates the regression coefficient is statically significant at the five per cent level, a two-asterisk superscript indicates significance at the one per cent level, and + indicates statistical significance at the ten per cent level.

b - d' is the Durbin-Watson statistic for serial correlation among the calculated residuals. The presence of positive serial correlation is indicated by a two-asterisk superscript. One-asterisk indicates an inconclusive test. No superscript indicates no serial correlation among the residuals.

c - X_5 represents the total civilian labour force rather than the agricultural labour force when the coefficient in the table has the superscript; 0.

Table C.2

Estimates of Structural Demand and Supply Relationships for Hired Labour--Prairie Region 1954-73, Regression Coefficients[a] and Standard Errors, Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Non Farm Wage	X_5[c] Labour Force	X_7 Hired Labour Lagged	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{Y}_2$ Farm Wage	R^2[a]	d[b]
Demand Static 2-A	.322	.205	-.027	.027				.503	-.034	.051	.194	1.75*
		(.258)	(.148)	(.056)				(.602)	(.130)	(.724)		
Supply Static 2-B	-2.224			.108*	-.128	6.423**		-4.677**	-.687**	-.069	.725**	2.00
				(.048)	(.911)	(1.877)		(1.499)	(1.49)	(1.356)		
Demand Dynamic 2-C	.435	.113	-.032	.040			.164	.422	-.032	-.036	.215	1.94
		(.312)	(.151)	(.062)			(.292)	(.636)	(.134)	(.761)		
Supply Dynamic 2-D	-1.525			.104+	.048	6.011*	.052	-4.384*	-.665**	-.329	.724*	2.08
				(.052)	(1.270)	(2.603)	(.205)	(1.952)	(.170)	(1.924)		

See Table C.1 for footnotes.

Table C.3

Estimates of Structural Demand and Supply Relationships for Hired Labour--
Alberta 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Non Farm Wage	X_5[c] Labour Force	X_7 Hired Labour Lagged	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{Y}_2$ Farm Wage	R^2[a]	d[b]
Demand	2.671	-.017	.018	.012				.022	-.158^{+}	-.686		
Static											.301	.98*
3-A		(.215)	(.229)	(.054)				(.811)	(.095)	(.714)		
Supply	7.744			-1.089*	1.113	19.078^{*,o}		-2.746*	-1.314*	-25.251*		
Static											.684**	1.77*
3-B				(.496)	(1.885)	(8.369)		(1.454)	(.659)	(12.766)		
Demand	1.267	.085	-.137	.069			.537*	.261	-.103	-.332		
Dynamic											.460	1.49*
3-C		(.204)	(.226)	(.055)			(.259)	(.676)	(.087)	(.571)		
Supply	-5.225			-.090	-1.777^{+}	2.690^{*,o}	.346	.329	-.034	-.558		
Dynamic											.619^{+}	1.56*
3-D				(.075)	(.503)	(1.270)	(1.444)	(.685)	(.117)	(2.038)		

See Table C.1 for footnotes.

Table C.4

Estimates of Structural Demand and Supply Relationships for Hired Labour--Saskatchewan 1954-73, Regression Coefficients[a] and Standard Errors, Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Non Farm Wage	X_5[c] Labour Force	X_7 Hired Labour Lagged	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{Y}_2$ Farm Wage	R^2[a]	d'[b]
Demand Static 4-A	10.611	-.048	-.036	-.089				-1.301	-.497*	-3.098*	.824*	1.48*
		(.173)	(.081)	(.062)				(.973)	(.094)	(.912)		
Supply Static 4-B	14.345			-.216*	.627	-1.277*		-1.060+	-.558*	-3.916*	.861*	1.55*
				(.087)	(.843)	(.715)		(.708)	(.140)	(1.459)		
Demand Dynamic 4-C	1.083	.142	.007	.033			.727**	.384**	-.258**	-.614	.904**	2.06
		(.136)	(.061)	(.044)			(.134)	(.601)	(.080)	(.492)		
Supply Dynamic 4-D	.615			.033	-.627	-.003°	.603**	.213	-.222*	-.081	.905**	1.98
				(.044)	(.922)	(2.805)	(.157)	(.544)	(.091)	(.679)		

See Table C.1 for footnotes.

Table C.5

Estimates of Structural Demand and Supply Relationships for Hired Labour--Manitoba 1954-73, Regression Coefficients[a] and Standard Errors, Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 Non Farm Wage	X_5[c] Labour Force	X_7 Hired Labour Lagged	X_{11} Operator Labour	X_{12} Unpaid Family Labour	$\hat{Y}_2$ Farm Wage	R^2[a]	d'[b]
Demand Static 5-A	2.208	.028	.004	-0.027				.119**	-.262**	-.646*	.567+	1.47*
		(.037)	(.103)	(.036)				(.034)	(.075)	(.280)		
Supply Static 5-B	.073			-.031	-.849	.039[0]		.065	-.140	.465	.599*	1.39*
				(.032)	(.824)	(.035)		(.064)	(.144)	(1.113)		
Demand Dynamic 5-C	1.505	.020	.018	-.010			.421*	.080*	-.177*	-.506*	.681*	2.13*
		(.033)	(.092)	(.033)			(.209)	(.036)	(.080)	(.261)		
Supply Dynamic 5-D	.569			-.010	-.401	.023[0]	.392*	.059	-.130	.013	.684*	2.05
				(.032)	(.774)	(.033)	(.214)	(.059)	(.133)	(1.029)		

See Table C.1 for footnotes.

for hired labour in Saskatchewan can be explained by the independent variables included in the demand function. The R^2 values were significant at the one percent level for the Canadian and Saskatchewan models while significant at the five and ten percent levels for the Manitoba dynamic and static models, respectively. In the regional and Alberta models the demand equations were not statistically significant.

The real farm price variable had the expected positive coefficient in most of the demand functions, with one national, one Alberta, and one Saskatchewan equation (1 - C, 3 - A and 4 - A) the exceptions. In no instance was the real farm price coefficient statistically significant at the ten percent level or above.

Productivity had the expected negative coefficient and was statiscally significant in one static demand function (1 - A) at the five percent level. The coefficient was not statistically significant in other models but had the correct sign in (five) equations (1 - C, 2 - A, 2 - C, 3 - C, and 4 - A).

The trend variable was not statistically significant in the demand equations. It had a negative coefficient in the national and Manitoba functions, a positive coefficient in the regional and Alberta functions and was both negative (4 - A) and positive (4 - C) in the Saskatchewan functions.

With the exception of one national (1 - A), one Alberta (3 - C), and one Saskatchewan (4 - A) equation the operator labour variable had a theoretically inconsistent positive sign. In the three instances where the expected sign did occur, the coefficient was not statistically significant. The coefficient was both positive and statistically

significant in Saskatchewan at the one percent level (4 - C) and in Manitoba at the one percent (5 - A) and five percent (5 - C) levels. In all other equations, the attempt to use operator labour as a substitute for hired labour resulted in theoretically incorrect signs and statistically nonsignificant coefficients.

Unpaid family labour employment, acting as a substitution variable, had the expected negative coefficient in all cases. It was statistically significant only in the provincial models; specifically at the ten percent level (3 - A) in Alberta, one percent level (4 - A, 4 - C) in Saskatchewan and at the one percent (5 - A) and five percent (5 - C) levels in Manitoba.

The farm wage rate had the expected negative coefficient in all but one national (1 - C) and one regional (2 - A) equation. However, statistical significance was again a problem with the coefficient statistically significant only in Saskatchewan (4 - A) at the one percent level and Manitoba (5 - A, 5 - C) at the five percent level.

The coefficient for the lagged dependent variable was significantly different from zero and significantly less than one only in the Manitoba demand functions. When the T.C.L.F. variable was used in the Manitoba model (5 - C) the elasticity of adjustment (γ) value obtained was .579, compared to a value of .590 when the A.L.F. variable was used.

Supply. On the supply side of the hired labour market the statistical results were improved. The R^2 values ranged from a low of .599 in Manitoba (5 - B) to a high of .905 in Saskatchewan (4 - D). All regression equations were statistically significant at the ten percent level or higher.

The nonfarm wage rate variable had the expected negative sign and statistical significance at the ten percent level in Alberta (3 - D). Of the remaining nine supply equations for hired labour, five equations (1 - D, 2 - B, 4 - D, 5 - B, and 5 - D) had the expected sign on the nonfarm wage rate coefficient but the coefficient was not statistically significant at the ten percent level or higher.

The labour force variable had the expected positive sign in all but the Saskatchewan equation (4 - B). Labour force was a statistically significant variable at the five percent level or higher in the Canadian, regional and Alberta supply equations for hired labour. The coefficient was not statistically significant in Saskatchewan or Manitoba. For the national and regional models the agricultural labour force (A.L.F.) variable worked better than the total civilian labour force variable (T.C.L.F.) in terms of the overall model evaluation. The T.C.L.F. variable had the more favourable effect in the provincial models with the exception of the static Saskatchewan model.

The coefficient of the operator labour variable had the expected negative sign and was significant at the ten percent level or higher in the Canadian, regional, Alberta (3 - B only) and Saskatchewan (4 - B only) supply equation. These results were quite surprising considering the lack of success of this substitution variable in the hired labour demand equations. In Manitoba, the coefficient did not have the expected sign nor was it statistically significant.

The unpaid family labour variable was consistent with a priori expectations. The coefficient was negative in all cases. Statistical significance at the five percent level or higher was obtained in all

but three cases. Specifically, in the Manitoba (5 - B, 5 - D) equations and one Alberta (3 - D) supply equation the coefficient was not statistically significant.

The trend variable had the same sign in the supply functions as it did in the demand functions with the exception of the Alberta model. Here the signs were reversed with a negative trend coefficient in the supply functions. Statistical significance was limited to the regional, Alberta (3 - B only) and Saskatchewan (4 - B only) models at the five percent level or higher.

The results for the farm wage rate presented serious problems. The expected positive coefficient appeared only in the Canadian and Manitoba supply functions and was not statistically significant. A theoretically incorrect negative coefficient was present in the other models and was statistically significant at the five (3 - B) and one (4 - B) percent levels in two cases.

The lagged variable did not have a statistically significant coefficient in the national, regional, or Alberta models. Because this coefficient was not statistically significant from zero, the γ values equal one which implies all adjustments in supply to an economic stimuli occur in the first time period. In the Manitoba supply equation (5 - D) a γ value of .608 was obtained which indicates a similar adjustment rate to the γ value of .579 for the Manitoba demand equation (5 - C) and to the γ value of .627 for the Manitoba supply equations of the preliminary models (Model I). The elasticity of adjustment values in the Saskatchewan supply equations were smaller than those for Manitoba with .397 and .314 the values for the supply equations using the T.C.L.F. (4 - D) and A.L.F. variables respectively.

In general the tests for serial correlation of the calculated residual in both the demand and supply equations of hired labour came up with inconclusive results although some equations (2 - B, 2 - C, 2 - D, 4 - C, 4 - D, 5 - D) had no autocorrelation problems. In no equation was positive or negative autocorrelation actually detected and in most cases the Durbin-Watson statistic was near the upper limit of the inconclusive range.

The Market for Operator Labour in Agriculture

Demand. The R^2 values for the operator labour demand equations were all greater than .950 except in the static equation (7 - A) at the regional level where the R^2 value was .927. All of the regression equations were statistically significant at the one percent level.

The real farm price variable had the expected positive coefficient in all demand equations except for Manitoba (10 - A and 10 - C). Statistical significance at the five percent level or higher appeared for the coefficient in the national, regional and Saskatchewan models. It was not statistically significant in the Alberta and Manitoba models.

The productivity variable did not work as expected. The coefficient had a theoretically incorrect positive sign and was significant at the ten percent level or higher in the national, regional and Saskatchewan models. Only in the Manitoba models did the productivity coefficient appear with the expected negative sign where it was statistically significant at the one percent (10 - A) and five percent (10 - C) levels.

Table C.6

Estimates of Structural Demand and Supply Relationships for Operator Labour--
Canada, 1947-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_6 Owner's Equity	X_8 Operator Labour Lagged	X_{10} Hired Labour	X_{12} Unpaid Family Labour	$\hat{Y}_4$ Net Farm Income	R^2[a]	d'[b]
Demand Static 6-A	1.525	3.781**	2.153**	-.036					.862**	.521**	-1.774**	.980**	1.19*
		(.641)	(.477)	(.053)					(.241)	(.144)	(.296)		
Supply Static 6-B	2.842			.015	-.279*	.611*	-.216**		-.094+	-.052	-.039*	.998**	2.34*
				(.017)	(.132)	(.286)	(.071)		(.057)	(.097)	(.021)		
Demand Dynamic 6-C	.699	1.271*	.687+	-.012				.596**	.348*	.176+	-.613*	.991**	2.69*
		(.689)	(.452)	(.038)				(.126)	(.200)	(.125)	(.318)		
Supply Dynamic 6-D	3.007			.019	-.401**	.883**	-.202**	-.200+	-.152*	-.120	-.031+	.998**	2.00
				(.017)	(.148)	(.323)	(.069)	(.124)	(.065)	(.102)	(.020)		

See Table C.1 for footnotes.

Table C.7

Estimates of Structural Demand and Supply Relationships for Operator Labour--
Prairie Region 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_6 Owner's Equity	X_8 Operator Labour Lagged	X_{10} Hired Labour	X_{12} Unpaid Family Labour	$\hat{Y}_4$ Net Farm Income	R^2[a]	d'[b]
Demand Static 7-A	2.002	1.511**	1.298**	-.045*					.015	.099**	-.750**	.927**	.41**
		(.292)	(.239)	(.019)					(.108)	(.027)	(.142)		
Supply Static 7-B	-.613			.020**	-.102**	1.307**	.059*		-.097**	-.126**	-.002	.997**	2.87*
				(.005)	(.037)	(.071)	(.032)		(.029)	(.010)	(.006)		
Demand Dynamic 7-C	.907	1.144**	1.006**	.003				.481**	.031	.087**	-.590**	.978**	1.41*
		(.179)	(.145)	(.014)				(.090)	(.062)	(.016)	(.085)		
Supply Static 7-D	-.564			.019**	-.115*	1.316**	.058+	-.026	-.098**	-.129**	-.001	.997**	2.82*
				(.006)	(.052)	(.080)	(.034)	(.066)	(.031)	(.014)	(.007)		

See Table C.1 for footnotes.

Table C.8

Estimates of Structural Demand and Supply Relationships for Operator Labour--
Alberta 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_6 Owner's Equity	X_8 Operator Labour Lagged	X_{10} Hired Labour	X_{12} Unpaid Family Labour	$\hat{Y}_4$ Net Farm Income	R^2[a]	d'[b]
Demand Static 8-A	1.635	.054	-.109	-.073*					.247+	.147**	-.004	.955**	1.25*
		(1.055)	(.760)	(.032)					(.150)	(.046)	(.457)		
Supply Static 8-B	1.130			-.034+	-.170	.478	-.116		.011	.034	-.022	.985**	2.48*
				(.017)	(.395)	(.886)	(.117)		(.121)	(.035)	(.036)		
Demand Dynamic 8-C	.969	.378	.159	-.034				.435*	.138	.091*	-.147	.972**	2.33*
		(.864)	(.624)	(.029)				(.164)	(.131)	(.044)	(.375)		
Supply Dynamic 8-D	1.579			-.038*	-.296	.767	-.177**	-.428*	-.036	.020	-.035	.988**	1.91
				(.016)	(.367)	(.830)	(.111)	(.234)	(.114)	(.033)	(.033)		

See Table C.1 For footnotes.

Table C.9

Estimates of Structural Demand and Supply Relationships for Operator Labour--
Saskatchewan 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_6 Owner's Equity	X_8 Operator Labour Lagged	X_{10} Hired Labour	X_{12} Unpaid Family Labour	$\hat{Y}_4$ Net Farm Income	R^2[a]	d[d]
Demand Static 9-A	1.591	.598*	.498+	-.040					.217**	.192**	-.353+	.976**	1.66*
		(.317)	(.313)	(.023)					(.079)	(.035)	(.201)		
Supply Static 9-B	1.261			.014	-.133	.352	-.210+		.234	.099**	-.033*	.990**	2.54*
				(.039)	(.313)	(.319)	(.143)		(.175)	(.034)	(.014)		
Demand Dynamic 9-C	1.079	.506*	.441*	-.022				.340*	.128+	.125**	-.310*	.985**	2.15*
		(.252)	(.245)	(.020)				(.144)	(.074)	(.040)	(.158)		
Supply Dynamic 9-D	1.553			.026	-.238	.504+	-.264*	-.269	.263+	.104**	-.040**	.992**	2.06
				(.038)	(.313)	(.328)	(.144)	(.206)	(.170)	(.033)	(.014)		

See Table C.1 For footnotes.

Table C.10

Estimates of Structural Demand and Supply Relationships for Operator Labour--
Manitoba 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_6 Owner's Equity	X_8 Operator Labour Lagged	X_{10} Hired Labour	X_{12} Unpaid Family Labour	$\hat{Y}_4$ Net Farm Income	R^2[a]	d_i[b]
Demand	2.110	-.029	-1.096**	-.029					.259*	.100**	.465**		
Static												.976**	2.19*
10-A		(.027)	(.234)	(.029)					(.135)	(.020)	(.115)		
Supply	2.084			-.079**	-.666**	.023[0]	-.012		.300*	.037+	-.034		
Static												.983**	2.25*
10-B				(.018)	(.138)	(.019)	(.016)		.121	.022	(.028)		
Demand	1.365	-.025	-.622*	-.025				.334+	.159	.069**	.257+		
Dynamic												.981**	2.27*
10-C		(.025)	(.338)	(.026)				(.195)	(.136)	(.026)	(.155)		
Supply	2.606			-.094*	-.844*	.034[0]	-.017	-.195	-.390+	.038+	-.035		
Dynamic												.983**	2.21*
10-D				(.033)	(.381)	(.029)	(.019)	(.388)	(.219)	(.023)	(.029)		

See Table C.1 for footnotes.

Trend had a negative coefficient in all but one demand equation (7 - C). The trend coefficient was found statistically significant in the regional (7 - A) and Alberta (8 - A) demand functions at the five percent level. In all other cases the coefficient was not statistically significant.

The substitute variables, quantity of hired labour and quantity of unpaid family labour had theoretically inconsistent positive signs in every demand function. Moreover, in most cases the coefficient was statistically significant. The coefficient for hired labour employment was statistically significant at the ten percent level or higher in all but four (7 - A, 7 - C, 8 - C, and 10 - C) demand equations. The coefficient for unpaid family labour was statistically significant at the one percent level except for two equations (6 - C and 8 - C) which were significant at the ten and five percent levels respectively.

Net farm income worked well as a proxy indicator for the "price" of operator labour in the demand functions. The Manitoba models were an exception. In the Manitoba models the coefficient had a theoretically inconsistent positive sign and was significant at the one (10 - A) and ten (10 - C) percent levels. In all other demand equations the coefficient had the expected sign. It was statistically significant at the five percent level or higher except for the Alberta equations (8 - A and 8 - C) in which the coefficient was not statistically significant.

The lagged dependent variable worked well in the operator demand functions. In all models it was statistically different from zero and statistically less than one. The values obtained for γ increased as the level of disaggregation increased. That is, the values

for γ at the provincial level were greater than those for the regional or national operator labour demand equations. For example, the elasticity of adjustment values for Alberta (8 - C), Saskatchewan (9 - C), and Manitoba (10 - C) were .565, .660 and .666, respectively compared to values for the regional (7 - C) and national (6 - C) demand equations of .519 and .404, respectively. This situation was the reverse of that found in the preliminary model experiments. The provincial γ values indicated that, within the three prairie provinces, the rate of adjustment in the demand for operator labour in response to economic stimuli is quite similar.

Supply. In all operator labour supply equations the R^2 values were greater than .980. All regression equations were statistically significant at the one percent level.

In the supply equations, the nonfarm wage rate had the expected negative coefficient at all times. The Canadian, regional and Manitoba nonfarm wage rate coefficients were statistically significant at the five percent level or higher. The coefficient was not statistically significant in the Alberta or Saskatchewan models.

The labour force variable had the expected positive sign in all cases. The A.L.F. variable appeared in the "better" models except for Manitoba where the results were improved if the T.C.L.F. variable was used. The coefficient was statistically significant in the national, regional and Saskatchewan (9 - D only) models.

A negative coefficient appeared for the owner's equity variable except in the regional supply equations. This negative coefficient was statistically significant in the national, Alberta (8 - D only) and

Saskatchewan models at the ten percent level or higher. In the regional supply equations, the coefficient was statistically significant in both the static and dynamic models at the five and ten percent levels, respectively.

The trend variable had a positive coefficient in the national, regional and Saskatchewan supply equations. Only the coefficient in the regional model was statistically significant. There, it was statistically significant at the one percent level. The trend coefficient was negative in the remaining models and statistically significant at the ten percent level or higher in all cases.

The coefficient of the hired farm labour variable had the hypothesized negative sign except in the Saskatchewan supply equations and the static (8 - B) Alberta supply equation. Statistical significance was attained, at the ten percent level or higher, for this variable in the national, regional and Manitoba models.

Unpaid family labour had the expected negative coefficient in the national and regional supply equations although it was only statistically significant in the regional equations at the one percent level. In the provincial models, a theoretically inconsistent positive coefficient was present with statistical significance at the one percent level for Saskatchewan and the ten percent level for Manitoba.

The net farm income variable did not work as expected in the supply functions. In every case it had a negative coefficient which was only significant at the ten percent level or higher in the national and Saskatchewan models.

The lagged dependent variable presented statistical problems in the supply equations. In the regional (7 - D) Saskatchewan (9 - D), and Manitoba (10 - D) models the coefficient was not significantly different from zero, indicating that there is no lag in the adjustment to economic stimuli. In the national (6 - D) and Alberta (8 - D) models the coefficient was significantly different from zero and one but it had a negative sign which was inconsistent with a priori constraints ($0 < \gamma < 1$) placed on the elasticity of adjustment values.

On the basis of the Durbin-Watson statistic, positive serial correlation of the calculated residual was present in one instance - the static demand function (7 - A) of the regional model. All other tests gave inconclusive results except the dynamic supply equations of the national (6 - D), Alberta (8 - D) and Saskatchewan (9 - D) models which had no autocorrelation. As in the hired labour equations, the Durbin-Watson statistic was generally near the upper limit of the inconclusive range.

The Market for Unpaid Family Labour

Demand. In the market for unpaid family labour, the R^2 values were all high with the average around .940. The regression equations were statistically significant at the one percent level in all cases.

The real farm price variable did not have a statistically significant coefficient in any demand equations. The coefficient appeared with the expected positive sign in the national regional (12 - C only) and Manitoba models only.

Table C.11

Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--Canada, 1947-73, Regression Coefficients[a] and Standard Errors, Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	$\hat{Y}_6$ Farm Wage	R^2[a]	d[b]
Demand Static 11-A	2.202	.297	-.057	-.284**				-.144	.217	.059	.957**	.78*
		(.387)	(.209)	(.067)				(.264)	(1.092)	(.693)		
Supply Static 11-B	-1.93			-.070	-.152	3.096**		-.479**	-1.492**	.285	.987**	1.52*
				(.047)	(.449)	(.466)		(.140)	(.487)	(.279)		
Demand Dynamic 11-C	6.161	.064	-.374**	.017			.938**	-.062	-1.396*	-.739*	.984**	2.00
		(.214)	(.142)	(.069)			(.167)	(.164)	(.674)	(.403)		
Supply Dynamic 11-D	-1.612			-.039	-.119	2.566**	.208	-.376*	-1.275**	.211	.989**	1.67*
				(.047)	(.432)	(.580)	(.179)	(.161)	(.425)	(.317)		

See Table C.1 for footnotes.

Table C.12

Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--
Prairie Region 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	$\hat{Y}_6$ Farm Wage	R^2[a]	d'[b]
Demand Static 12-A	16.238	-.001	-.127	.010				-.091	-2.167*	-4.556**	.922**	1.32*
		(.542)	(.301)	(.116)				(.570)	(1.149)	(.889)		
Supply Static 12-B	.995			.118*	.351	7.691**		-.889**	-6.123**	-1.442	.993**	2.17*
				(.049)	(1.039)	(1.611)		(.186)	(1.155)	(1.595)		
Demand Dynamic 12-C	13.001	.083	-.170	.024			.199	-.307	-1.719	-3.407*	.908**	2.19*
		(.630)	(.338)	(.137)			(.351)	(.717)	(1.277)	(1.650)		
Supply Dynamic 12-D	3.908			.145**	1.344	8.004**	-.373	-.770**	-5.961**	-3.381	.993**	2.24*
				(.042)	(1.723)	(1.444)	(.281)	(.214)	(1.261)	(2.965)		

See Table C.1 for footnotes.

Table C.13

Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--
Alberta 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	$\hat{Y}_6$ Farm Wage	R^2[a]	d[b]
Demand Static	1.468	-.199	-.714	.196				-1.041**	2.330	-.976	.900**	1.87*
13-A		(.636)	(.631)	(.154)				(.746)	(2.538)	(2.077)		
Supply Static	8.408			-.498	2.564	9.009[0]		-.279	-.768	-14.934	.905**	1.96
13-B				(1.420)	(4.719)	(22.326)		(1.048)	(6.529)	(21.646)		
Demand Dynamic	1.197	-.158	-.688	.177			.083	-.969	2.177	-.814	.903**	2.11*
13-C		(.662)	(.661)	(.166)			(.374)	(.843)	(2.112)	(2.317)		
Supply Dynamic	11.775			.281	5.292	-1.239[0]	-.564	-.420	3.555+	-7.045	.905**	2.12*
13-D				(.398)	(4.605)	(11.794)	(1.866)	(1.262)	(2.506)	(18.036)		

See Table C.1 for footnotes.

Table C.14

Estimates of Structural Demand and Supply Relationships for Unpaid Family Labour--
Saskatchewan 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	$\hat{Y}_6$ Farm Wage	R^2[a]	d'[b]
Demand Static 14-A	-1.725	-.144	.085	.066				-1.086	2.757**	-.669*	.938**	2.14*
		(.364)	(.165)	(.121)				(.306)	(1.553)	(1.409)		
Supply Static 14-B	1.607			.013	1.256	-.277		-.769+	2.504*	-2.034	.939**	2.31*
				(.200)	(1.732)	(1.853)		(.533)	(1.341)	(1.864)		
Demand Dynamic 14-C	1.000	-.270	.079	.110			-.519+	-1.547**	3.297**	-1.969	.945**	1.85*
		(.368)	(.163)	(.116)			(.378)	(.445)	(1.441)	(2.061)		
Supply Dynamic 14-D	10.712			-.001	2.669+	-.973	-.975*	-1.359**	3.432**	-5.985*	.952**	2.20*
				(.185)	(1.932)	(1.709)	(.454)	(.491)	(1.205)	(3.070)		

See Table C.1 for footnotes.

Table C.15

Estimates of Demand and Supply Relationships for Unpaid Family Labour--
Manitoba 1954-73, Regression Coefficients[a] and Standard Errors,
Static and Dynamic Models, Model IV

	Constant	X_1 Real Farm Prices	X_2 Productivity	X_3 Trend	X_4 NonFarm Wage	X_5[c] Labour Force	X_9 Unpaid Family Labour Lagged	X_{10} Hired Labour	X_{11} Operator Labour	$\hat{Y}_6$ Farm Wage	R^2[a]	d'[b]
Demand Static 15-A	7.665	.036	-.251	-.095				-2.156**	.127+	-2.224*	.898**	1.60*
		(.144)	(.403)	(.140)				(.760)	(.073)	(.832)		
Supply Static 15-B	5.984			-.148	-.943	.098[0]		-2.506+	.127+	-1.487	.897**	1.46*
				(.192)	(5.091)	(.193)		(1.531)	(.073)	(5.169)		
Demand Dynamic 15-C	3.847	.065	-.252	-.117			.402	-1.526	.163+	-.826	.932**	2.18*
		(.136)	(.353)	(.137)			(.619)	(1.187)	(.092)	(2.651)		
Supply Dynamic 15-D	-1.155			.078	2.795	3.903	.037	-1.298	.125+	-2.293	.937**	2.30*
				(.149)	(2.253)	(3.780)	(.797)	(1.472)	(.092)	(5.055)		

See Table C.1 for footnotes.

The productivity variable had the expected negative coefficient but was not statistically significant except in the dynamic demand equation (11 - C) at the national level. Saskatchewan was an exception as the coefficient was positive. However, it was not statistically significant in the static or dynamic demand equation.

As with the other labour markets, the trend variable did not have a consistent sign in the demand equations. At the national level, the static (11 - A) and dynamic (11 - C) demand functions had a negative and a positive coefficient, respectively. At the regional level, the signs on the coefficient were opposite those of the national demand equations. Trend had a positive coefficient in the Alberta and Saskatchewan demand functions while, in Manitoba, the coefficient was negative. The trend variable was only significant in one case; the static (11 - A) demand function of the national model. There it was significant at the one percent level.

The hired labour substitution variable had the expected negative coefficient in all demand equations. The coefficient was statistically significant in Alberta (13 - A only), Saskatchewan (14 - C only) and Manitoba (15 - A only) at the one percent level. In the national and regional demand equations, the coefficient was not statistically significant at the ten percent level or higher.

The operator labour substitution variable had a theoretically inconsistent positive coefficient in all the provincial demand equations and the static (11 - A) demand equation at the national level. This positive coefficient was only significant in the Saskatchewan functions at the one percent level and the Manitoba functions at the ten percent level. Although the operator labour variable had the expected sign in

the national demand equations and one (11 - C) regional demand equation, the coefficient was not statistically significant at the ten percent level or higher in these cases.

Except for one demand equation (11 - A) at the national level, the farm wage rate variable had the expected negative coefficient. It was statistically significant at the five percent level or higher in the national (11 - C), regional, Saskatchewan (14 - A) and Manitoba (15 - A) models.

The lagged dependent variable did not work in the demand functions for unpaid family labour. The coefficient was not significantly different from zero in the regional (12 - C), Alberta (13 - C) and Manitoba (15 - D) models. The national (11 - C) and Saskatchewan (14 - C) demand equations had coefficients for the lagged variable that were not significantly different from one.

Supply. The R^2 values for the unpaid family labour supply equations were .900 or higher and the regression equations were statistically significant at the one percent level. One minor exception was the Manitoba equation (15 - B) which had an R^2 value of .897. It was statistically significant at the one percent level.

The coefficient for the nonfarm wage rate variable had the expected sign in the regional, Alberta, Saskatchewan and Manitoba (15 - D only) models. However, it was statistically significant at the five percent level, only in the Saskatchewan supply (14 - D) equation.

The labour force variable had the expected positive coefficient and was statistically significant at the one percent level in the

national and regional models. The coefficient was also positive in the Alberta (13 - B only) and Manitoba models but was not statistically significant. The A.L.F. variable was used in all models except for Alberta and the static model for Manitoba where the T.C.L.F. variable resulted in more favourable results.

Trend had a statistically significant, positive coefficient in the regional models. Here it was significant at the five percent and one percent levels in the static and dynamic supply equations, respectively. The trend coefficient was not statistically significant in any other supply equation. Reference to Tables 5.11-5.15 shows the inconsistency of the sign on this coefficient.

The hired labour variable had the expected negative sign in all cases. It was statistically significant at the ten percent level or higher in the national, regional, Saskatchewan and Manitoba (15 - B only) models.

A priori consideration suggested that a negative relationship would exist between the number of farm operators and the supply of unpaid family labour. The statistical results at the national and regional level supported this hypothesis as the coefficient was negative and statistically significant at the one percent level. However, a contradiction was present at the provincial level as the coefficient was positive and statistically significant at the ten percent level in Alberta (13 - D), Saskatchewan, and Manitoba.

The farm wage rate variable did not work as expected in the supply equations for unpaid family labour. Only in the national model did the variable have the expected positive coefficient and there it was not statistically significant.

Again the lagged dependent variable was unable to identify any lagged adjustment mechanism. It was not significantly different from zero in the national (11 - D), regional (12 - D), Alberta (13 - D), and Manitoba (15 - D) models, which indicated γ was equal to one and all adjustment occurred in the first time period. In the Saskatchewan (14 - D) model, the lagged coefficient was not significantly different from one which indicated γ was equal to zero and there was no adjustment in the first time period.

In the equations of the market for unpaid family labour, the tests for serial correlation of the calculated residual were inconclusive except for one national demand (11 - C) and one Alberta supply (13 - B) equation where no autocorrelation was present.

APPENDIX D: SIMPLE CORRELATION COEFFICIENT MATRICES

Table D.1

Simple Correlation Coefficient Matrix for Variables in Canada Demand and Supply Equations

	Y_1	Y_3	Y_5	$Y_{2,6}$	Y_4	X_1	X_2	X_3	X_4	$X_{5,TCLF}$	$X_{5,ALF}$	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	1.000																	
Y_3	*	1.000																
Y_5	*	*	1.000															
$Y_{2,6}$	-.579	*	-.719	1.000														
Y_4	*	-.633	*	*	1.000													
X_1	.659	.876	.932	-.657	-.234	1.000												
X_2	-.683	-.961	-.817	.945	.764	-.765	1.000											
X_3	-.675	-.991	-.879	.943	.657	-.846	.963	1.000										
X_4	-.655	-.973	-.837	.970	.704	-.802	.973	.988	1.000									
$X_{5,TCLF}$	-.622	-.958	-.789	.986	.730	-.750	.963	.982	.990	1.000								
$X_{5,ALF}$	.756	.989	.955	-.866	-.580	.908	-.934	-.974	-.948	*	1.000							
X_6	*	-.935	*	*	.714	-.717	.947	.956	.969	.983	-.888	1.000						
X_7	.666	*	*	-.599	*	.745	-682	-.702	-.671	-.632	.792	*	1.000					
X_8	*	.990	*	*	-.623	.879	-.953	-.993	-.977	-.963	.983	-.934	*	1.000				
X_9	*	*	.990	-.711	*	.947	-.802	-.881	-.835	-.790	.952	*	*		1.000			
X_{10}	*	.722	.707	-.579	-.416	.659	-.683	-.675	-.655	-.622	.756	-.604	*	.683	.706	1.000		
X_{11}	.722	*	.910	-.911	*	.876	-.961	-.991	-.973	-.958	.989	*	.738	*	.908	.722	1.000	
X_{12}	.707	.910	*	-.719	-.421	.932	-.817	-.879	-.837	-.789	.955	-.736	.834	.904	*	.707	.910	1.000

NOTE: Variables defined the same as in Appendix C.

* Intersecting variables did not appear in the same equation.

Table D.2

Simple Correlation Coefficient Matrix for Variables in Prairie Region Demand and Supply Equations

	Y_1	Y_3	Y_5	$Y_{2,6}$	Y_4	X_1	X_2	X_3	X_4	$X_{5,TCLF}$	$X_{5,ALF}$	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	1.000																	
Y_3	*	1.000																
Y_5	*	*	1.000															
$Y_{2,6}$	-.220	*	-.917	1.000														
Y_4	*	-.513	*	*	1.000													
X_1	.304	-.501	.508	-.454	.181	1.000												
X_2	-.134	-.644	-.793	.767	.784	-.414	1.000											
X_3	-.157	-.889	-.928	.968	.587	-.520	.801	1.000										
X_4	-.172	-.907	-.859	.974	.547	-.510	.735	.963	1.000									
$X_{5,TCLF}$	-.131	-.898	-.908	.968	.593	-.490	.780	.997	.973	1.000								
$X_{5,ALF}$	.320	.963	.922	-.950	-.561	.533	-.741	-.948	-.923	*	1.000							
X_6	*	-.913	*	*	.520	-.577	.738	.938	.921	.927	-.965	1.000						
X_7	.314	*	.340	-.318	*	.614	-.236	-.365	-.364	-.353	.444	*	1.000					
X_8	*	.906	*	*	-.438	.512	-.626	-.889	-.901	-.903	.877	*	*	1.000				
X_9	*	*	.923	-.942	*	.491	-.744	-.920	-.875	-.906	.942	-.967	*	*	1.000			
X_{10}	*	.333	.157	-.220	-.047	.304	-.134	-.157	-.172	-.131	.320	-.352	*	.241	.293	1.000		
X_{11}	.333	*	.789	-.903	*	.501	-.644	-.889	-.907	-.898	.963	*	.457	*	.873	.333	1.000	
X_{12}	.157	.789	*	-.917	-.564	.508	-.793	-.928	-.859	-.908	.922	-.920	.340	.727	*	.157	.789	1.000

NOTE: Variables defined the same as in Appendix C.

*** Intersecting variables did not appear in the same equation.**

Table D.3

Simple Correlation Coefficient Matrix for Variables in Alberta Demand and Supply Equations

	Y_1	Y_3	Y_5	$Y_{2,6}$	Y_4	X_1	X_2	X_3	X_4	$X_{5,TCLF}$	$X_{5,ALF}$	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	1.000																	
Y_3	*	1.000																
Y_5	*	*	1.000															
$Y_{2,6}$	-.360	*	-.918	1.000														
Y_4	*	-.625	*	*	1.000													
X_1	.127	.441	.396	-.338	.340	1.000												
X_2	-.232	-.929	-.913	.895	.724	-.369	1.000											
X_3	-.320	-.986	-.919	.975	.629	-.424	.913	1.000										
X_4	-.447	-.948	-.866	.980	.617	-.366	.854	.971	1.000									
$X_{5,TCLF}$	-.379	-.975	-.903	.985	.647	-.379	.896	.993	.991	1.000								
$X_{5,ALF}$	.354	.980	.918	-.989	-.643	.398	-.908	-.995	-.984	*	1.000							
X_6	*	-.965	*	*	.590	-.453	.901	.973	.957	.971	-.980	1.000						
X_7	.481	*	-.126	-.040	*	-.053	.098	-.108	-.175	-.142	.098	*	1.000					
X_8	*	.962	*	*	-.624	.419	-.906	-.986	-.957	-.978	.982	*	*	1.000				
X_9	*	*	.920	-.936	*	.341	-.875	-.898	-.869	-.891	.911	-.947	*	*	1.000			
X_{10}	*	.313	.114	-.360	-.217	.127	-.232	-.320	-.447	-.379	.354	-.293	*	.298	.142	1.000		
X_{11}	.313	*	.917	-.957	*	.441	-.929	-.986	-.948	-.975	.980	*	.051	*	.900	.313	1.000	
X_{12}	.114	.917	*	-.918	-.616	.396	-.913	-.919	-.866	-.903	.918	-.935	-.126	.908	*	.114	.917	1.000

NOTE: Variables defined the same as in Appendix C.

* Intersecting variables did not appear in the same equation.

Table D.4

Simple Correlation Coefficient Matrix for Variables in Saskatchewan Demand and Supply Equations

	Y_1	Y_3	Y_5	$Y_{2,6}$	Y_4	X_1	X_2	X_3	X_4	$X_{5,TCLF}$	$X_{5,ALF}$	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	1.000																	
Y_3	*	1.000																
Y_5	*	*	1.000															
$Y_{2,6}$	-.516	*	-.900	1.000														
Y_4	*	-.611	*	*	1.000													
X_1	.293	.493	.453	-.451	.108	1.000												
X_2	-.148	-.644	-.603	.556	.829	-.320	1.000											
X_3	-.529	-.988	-.931	.962	.588	-.496	.610	1.000										
X_4	-.651	-.944	-.854	.969	.522	-.549	.458	.967	1.000									
$X_{5,TCLF}$	-.670	-.944	-.849	.947	.535	-.505	.543	.968	.987	1.000								
$X_{5,ALF}$	.446	.946	.891	-.853	-.548	.413	-.565	-.948	-.859	*	1.000							
X_6	*	-.951	*	*	.533	-.557	.589	.949	.914	.893	-.873	1.000						
X_7	.849	*	.273	-.424	*	.121	-.104	-.499	-.557	-.602	.493	*	1.000					
X_8	*	.970	*	*	-.589	.490	-.615	-.988	-.951	-.952	.942	*	*	1.000				
X_9	*	*	.928	-.934	*	.456	-.609	-.925	-.872	-.853	.855	-.969	*	*	1.000			
X_{10}	*	.489	.236	-.516	-.195	.293	-.148	-.529	-.651	-.670	.446	-.329	*	.490	.260	1.000		
X_{11}	.489	*	.935	-.948	*	.493	-.644	-.988	-.944	-.944	-.946	*	.440	*	.930	.489	1.000	
X_{12}	.236	.935	*	-.900	-.569	.453	-.603	-.931	-.854	-.849	.891	-.944	.273	.928	*	.236	.935	1.000

NOTE: Variables defined the same as in Appendix C.

*** Intersecting variables did not appear in the same equation.**

Table D.5

Simple Correlation Coefficient Matrix for Variables in Manitoba Demand and Supply Equations

	Y_1	Y_3	Y_5	$Y_{2,6}$	Y_4	X_1	X_2	X_3	X_4	$X_{5,TCLF}$	$X_{5,ALF}$	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	1.000																	
Y_3	*	1.000																
Y_5	*	*	1.000															
$Y_{2,6}$	-.177	*	-.905	1.000														
Y_4	*	-.915	*	*	1.000													
X_1	.046	-.825	-.789	.740	.612	1.000												
X_2	-.049	-.869	-.849	.853	.782	.788	1.000											
X_3	-.107	-.983	-.924	.947	.616	.861	.843	1.000										
X_4	-.297	-.915	-.831	.966	.631	.714	.809	.937	1.000									
$X_{5,TCLF}$	-.000	-.596	-.513	.508	.275	.844	.367	.674	.526	1.000								
$X_{5,ALF}$	.130	.987	.926	-.956	-.639	-.818	-.863	-.994	-.947	*	1.000							
X_6	*	-.719	*	*	.366	.524	.611	.728	.792	.403	-.736	1.000						
X_7	.691	*	*	-.089	*	-.051	-.057	-.105	.922	-.083	.115	*	1.000					
X_8	*	.968	*	*	-.612	-.767	-.865	-.975	-.933	-.521	.987	*	*	1.000				
X_9	*	*	.934	-.926	*	-.766	-.814	-.919	.809	.367	.916	-.690	*	*	1.000			
X_{10}	*	.103	-.146	-.177	-.131	.046	-.049	-.107	-.297	-.000	.130	-.276	*	.093	-.142	1.000		
X_{11}	.201	*	.790	-.819	*	-.825	-.869	-.983	-.915	-.596	.987	*	.133	*	.717	.103	1.000	
X_{12}	-.099	.928	*	-.905	-.614	-.789	-.849	-.924	-.831	-.513	.926	-.631	-.070	.920	*	-.149	.790	1.000

NOTE: Variables defined the same as in Appendix C.

* Intersecting variables did not appear in the same equation.