THE UNIVERSITY OF MANITOBA

THE IMPACT OF FREIGHT SUBSIDIES FOR FEED GRAINS ON THE OPTIMAL SPATIAL PATTERN OF LIVESTOCK AND MEAT PRODUCTION IN CANADA

by

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ABSTRACT

The study examined the effects of subsidies on feed grain movement in Canada on the optimal spatial pattern of beef cattle and hog production and the subsequent effects on regional production of beef and pork. The subsidies examined included both the Feed Freight Assistance Program (F.F.A.P.) and the Statutory Grain Rates.

The study first looked into the present situation in the primary processing of meat and reviewed previous studies on the problem of grain freight subsidy and livestock and meat production. Then it surveyed the theory of industrial location and constructed a theoretical analysis of the problem. Based on the theoretical framework reviewed, an empirical model was set up to examine the effects of various levels of subsidies on feed grain movement on optimal regional output of cattle, pigs, beef and pork. The varying levels were the situation under the old F.F.A.P., the situation under the new F.F.A.P., the new F.F.A.P. with removal of the Statutory Grain Rates, and the elimination of both F.F.A.P. and the Statutory Grain Rates together. Changes in regional distribution of basic herds and relaxation of slaughter capacities were allowed in the model. Furthermore, the model examined both the conditions when the Prairie livestock producers provided their own grains for feeding and when they have to buy grains from the elevators.

Analysing the results from the model, the study concluded that the subsidies on feed grains had favoured livestock and meat production in Eastern Canada and B. C. at the expense of the Prairies. With no change in production capacities, elimination of both the F.F.A.P. and Statutory Grain Rates would result in increased livestock and meat production in the Prairies. Less grains but more meat would be exported from the Prairies and Alberta would be most benefitted. Eliminating the grain freight subsidies would also lower the total cost of the feed grains - livestock - meat sector by two percent even without allowing changes in production capacities in livestock and meat. Allowing changes in production capacities, the saving would be in the neighbourhood of 3.5 percent and there would be further expansion of livestock and meat production in the Prairies.

However, the study also discovered that other factors should also be considered in considering the problem of grain freight rates and livestock and meat production. Availablity of local produced grains, slaughter capacities, freight rate structure on livestock and meat and institutional factors would interact with grain freight costs to affect the spatial pattern of livestock and meat production. Consequently, the response to changes in grain freight rates, as estimated by the model, was different in different provinces in the Prairies as well as in the non-Prairie regions.

The study also analysed the differences between the empirical results from the model and the real world. Then it provided suggestions for further research based on the problems encountered in the study. Based on the findings, the study also gave recommendations for public policy.

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CHAPTER ONE

INTRODUCTION

There has been much discussion on the issue of interrelationships between feed grains and the production of livestock and meat in Canada. To a large extent these debates have been brought forward by the fluctuating grain and meat prices in the seventies. However, along with the changes in price relationships there have been changes in the feed grain policy and transportation policy in general. The Feed Freight Assistance Program (F.F.A.P.) and the Statutory Grain Rates are two of the most widely debated issues related to the transportation of grain and are perceived by many as having distorted Western Canada's natural advantage in livestock and meat production. Since August 1976, the F.F.A.P. has been substantially modified. Also, with the publication of the Snavely Report[1], which confirms the losses incurred by the railways in shipping grains over the Prairies, the debates seem to have shifted to the Statutory Grain Rates.

In order to understand the effects of the changes that have either occured or are likely to occur in the transportation cost structure, the general objective of this study is to examine the impact of transportation rate structure for feed grains under the pre-and post- August 1976 F.F.A.P., the Statutory Grain Rates

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1. Carl Snavely, <u>The Commission on the Costs of Transporting Grain by Rail, Report</u>, Vol. 1 (Ottawa: Minister of Supply and Services, 1977).

and simulated cost-of-service rates on the spatial patterns of beef cattle and hog production, the associated spatial patterns of beef and pork production, along with the relevant inter regional trade flows.

In order to accomplish this general objective, the specific objectives of this study are to:

(1) construct a spatial equilibrium model of beef cattle, hog, beef and pork production using alternative transportation rate structures — such as those under the old and the new F.F.A.P. and under assumed possible changes in the Statutory Grain Rates;

(2) analyse and compare the implications of objective (1) above for the welfare of livestock producers and estimate direct and indirect regional benefits to Western Canada;

(3) derive policy implications from the above analysis for livestock and meat porduction and grain transportation which will be most beneficial to the nation as a whole.

In carrying out this study, the first step was to examine the present state of the meat insustry, the Statutory Grain Rates, the F.F.A.P. and the Feed Grains Policy in Canada. This appears in this chapter (Chapter One). That is followed by a review of literature on the problem in chapter two. Chapter 3 presents a theoretical analysis of the problem. Based on the theoretical analysis a spatial equilibrium model was constructed. The construction of the model as well as description of the data used form the subject matter of chapter 4. Using that model, chapter 5 analyses and compares the results using alternative transportation cost scenarios in terms of the varying levels of grain feight cost under studied in the project. The varying levels of grain freight cost under studied are the freight cost structure under the old F.F.A.P., the new F.F.A.P., the assumed cost structure under the new F.F.A.P. and elimination of Statutory Grain Rates, and the assumed cost structure under the situation which both F.F.A.P. and Statutory Grain Rates are eliminated. Chapter 6 evaluates the results presented in chapter 5, presents conclusions, discusses implications for public policy, and provides some recommendations for further study.

THE CANADIAN MEAT PROCESSING INDUSTRY

Slaughtering and meat processing industry is one of the five largest manufacturing industries in Canada.[1] In 1976 it had 467 establishments employing nearly 25 thousand workers in production and related activities and contributed over 800 million in value added to the economy.[2]

The operations in the industry can be broadly classified into two categories: primary processing and secondary processing.

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1. Statistics Canada, Canada 1975 (Ottawa: Information Canada, 1974), p. 295.

2. Statistics Canada, Slaughtering and Meat Processors 1976, Cat. 32-221 (Ottawa: The Minister of Industry trade and Commerce, 1978), table 1, p. 4.

Primary processing includes slaughtering (including dressing to carcass form) and chilling the carcass. The remaining operations, such as cutting, boxing, canning, freezing and by-product processing are included in the category of secondary processing.[3]

A major problem in studying the industry is the lack of published data, especially on cost of production.[4] As to the output figures, only those of the federally inspected plants are published. This poses problems because in certain provinces — B. C., for example, where less than 40 percent of the cattle slaughter and 60 percent of its hog slaughter are under federal inspection. A substantial portion of slaughter in Quebec and the Maritimes is also not under federal inspection.[5] (Tables 1.1 and 1.2)

Nonetheless, it is safe to say that transportation cost plays an important role in influencing the location of the meat

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3. J. L. Morris and D. C. Iler, Meat Processing Capacity (Ottawa: Food Prices Review Board, 1975), p. 5.

4. This fact has also been discussed by John Morris. See John Morris, p. 27. H. K. Leckie, the general manager of the Meat Packers Council of Canada, admitted this fact. See H. K. Leckie, "Discussion of the Competitive Characteristics of the Canadian Food Processing Industry", in R. M. A. Loyns and R. L. Louks (ed.), Competition and Public Policy on Competition in The Canadian Food Industry, p. 49.

5. All meat which enters inter-provincial and export trade has to be slaughtered in federally inspected plants. These plants are inspected by Canadian Department of Agriculture inspectors on site. The provinces which are major exporters of meat have the largest percentages of their plants under federal inspection. The reverse is true for provinces which mainly produce meat for themselves. Plants not under federal inspection may be provincially inspected. They are mainly small slaughterers.

Table 1.1

Total Number of Cattle Slaughter by Province, 1971-77 (in thousands)

	Maritimes	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	Canada
1971								
Inspected	36.9	198.5	915.1	425.3	155.7	1,016.0	39.3	2,786.9
Uninspected	30.0	59.0	132.9	7.1	11.6	31.9	24.9	297.4
Farm Kill	11.6	58.0	60.0	12.3	24.4	21.7	16.4	204.4
Total	78.5	315.5	1,108.0	447.7	191.7	1,069.6	80.6	3,288.7
Percentage	2.4	9.6	33.7	13.5	5.8	32.5	2.5	100.0
1972								
Inspected	38.4	163.1	925.4	435.7	171.0	1,112.3	32.7	2,878.6
Uninspected	31.6	59.0	156.2	8.0	13.4	31.9	30.8	330.8
Farm Hill	12.3	70.5	62.0	11.6	25.0	21.0	17.1	219.7
Total	82.3	292.6	1,143.6	455.3	209.4	1,165.2	80.6	3,429.1
Percentage	2.4	8.5	33.3	13.3	6.1	34.0	2.4	100.0
1973								
Inspected	38.1	166.5	930.8	435.0	161.7	1,112.3	33.6	2,878.0
Uninspected	26.6	50.0	163.0	9.0	15.5	36.9	33.2	332.3
Farm Kill	16.9	70.5	65.5	11.8	25.0	22.0	17.6	228.9
Total	81.6	287.0	1,159.3	455.8	202.2	1,171.2	84.4	3,439.2
Percentage	2.4	8.3	33.7	13.3	5.9	34.1	2.5	100.0
1974								
Inspected	37.6	165.7	980.2	455.5	171.1	1,131.5	34.2	2,975.8
Uninspected	23.2	49.5	192.4	10.3	24.3	42.1	42.7	384.5
Farm Kill	19.6	65.0	65.0	11.3	23.8	20.8	17.6	223.1
Total	80.4	280.2	1,237.6	477.1	219.2	1,194.4	94.5	3,583.4
Percentage	2.2	7.8	34.5	13.3	5.9	33.3	2.6	100.0
1975								
Inspected	51.1	205.2	1,018.1	507.8	168.4	1,352.1	35.0	3,337.7
Uninspected	25.4	65.5	246.9	13.5	31.5	53.8	60.2	496.8
Farm Kill	25.5	68.5	61.3	11.5	25.5	21.8	17.2	276.8
Total	102.2	339.2	1,326.3	532.8	225.4	1,427.7	112.4	4,065.8
Percentage	2.5	8.3	32.6	13.1	5.5	35.1	2.8	100.0
1976								
Inspected	55.9	254.2	1,061.4	537.7	199.1	1,537.6	30.4	3,676.3
Uninspected	23.3	64.0	230.0	13.5	28.0	55.7	55.2	469.7
Farm Kill	22.9	68.5	59.0	10.7	25.5	20.8	16.5	223.9
Total	102.1	386.7	1,350.4	561.9	252.6	1,614.1	102.1	4,369.9
Percentage	2.3	8.8	30.9	12.9	5.8	36.9	2.3	100.0
1977								
Inspected	55.7	270.3	1,010.7	515.0	208.9	1,590.2	50.6	3,761.4
Uninspected	n.a.	n.a.	198.0	n.a.	n.a.	n.a.	44.0	n.a.
Farm Kill	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Notes: (a) Figures for the Maritimes do not include Newfoundland.

(b) Inspected: Slaughtered at federally inspected establishments.
Uninspected: Slaughtered at establishments not federally inspected.

Table 1.2

Total Number of Hogs Slaughter by Province, 1970-77 (in thousands)

	Maritimes	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	Canada
1971								
Inspected	364.2	1,799.2	2,948.3	1,555.2	957.8	1,972.0	146.0	9,742.8
Uninspected	22.7	31.7	n.a.	21.0	29.0	83.0	47.3	n.a.
Farm Kill	19.6	107.0	104.0	37.0	84.0	69.0	14.7	462.5
Total	406.5	1,973.9	n.a.	1,613.2	1,070.8	2,124.0	208.0	n.a.
1972								
Inspected	328.1	2,029.0	2,785.0	1,239.0	979.8	1,872.3	124.0	9,357.1
Uninspected	20.1	29.0	205.0	18.0	28.0	72.6	42.7	415.3
Farm Kill	11.2	102.0	104.0	32.0	81.0	53.0	10.9	394.1
Total	359.4	2,160.0	3,094.0	1,289.0	1,088.8	1,997.9	177.6	10,166.5
Percentage	3.5	21.2	30.4	12.7	10.7	19.7	1.7	100.0
1973								
Inspected	312.4	1,821.0	2,563.8	1,234.1	951.4	1,761.1	78.2	8,721.9
Uninspected	15.2	27.6	206.5	19.0	29.0	78.3	37.8	413.5
Farm Kill	17.5	106.0	117.0	38.0	84.0	55.0	12.3	429.8
Total	345.1	1,954.6	2,887.3	1,291.1	1,064.4	1,894.4	128.3	9,565.2
Percentage	3.6	20.4	30.2	13.5	11.1	19.8	1.3	100.0
1974								
Inspected	307.1	2,113.9	2,678.5	1,196.3	966.9	1,596.7	79.9	8,939.3
Uninspected	12.1	30.0	231.0	17.0	37.1	84.2	46.8	458.2
Farm Kill	20.1	100.0	97.0	34.0	78.0	55.0	11.8	395.9
Total	339.3	2,243.9	3,006.5	1,247.3	1,082.0	1,735.9	138.5	9,793.4
Percentage	3.5	22.9	30.7	12.7	11.0	17.7	1.4	100.0
1975								
Inspected	294.0	2,207.4	2,403.4	862.3	599.5	1,230.7	58.9	7,656.3
Uninspected	10.8	22.0	176.3	11.0	30.5	38.3	45.7	334.7
Farm Kill	18.3	104.0	102.0	28.5	54.0	49.5	13.4	369.7
Total	323.1	2,333.4	2,681.7	901.8	684.0	1,318.5	118.4	8,360.7
Percentage	3.9	27.9	32.1	10.8	8.2	15.8	1.4	100.0
1976								
Inspected	287.2	2,333.6	2,414.9	795.6	541.2	1,089.0	31.8	7,493.2
Uninspected	9.2	18.0	191.7	12.5	29.0	35.6	47.9	343.9
Farm Kill	10.2	97.0	95.0	34.0	60.0	56.0	13.4	365.6
Total	306.6	2,448.6	2,701.6	842.1	630.2	1,180.6	93.1	8,202.7
Percentage	3.7	29.9	32.9	10.3	7.7	14.4	1.1	100.0
1977								
Inspected	304.8	2,632.5	2,491.0	828.0	547.8	1,157.0	46.1	7,400.1
Uninspected	n.a.	n.a.	201.7	n.a.	n.a.	n.a.	56.1	n.a.
Farm Kill	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

n.a. not available

See notes at table 1.2.

Data sources for tables 1.2 and 1.3:

Inspected slaughter, 1971-76: Canada Department of Agriculture, Livestock Market Review, relevent years (Ottawa: Canada Department of Agriculture). For 1977 data: Canada Department of Agriculture, Canada Livestock and Meat Trade Report, Vol. 58, No. 1 (Ottawa: Canada Department of Agriculture, 1978), pp. 7, 11.

Uninspected slaughter, 1971-76: Statistics Canada, unpublished data supplied by officials in the Livestock Section, Agricultural Division, Statistics Canada.

Farm kill, 1971-73: Statistics Canada, Handbook of Agricultural Statistics, Part VI -- Livestock and Animal Products (Ottawa: Information Canada, 1974). Information for 1974-77 was obtained through a personal communication with an official in the Livestock Section, Agricultural Division, Statistics Canada, dated February 28, 1978.

industry. The location of the slaughtering and meat processing industry has become increasingly oriented toward its major input — livestock. In the United States, major packing plants have almost entirely moved out of Chicago to locations further west which are closer to major areas of cattle and hog feeding.[6] The phenomenon is not as marked in Canada but the trend has been in that direction. The Commission of Inquiry into the Marketing of Beef and Veal observed that in the cattle slaughter segment of the industry, "Modern plants have been built in areas close to the point of cattle production (e.g. Southern Alberta)"[7] and

> Alberta has been emerged as the most important slaughter area while the Maritimes and B. C. have dropped in relative production and Quebec in absolute production. . . With increasing slaughter occuring in the West, fewer slaughter cattle are shipped East as well as relatively fewer feeder cattle and calves.[8]

With respect to hogs, the packers are even more oriented to locations of hog production. Cars for hogs are loaded to a lower weight limit than cattle cars and hence the freight charges paid on live hogs are generally higher than on cattle. The amount of live hogs shipped over long distance is in fact negligible.[9]

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6. H. K. Leckie, "Canada's Meat Packing Industry", Proceedings of the 1970 Workshop of the Canadian Agricultural Economics Society (June 1970), pp. 29-30.

7. Commission of Inquiry into the Marketing of Beef and Veal, Report, p. 72.

8. Ibid., p. 11.

9. Canadian Transport Commission, Transportation Factors and the Canadian Livestock and Meat Industries, An Updated Summary (mimeograph), (Ottawa: Canadian Transport Commission, 1977), pp. 11-13.

Location of Meat Processing Plants

In 1976, the Prairie provinces provided about thirty percent of total value added in manufacturing activities of the meat processing industry. Quebec and Ontario provided about twenty and thirty percent respectively.[10] As shown in table 1.3, the average establishment in the Prairies produces more value added and is larger in size than in the rest of the country.

However, in recent years the capacity in Western slaughtering plants has been noticably under-utilized. A Food Prices Review Board study shows that from January 1974 to July 1975 Saskatchewan only utilized 43 percent of its capacity in cattle slaughter and Manitoba was also much below the national average. On the other hand, Ontario had over three quarters of its capacity being utilized.[11]

The situation in hog slaughter was even more alarming for Western Canada. All three Prairie Provinces showed less than capacity utilization. Manitoba, with the third largest capacity for hog slaughter in Canada, had less than a third of its capacity being utilized between July 1974 and July 1975.[12] A personal interview by the author with the officials in the Swift Canadian packing plant in Winnipeg in November 1976 showed

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10. Statistics Canada, Slaughtering and Meat Processors, table 1, p. 4.

11. Morris and Iler, Meat Processing Capacity, p. 4.

12. Ibid..

Table 1.3

Average Size and Value Added of Meat Processing Establishments By Province, 1976

Province	Number of Establishment	Average Number of Production and Related Workers	Average Value Added ($ '000s)
Newfoundland	1	n. d.	n. d.
P. E. I.	4	n. d.	n. d.
N. S.	10	n. d.	n. d.
N. B.	9	50	888
Quebec	119	46	1,407
Ontario	167	52	1,943
Manitoba	30	87	2,148
Sask.	28	37	1,015
Alberta	58	83	2,449
B. C.	41	35	1,027
Canada	467	53	1,687

Note: n. d. — No published data on total number of production and related workers and value added.

Source: Calculated from Statistics Canada, _Slaughtering and Meat Processors 1976_, Cat. 32-221 (Ottawa: The Minister of Industry, Trade and Commerce, 1978), table 1, p. 4.

that only about a third of the plant's hog slaughter capacity was being used at that time. There was also closure of some hog slaughter plants in the latter part of 1976.[13] The situation did not improve up to 1977.[14]

The Spatial Distribution of Cattle and Hog Production

There is a trend, especially in cattle production, for livestock production to locate closer to where the input — feeds are produced. Again the reason is that of transport costs.

As shown in table 1.4, the prairie Provinces have close to sixty percent of the total number of cattle on farm in the country. The growth is mainly due to the increases in Alberta. As the relative percentages of dairy cattle by province are more or less fixed by the quotas of dairy marketing boards and commissions, the percentage growth or decline in cattle on farm by province has been mainly due to the changes in the number of beef cattle in each province. As shown in table 1.4, Alberta's share has grown from 24 percent of the national figure in 1961 to 30 percent in 1976. Saskatchewan's share has also grown slightly from 18 to 20 percent. Manitoba's share stayed more or less the same. However, the shares of Ontario, Quebec and the Maritimes have been declining.

With respect to hogs, however, the share of hogs on farm in the Prairies has been fluctuating. As shown in table 1.5,

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13. Free Press Report on Farming (Winnipeg), December 1, 1976, p. 2.

14. See H. K. Leckie, "Discussion of the Competitive Characterics of the Canadian Food Processing Industries", p. 49.

Table 1.4

Number and Percentage of Cattle on Farms by Province, June 1*

(Number in thousands)

	1961	1966	1971	1972	1973	1974	1975	1976
P.E.I.								
Number	121.1	125.2	106.1	103.0	98.0	104.4	106.0	105.0
Percent	1.01	0.97	0.80	0.75	0.69	0.70	0.69	0.72
N.S.								
Number	163.7	147.6	130.9	130.0	131.0	135.0	145.0	137.0
Percent	1.37	1.15	0.99	0.95	0.93	0.90	0.95	0.93
N.B.								
Number	160.2	136.5	112.7	110.0	107.0	113.6	116.0	115.0
Percent	1.34	1.06	0.85	0.81	0.76	0.76	0.76	0.78
Quebec								
Number	1,915.2	1,797.6	1,780.8	1,776.0	1,830.0	1,920.0	1,979.0	1,877.0
Percent	16.05	13.96	13.42	13.00	12.95	12.84	12.97	12.79
Ontario								
Number	3,115.7	3,137.0	3,082.0	3,116.5	3,168.5	3,206.0	3,141.0	3,165.0
Percent	26.11	24.36	23.22	22.82	22.42	21.45	20.58	21.57
Manitoba								
Number	995.6	1,151.2	1,138.1	1,176.0	1,196.0	1,291.0	1,339.0	1,256.0
Percent	8.34	8.94	8.58	8.61	8.46	8.64	8.77	8.56
Saskatchewan								
Number	2,121.1	2,398.0	2,645.0	2,770.0	2,852.0	3,027.0	3,150.0	2,910.0
Percent	17.77	18.62	19.93	20.28	20.18	20.25	20.68	19.83
Alberta								
Number	2,879.4	3,439.7	3,702.1	3,881.0	4,133.0	4,479.0	4,553.0	4,425.0
Percent	24.13	26.71	27.90	28.42	29.24	29.96	29.84	30.15
B.C.								
Number	461.8	546.0	573.2	594.0	618.0	672.0	725.0	686.0
Percent	3.87	4.24	4.32	4.35	4.37	4.50	4.75	4.67
Canada								
Number	11,933.8	12,878.8	13,270.9	13,656.5	14,133.5	14,948.0	15,260.0	14,676.0

* July 1 from 1974 onwards

Source: Statistics Canada, Livestock and Animal Products Statistics, Cat. 23-203, relevant years (Ottawa: The Minister of Supply and services).

Table 1.5

Average Number of Hogs on Farms, by Province

Crop Year		P.E.I.	N.S.	N.B.	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	Canada
1961/62	Number	51.5	49.5	46.0	959.5	1,725.0	370.5	608.9	1,296.0	41.5	5,049.5
	Percent	1.0	1.0	0.9	19.0	34.2	7.3	12.1	25.7	0.8	100.0
1965/66	Number	79.5	56.8	35.1	1,165.4	1,894.3	477.6	459.6	1,097.9	38.2	5,244.7
	Percent	1.5	1.1	0.7	22.2	36.1	9.1	8.8	21.0	0.7	100.0
1970/77	Number	105.9	79.4	56.6	1,297.0	2,237.8	1,060.1	1,098.6	1,730.1	80.3	7,672.0
	Percent	1.4	1.0	0.7	36.1	9.1	8.8	14.3	22.6	1.1	100.0
1971/72	Number	91.0	76.5	53.0	1,253.0	2,197.0	890.5	921.5	1,575.0	63.0	7,191.5
	Percent	1.3	1.1	0.7	17.4	30.6	12.4	12.8	21.9	0.9	100.0
1972/73	Number	94.5	72.5	51.5	1,237.5	2,064.0	941.0	941.0	1,531.5	53.0	6,983.0
	Percent	1.4	1.0	0.7	17.7	29.6	13.5	13.5	21.9	0.8	100.0
1973/74	Number	90.0	75.5	49.5	1,267.5	2,100.0	842.5	870.0	1,427.5	55.0	6,777.5
	Percent	1.3	1.1	0,7	18.7	31.0	12.4	10.8	21.1	0.8	100.0
1974/75	Number	82.0	71.0	44.0	1,207.5	1,866.0	587.5	647.5	1,057.5	56.0	5,559.5
	Percent	1.5	1.3	0.8	21.7	33.6	10.6	11.7	19.0	1.0	100.0
1975/76	Number	75.0	69.0	43.5	1,210.0	1,975.0	568.0	533.7	955.5	56.0	5,585.7
	Percent	1.4	1.3	0.8	22.1	36.0	10.4	9.7	17.4	1.0	100.0

Note: The Numbers are in thousands and calculated by averaging the numbers in December 1 and June 1 in crop years before 1973-74, and the numbers in January 1 and July 1 in crop years after 1973-74.

Source: Statistics Canada, Livestock and Animal Products Statistics, Cat. 23-203, and Report on Livestock Surveys, Cat. 23-005, relevant years (Ottawa: The Minister of Industry, Trade and Commerce).

the Prairies had 45 percent of Canada's hogs in 1961. The percentage declined to 38 in 1965. In 1970 the percentage rose back to 51 but then dropped to 24 in 1976. The figures for the eastern provinces fluctuate in the opposite direction. One of the reasons for this phenomenon is that the hog cycles in Eastern Canada and Western Canada have been affected by different factors.[15] As to the distribution within the Prairie Provinces, the proportion in Alberta has been declining while that of Manitoba has been increasing, as can be observed from table 1.5.

The Inter-regional Movement of Livestock and Meat

As the major locations of demand for meat are different from the major locations of supply of meat-producing animals, transportation is the link. For beef, there are basically three ways to satisfy demand through transportation — the shipping of beef, the shipping of feeder cattle and the shipping of slaughter cattle from producing areas to the consuming areas.

In the Maritimes, only P. E. I. is self-sufficient in cattle and beef production. Both Nova Scotia and New Brunswick cannot produce enough cattle to meet their own demand for beef and they have to meet over seventy percent of their beef requirements by importing slaughter cattle from P. E. I. and

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15. See S. B. Chin and D. A. West, "Factors Affecting the Supply of Hogs at the National and Regional Level.", Canadian Farm Economics, 10, No. 2 (April 1975), pp. 12-16.

dressed beef from the Prairies and Ontario. However, the Maritimes as a whole export about half of their low grade dairy cows to Montreal for slaughter.

Quebec is the largest beef-deficit province in Canada with a deficit production of ten millions pounds per week. The province's own beef production is mainly a by-product of dairy production. It has to import high grade beef from Western Canada.

While Ontario is the second largest beef producing province, it is still a deficit province because of its large population. Its beef cattle production is also very dependent on Western Canada for feeder calves, especially from Saskatchewan and Manitoba. In fact over a third of Ontario's slaughter cattle production is from feeders imported from the West. Even so, Ontario produces only about seventy percent of its own beef requirement. Dressed beef is imported from the Prairies to meet the deficit.

B. C. is the second largest deficit province in beef, with a deficit of about 4.5 million pounds a week. Consequently, it has to import beef, mainly from Alberta. Surprisingly, the province's beef cattle industry is mostly for feeders to be exported to other provinces and the U. S.. The reason is mainly due to its large deficit of feed grains.

As to the beef surplus provinces, Manitoba exports over sixty percent of its beef production but over forty percent of the province's slaughter cattle is from Saskatchewan.

While being the second largest province in beef cattle production, much of Saskatchewan's cattle is exported. In 1976, domestic and international export took two-thirds of the slaughter cattle and nearly three-quarters of feeder cattle marketed in the province.

By contrast, Alberta has not only the largest number of cattle but it also has the largest production of beef. It is the largest exporting province in Canada, exporting over three-quarters of its beef production. Its biggest market is Quebec which usually takes about forty percent of its weekly slaughter, followed by B. C..[16]

As to hogs, the hog producing areas are much closer to the consuming areas. Therefore, transportation is a relatively less important problem. In fact, the number of live hogs that moved from Western Canada to Eastern Canada was less than two percent of all the hogs produced in Canada in 1976.[17]

Relative to their population, B. C. and the Maritimes are most deficient in their port production. With over ten percent of the population, B. C. produces only one percent of Canada's hogs and accounts for only a slightly higher percentage of the total pork produced in Canada. Consequently, B. C. has to import pork heavily from the Prairies and the U. S. A.. Alberta is the largest source of pork for B. C.. The Maritimes, with also about ten percent of the population have only about three percent of hogs on the farms

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16. See G. R. McGlaughlin, A Study of the Canadian Cattle Marketing System (Regina: Saskatchewan Wheat Pool, 1977), pp. 13-25.

17. Canadian Transport Commission, An Updated Summary, pp. 11-13.

and four percent of hogs slaughter in the country. Hence that region is also heavily dependent on imports for meeting their demand.

Ontario and Quebec, however, have both become more self-sufficient in pork. Quebec's hog industry has been growing, due to vertical integration of the industry.[18] It provided over nine-tenths of its pork requirement in 1976. As to Ontario, it is also close to the point of self-sufficiency in both live hog and pork production. However, because of their large population, both Ontario and Quebec are major markets of pork from the Prairies.

The Prairie Provinces are again surplus provinces and they export their surplus pork and, to a much lesser extent, live hogs to other provinces.[19]

GRAIN FREIGHT SUBSIDIES AND THE LOCATION OF LIVESTOCK AND MEAT PRODUCTION

It has often been suggested that had there been no artificial intervention through government policies, the location of livestock production and, therefore, slaughtering would have been even more oriented to the areas where the input for livestock — feedgrains — are produced, as in the United States. The government

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18. See Jacques Lebeau, "Quebec's Dependence on Imported Grains: An Historical Perspective", Canadian Farm Economics, 12, No. 2 (April 1977), pp. 16-21.

19. See Canada Department of Agriculture, Livestock Market Review (Ottawa: Livestock Production and Marketing Branch Department of Agriculture), 1971-1975; and George Winter, Protein Efficiency in Canada (Montreal: Canadian Livestock Feed Board, 1975), pp. 113-14.

policies which have often been blamed for altering the optimal location of livestock and meat production are the Statutory Grain Rates and the Feed Freight Assistance Program (F.F.A.P.).

All grains and certain feed products moving from the Prairies to Eastern Canada, both for domestic consumption and export are shipped under the Statutory Grain Rates. West-bound grains are covered by the Statutory Grain Rates only if they are for export. The rates were set by statue in 1925 and were fixed at the 1897 level. The revenue for grains shipped under this rate schedule is about 0.5 cent per ton-mile.[20] Obviously, with inflation over the years the rates are no longer compensatory. While the loss of the railways in shipping grains is not directly compensated by the Federal Government, the Federal Government compensates the loss indirectly through its subsidy on branch lines. It is because that over ninety percent of the freight movement over most of the subsidized branch lines is grain shipment. The Snavely Commission reported that in 1974 for every ton of grain shipped under the Statutory Grain Rates the users paid only 38.9 percent of the cost, which amounted to $4.36 per ton. The Federal Government paid 22.4 percent of the cost ($2.52). The railways paid $4.34 or 38.7 percent.[21] Snavely also estimated that in 1976

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20. See C. Nachtigall, G. F. Skinner and E. W. Tyrchniewicz, "Crowsnest Pass Grain Rates: Time for a Change?", Canadian Transportation Research Forum Proceedings — Sixteen Annual Meeting, Toronto, November 1975, 14, No. 1, pp. 269-76. See also E. W. Tyrchniewicz, "Transportation Problems in Canadian Agriculture", Proceedings of the 1976 Annual Meeting of the Canadian Agriculture Society, Halifax, July 1976, pp. 18-31.

21. Carl Snavely, The Commission on the Costs of Transporting Grain by Rail, Report, Vol. I (Ottawa: The Minister of Supply and Services, 1976). p. 206.

the share by the Federal Government had risen to 33 percent while those of the users and the railways had fallen to 33 and 34 percent respectively.[22]

The Feed Freight Assistance Program is a direct subsidy on the movement of feed grains from the Prairies to destinations in Eastern Canada and British Columbia as well as on Ontario corn and feed wheat moving into central and Eastern Quebec and the Maritimes. Each year, the Canadian Livestock Feed Board establishes the subsidy rates based on transport cost for grains from Thunder Bay for regions east of Thunder Bay and from Western Prairie points for regions in B. C.. The grains have to be used exclusively as feed for livestock in Canada. The subsidy is paid to feed mills which have to declare that the price charged at the retail level is reduced by the amount of the subsidy.

In the crop year 1975-76, the total freight-assisted shipment was a little over 2.4 million tons with a total expenditure (administrative cost excluded) of more than $18.4 million. The average cost of the subsidy was $7.58 per ton.[23] It has been calculated that in the early seventies, the average subsidy on feed grains moving from Saskatoon to the Toronto area was 26.5 percent of the total freight cost, to the Montreal area 46 percent

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22. Carl Snavely, "Freight Rates Costs in Perspective", speech given at the Meat-Grain Interface Workshop, sponsored by University of Saskatchewan, February 2, 1976, Winnipeg.

23. Canadian Livestock Feed Board, Annual Report Crop Year 1975-76 (Montreal: Canadian Livestock Feed Board, 1977), Appendix table II, p. 44.

and to Moncton area about 69 percent.[24]

As shown in table 1.6, with the exception of Ontario, the non-Prairie Provinces have become increasingly more dependent on feed grains from the Prairies, though this may have been somewhat lessened by the importation of U. S. corn in British Columbia and Quebec in recent years. However, the Maritimes region (with the exception of P. E. I.) is especially dependent on Western feed grains.

While the Statutory Grain Rates was not originally a freight subsidy, by fixing the freight rates and indirectly subsidizing the railways through the branch line subsidy, it has the same effect as a freight subsidy on grain. It has been roughly estimated that the Statutory Grain Rates and the Feed Freight Assistance Program in 1975 together reduced the freight of grains from Edmonton to Montreal in the order of $15 per ton. Slightly more than half of this reduction was due to the Statutory Grain Rates.[25]

As noted by Tyrchniewicz, the freight subsidy on grains has "led to an overcommitment of resources to grain production"[26], and:

> The transportation rate structure in general, and

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24. E. W. Tyrchniewicz, "The Feed Freight Assistance Program in Canada", The Logistics and Transportation Review, 9, No. 4 (Dec. 1973), p. 311.

25. Canadian Transport Commission, Transportation FActors and the Canadian Livestock and Meat Industries, p. 26.

26. E. W. Tyrchniewicz, "Transportation and Canadian Agriculture", p. 27.

Table 1.6

Percentages of feed wheat, oats, barley and rye consumed in the Eastern provinces and B. C. imported under the Feed Freight Assistance Program

		P.E.I.	N.S.	N.B.	Que.	Ont.	B.C.
1964-65	Freight Assisted Shipment ('000 tons)	13.83	90.85	43.06	771.49	537.66	187.71
	Total Consumption ('000 tons)	103.46	115.29	110.92	1,580.17	2,299.58	290.36
	Freight Assisted Shipment as a percentage of total consumption	13.37	78.80	38.82	48.82	23.38	64.65
1969-70	Freight Assisted Shipment ('000 tons)	21.34	141.46	84.26	1,051.93	804.64	292.17
	Total Consumption ('000 tons)	131.13	170.66	140.91	1,569.93	1,743.30	344.41
	Freight Assisted Shipment as a percentage of total Consumption	16.27	82.95	59.80	66.97	46.16	84.83
1974-75	Freight Assisted Shipment ('000 tons)	20.67	114.86	48.43	1,209.61	440.69	265.28
	Total Consumption ('000 tons)	89.76	130.8	115.19	1,696.13	1,241.23	338.83
	Freight Assisted Shipment as a percentage of total consumption	23.03	87.81	42.04	71.32	35.50	78.29

Source: Statistics Canada, unpublished data.

> the statutory rates specifically, favor the shipping of raw materials out of the Prairies over their processing in the West. Normally, due to the weight loss involved in processing, one would expect those who use grain as a raw material to locate near the source of supply. However, the situation in Canada is that it is more profitable to transport raw grain to the large ultimate markets of the East, and process there. A good example of this is the livestock porduction and processing industry.[27]

It has generally been agreed that the Statutory Grain Rates and the Feed Freight Assistance Program, by reducing the transfer cost on grains from the Prairies to other provinces, encourage grain production in the Prairies. Furthermore, it has often been argued that because of reducing the transfer cost for grains but not the transfer cost for livestock and livestock products, poultry and livestock production as well as meat processing have been shifting away from the Prairies to Ontario and Quebec, where most of the market lies. If this argument is valid, one can further argue the total costs for livestock, meat and meat product would have become more expensive to consumers.[28]

As with most other subsidization policies, it is easier to introduce the Statutory Grain Rates and the Feed Freight Assistance Program than to remove them. Different interest groups in different regions who have benefited from these subsidies would certainly oppose the reduction in the benefits they have been receiving. Eastern livestock producers, for example, would

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27. Ibid., p. 28.

28. Ibid., p. 29.

object to any policy that would increase their cost in obtaining feed grains. The Statutory Grain Rates have also long been viewed as inviolable by Prairie grain growers who perceive that their profitablilty in grain production depends much on low grain freight rates. Consequently, any suggestion to reduce the level of subsidization of grain movement will meet strong objections from the people who have been receiving benefits from the various forms of subsidies.

Changes in Government Policies

In the past the Canadian feed grain market has been much under the direct influence of the Canadian Wheat Board. The Canadian Wheat Board took into account of factors besides transport costs in the pricing of Western feed grains in the Eastern market. Consequently, the effects of transport cost subsidies of feed grains in the feed grain market in Eastern Canada might not be so evident. The pricing policies of the Canadian Wheat Board might aggravate or reduce the effects of freight subsidies on feed grains on regional livestock production.

However, on May 31, 1976, the Federal Government announced modification of its domestic feed grains policy. From August 1, 1976 onwards, domestic feed grains in all parts of Canada have been set at prices competitive with the U. S. corn. Consequently, other than regional aupply and demand conditions, transport costs are the major factor in regional price spreads of feed grains. Hence the effects of subsidization of feed grain movement on regional livestock production is have become more evident. (See Appendix I for an account of the changes in Feed Grains Policy).

The Feed Freight Assistance Program has also been modified substantially along with the change in Feed Grains Policy in 1976. The freight subsidies of feed grains to Eastern Canada have been reduced. Major features of the modifications are as follows:

(1) The rates of subsidy payment to B.C. were reduced from their 1975 levels by $4 a ton (the reduction was, however, rescinded in most parts of the province latter in the same year);

(2) In Ontario and Western Quebec, subsidy rates of $6 a ton and less were eliminated and other rates were adjusted accordingly;

(3) Most of the rates to Eastern Quebec and the Maritimes were not affected; and

(4) Feed Freight Assistance is still available on shipment of Ontario corn and wheat to the Maritimes and Eastern Quebec.[29]

As to the Statutory Grain Rates, while the Hall Commission recommended retaining the Statutory Grain Rates with the Federal Government subsidizing the loss of the railways completely, there is still much agitation for removal of the Statutory Grain

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29. Government of Canada, Announcement by Hon. Eugene Whelan, Minister of Agriculture and Hon. Otto Lang, Minister Responsible for the Canadian Wheat Board on May 31, 1976 (Ottawa: Offices of the Minister of Agriculture and the Minister Responsible for the Canadian Wheat Board, 1976.)

Rates.[30] In fact, Carl Snavely criticized Hall's recommendations. Snavely strongly asserted that the Statutory Grain Rates have failed to provide incentive for "careful and systematic selection of the primary elevator and destination port combinations that will minimize the car-miles required to transport the annual grain in volume."[31] Furthermore, Snavely also declared that:

> The statutory and non-variable nature of the present rates offers no incentive to the shippers of their representatives to undertake capital expenditures which will permit economies of rail operation. And,..., the level of the rate offers no incentive to the railways to maintain, upgrade, or modernize the road property or equipment they provide for the transportation of statutory grains.[32]

Hence the recommendations of Hall on the Statutory Grain Rates have only brought in more agitations for the removal of them.

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30. Government of Canada, Grain and Rail in Western Canada, Vol. I, The Report of the Grain Handling and Transportation Commission (Ottawa: The Minister of Supply and Services Canada, 1977), pp. 336-37.

31. Carl Snavely, The Commission on the Costs of Transporting Grain by Rail, Report, Vol. II (Ottawa: The Minister of Supply and Services Canada, 1977); p. 156.

32. Ibid..

CHAPTER TWO

REVIEW OF PREVIOUS STUDIES ON THE PROBLEM

STUDIES CONDUCTED IN THE SIXTIES

There have been quite a number of studies completed on the effects of subsidizing the cost of moving grain on the location of livestock production. Many of the earlier studies, however, only focused on the Feed Freight Assistance Program.

Earlier Studies

One of the earliest studies was completed by Gilson and others in 1962.[1] Another one was completed by Wood in 1966.[2] Examing red meat consumption, livestock supply, distribution of livestock for slaughter and factors affecting location of meat production, both studies concluded that the feed freight subsidy had altered the comparative advantage of livestock production in favor of the non-Prairie Provinces. From the mid-sixties onwards,

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1. J. C. Gilson et. al., Development of the Livestock Industry in Canada by 1975 and Implications for the Meat Processing Industry in Manitoba, Department of Agricultural Economics, University of Manitoba, (A Study prepared for the Committee on Manitoba's Future, Winnipeg: 1962).

2. A. W. Wood, Effects of Federal Freight Assistance on Western Grains and Millfeeds Shipped into Eastern Canada and British Columbia, Agricultural Economics Bulletin No. 7 (Winnipeg: Department of Agricultural Economics, University of Manitoba, 1966).

many studies on the problem have been completed. This chapter reviews some of the more notable studies.

Kerr's study. Though it was completed in the mid-1960's, Kerr's work on the feed freight subsidy[3] is still much referred to. Using trade theory and location theory, Kerr hypothesized that the feed freight subsidy had shifted the location of livestock production away from the location of grain production without benefitting the consumers. Then he compared his hypothesis with historical data showing the trend in livestock and poultry production by province and inter-provincial trade in livestock and poultry products. In his theoretical analysis, Kerr argued that different livestock enterprise would experience different degrees of impact by the feed freight subsidy. The reason was due to different relationship of the production processes with the market and supply of inputs. For market-oriented commodities where perishability, bulkiness and consumer preference make it difficult to transport the product over long distance, the production process would be oriented to the market. Dairy milk and egg production belong to this category and grains would be transported from the grain producing areas to areas close to the markets for their production. Since they would locate close to the markets anyway, the freight subsidy on grains would have no effect on the location of production though it would reduce the

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3. T. C. Kerr, An Analysis of the Feed Freight Assistance Policy (Ottawa: Agricultural Economics Research Council of Canada, 1966).

cost of production to the producers and possibly to the consumers. In cow-calf production of the beef industry where it depends on both forage and grain as inputs and it is substantially weight-losing and it is relatively much cheaper to transport calves than forages, the production process is supply-oriented and usually locates close to the inputs. A freight subsidy on grain would have little effect on location of production. In between these two extremes are the inter mediate or "foot-loose" industries which are not particularly weight-losing, and the products can be transported over long distance. A subsidy on the input would enable the production to be shifted closer to the market as the procurement cost would be reduced. Turkey and hog production, as well as feedlot production in beef cattle production are inter mediate industries. The grain freight subsidy would enable these production process to locate closer to the market than they would otherwise. As the Prairies are input-producing areas for livestock and poultry industries in Canada and Eastern Canada (Ontario, Quebec and the Maritimes) and B. C.. Kerr hypothesized that the grain freight subsidy had resulted in a shift of location of production for these industries from the Prairies to Eastern Canada and B. C.. He further contended that this would also mean that the Canadian taxpayers were subsidizing the relocation of these industries.

By comparing his hypothesis with the historical data showing the trend of production of livestock and poultry products by province and inter-provincial trade Kerr concluded, as did

Gilson et. al. and Wood, that the subsidy had adverse effects on hog and turkey production and feedlot operation in beef cattle production in the Prairies by favouring the corresponding locations in Eastern Canada and B. C.. Kerr also concluded that these changes had been made with no benefit to the Canadian taxpayers.

Wilson and Darby study. Wilson and Darby were basically following up Kerr's work when they prepared their study for the Royal Commission on Consumer Problems and Inflation in 1968.[4] They compiled tables to compare the costs of shipping pork, turkey, beef and manufactured milk with the costs of shipping equivalent quantities of grains both with and without the grain freight subsidy. Wilson and Darby found that the grain freight subsidy had resulted in producing hogs and turkeys in Eastern Canada using grains shipped from the Prairies and hence concluded that the subsidy had shifted the location of hog and turkey production. With respect to beef production, the cost comparison between shipping beef and the equivalent amount of grain did not definitively indicate that the subsidy had been strong enough to shift the location of beef production, which is more supply-oriented than hog and turkey production. However, Wilson and Darby did argued that had there been no subsidy, beef prices in Eastern Canada would have been higher and would have resulted in more Prairie resourses being devoted to cattle production. They concluded,

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4. G. W. Wilson and L. Darby, Transportation on the Prairies, Supporting Studies No. 2, Prepared for the Royal Commission on Consumer Problems and Inflation (Regina: Queen's Printer, 1968), pp. 34-43, and 65-75.

therefore, that the Prairie cattle industry would have grown even further had there been no feed freight subsidy.

Gainer et. al.'s study. Gainer and his collaborators[5] examined the effects on meat packing in the Prairies. By comparing the amount of feed grains produced by the provinces and the amount imported through the feed freight subsidy, Gainer et. al. concluded that the non-Prairie provinces had become increasingly dependent on the subsidy. His other conclusions were similiar to those of the studies mentioned above.

Wilson's study. Wilson's Ph. D. thesis[6] was a more vigorus attempt to study the effects of the feed freight subsidy on location of livestock production and it used quantitative techniques such as linear programing to study the problem. An inter-regional competition model of livestock production was established taking into account the feed input and the transfer costs of grains, livestock and meat. With different transfer cost situations due to different levels of feed freight subsidy, Wilson estimated the effects of subsidizing the transfer costs of grains on livestock and meat production.

While obtaining a result basically similiar to that achieved by the mainly qualitative studies mentioned above,

5. W. D. Gainer et. al., Economic Analysis of the Effect of Transport Rates on Products of the Industrial, Chemical and Meat Packing Industry with Special Reference to Edmonton, Research Report for the Canadian Transport Commission (Ottawa: Canadian Transport Commission, 1975).

6. A. G. Wilson, The Impact of the Feed Freight Subsidy on the Location of Livestock Production, Unpublished Ph. D. thesis (Winnipeg: University of Manitoba, 1968).

Wilson showed that a more precise way of estimating the effects and testing the hypothesis is possible with quantitative methods. A quantitative method can, as Wilson noted, also approach the problem as a whole and allow simulation of alternative situations. Hence the model may be able to reflect the real world situation much better and also predict the effects which would be caused by alternative policies.

Wilson's study, however, also revealed a serious handicap in the use of quantitive techniques that require a large amount of data.[7] In fact, the more complicated the model is, the greater data problem one would encounter. Furthermore, even with a model of the size of Wilson's (489 equations and 1730 activities) there are still inconsistencies and deviations from the real world situation.[8]

STUDIES MADE IN THE SEVENTIES

Studies by the Canadian Transport Commission

With the inflation spiral in the early seventies, freight rates for grains, live animals and meat rose substantially but at different rates. Hence the effect of freight costs of grains

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7. For example, the data on supplies of feed, roughages and ground feed output was based on, in Wilson's own words, heroic simplification and extrapolation. See Wilson, pp. 146, 150 and 153.

8. An example is that Wilson's model predicted no cattle production in B. C. at all even under the feed freight subsidy. Certainly this is not the case in reality. See. Wilson, p. 186.

and live animals on the location of livestock and meat industries became an even more controversial issue. The Research Branch of the Canadian Transport Commission, attempted a comparison of the transport costs on grains, live animals and meat to find the effect on location of livestock and meat production.[9] An updated study was completed in 1976.[10]

The 1975 study concluded that although it was cheaper to ship grains than meat, very few Western grains had in fact been used in the East for beef cattle. While the study was not quite able to explain the movement of cattle and calves from the Prairies to the East or answer the question whether the freight rate structure on grain had adversely affected beef cattle production in the West, a comparison of the transportation costs did allow it to argue that "other things being equal, there is a transport incentive to produce hogs in Eastern Canada using Western feed grains rather than to transport pork form the West."[11]

With the change in the Feed Freight Assistance Program, an updated study was completed in 1976. The study contended that it was still cheaper to ship feeder steers from the West to the East than to ship feeder steers together with the amount of grain

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9. Canadian Transport Commission, Transportation Factors and the Canadian Livestock and Meat Industries (Ottawa: Canadian Transport Commission, 1975).

10. Canadian Transport Commission, Transportation Factors and the Canadian Livestock and Meat Industries, An Updated Summary (Ottawa: Canadian Transport Commission, 1976).

11. Canadian Transport Commission, Transportation Factors. . ., p. 33.

required in the same direction. Furthermore, the cost comparisons indicated that the new freight subsidy removed the advantage the Montreal/Toronto region used to enjoy. With the new schedule of subsidy which eliminated the subsidy to most parts of Southern Ontario and Western Quebec, it became cheaper to ship beef to these regions than to ship grain. However, as feed freight subsidy is still available to the Maritimes, it was still cheaper to ship grains from Western Canada to the Maritimes for feeding of cattle than to ship meat to that region. As to comparing the transportation costs of shipping meat from the West to the East as against the costs of shipping the grains versus pork to the Montreal/Toronto market, it was found to be cheaper to ship pork from Winnipeg or Moose Jaw but not from Calgary. Hence there was a disadvantage for Alberta.

While the Canadian Transport Commission studies have made a bold attempt to compare the costs of transportation between grains, feeder calves, slaughter cattle, beef and pork the study has its limitations. As it itself admitted, the Eastern cattle feeders only used a minute portion of Western grains in their operation, hence a comparison between shipping Western barley versus shipping feeder calves and slaughter cattle becomes rather meaningless.

The Study by Canadian Federation of Agriculture

The approach of the Canadian Transport Commission study, however, did inspire other researchers to look at the comparison between shipping grain, live animals at both the feeder and slaughter stages and meat. The Canadian Federation of Agriculture (C.F.A.), through its Research Branch, has also completed a similiar study after the announcement of the new feed grain policy and new Feed Freight Assistance Program.[12]

The study compared the transportation costs between barley, live steers and dressed carcasses between Edmonton and Montreal. However, unlike the previous studies, it also included the option of adding Prairie elevator charges in the cost of moving barley. It argued that prior to the modification of the feed freight subsidy in June 1976, it was cheaper to ship barley than live cattle for slaughter and dressed carcasses only if the Prairie elevator charges were not included, it was cheaper to move beef than to move barley. But with the new feed freight subsidy schedule, beef was the cheapest to move regardless of whether or not the Prairie elevator charges were included. In all cases, however, live cattle was more expensive to move than beef. The findings on hogs were similiar to those of cattle, though live hogs were found to be even more expensive to move than cattle over long distance.

In addition to comparing transportation costs alone, the study also examined the effects of corn-competitive pricing

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12. Canadian Federation of Agriculture, The Effects of the New Feed Grain Policy (August 1976) on the Equity of the Relative Transportation Costs of Feed Grains, Livestock and Meat in Canada, Research Paper on behalf of Canadian Federation of Agriculture and Canadian Pork Council, Ottawa, June, 1976 Mimeo. .

of Western grains on the Eastern market for those grains in the context of the new feed freight subsidy program. The calculation showed that the combined result of the two policies would increase the margin, as well as decrease the cost of production in Edmonton, and vice versa in Montreal.

Though it used rather simple techniques, the C.F.A. study did make a useful suggestion that besides freight rates, other factors such as the new corn-competitive pricing of Western grains and Prairie grain handling charges should also be taken into consideration. However, an important shortcoming of the study lies in its implicit assumption that the Eastern feeders used only Western feed grains. The contribution of locally produced feed was not considered. Nevertheless, the study did make some interesting estimates of the effects of both the Feed Freight Assistance Program and the Statutory Grain Rates on the prices of dressed pork and live steers. And it was bold enough to point out that the Statutory Grain Rates costed even more to the livestock producers in Western Canada and it was an even greater cause of distortion of the natural advantage in livestock production.

Chapter Three

THEORETICAL BACKGROUND AND ANALYSIS

The previous chapter has reviewed a number of studies which conclude that the Feed Freight Assistance Program and the Statutory Grain Rates have worked to the disadvantage of livestock and meat industries in Western Canada. In order to affirm or dispute their conclusions, and to examine how these policies work against Western Canada, if they indeed do, it is necessary to study, first of all, the theory of industrial location, and to apply the theory to the problem under study.

TRANSPORT COST AND INDUSTRIAL LOCATION

The theory of industrial location was formally originated by Alfred Weber[1] and was later developed further by Walter Issard[2] and Edgar Hoover[3] who together formed the "least cost school" of location theory which is basically followed in this study. The theory is normative in nature. Abstracting form demand, it seeks to find the lowest combination of processing and

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1. Alfred Weber, Theory of Location of Industries (Chicago: University of Chicago Press, 1929).

2. Walter Issard, Location and Space Economy (New York: Wiley Press, 1956).

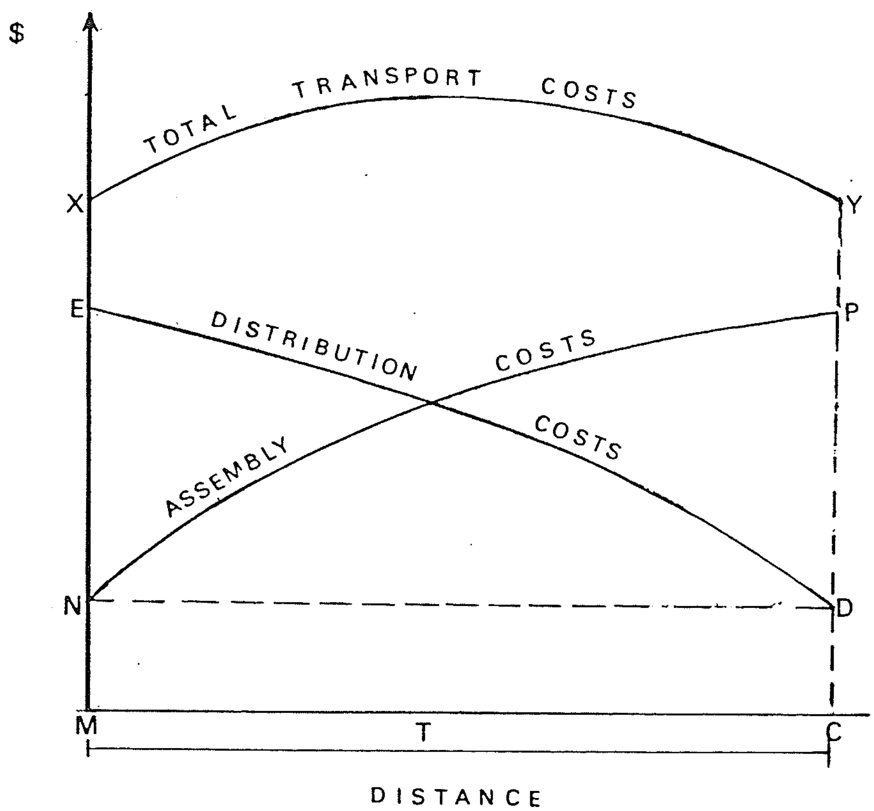
3. Edgar Hoover, The Location of Economic Activity (Toronto: McGraw-Hill, 1963).

transport costs. Transport cost played a dominant role in the early formation of the theory, but the relative importance of transport cost in the theory has declined. Nevertheless, it is still vital for the theoretical analysis to examine the nature of transport cost and how it affects the location of industry.

The Nature of Transport Cost

There are two forms of transport cost. The assembly cost and the distribution cost. The assembly or procurement cost is the cost incurred in acquiring and moving the raw material to the plant while the distribution cost of shipping the final product from the plant to the marlets. Both assembly costs and distribution costs involve two elements — terminal costs and movement costs. Terminal cost is independent of distance while movement cost is usually related to distance but may also be influenced by other factors such as topography, density of traffic and perishability of the product. Even if distance is the only determinant, it does follow that movement cost always increases in a linear fashion. In the real world, it often increases in steps at a decreasing rate with distance. If the distance is long enough with a large number of steps through which increases take place one can generalize that the movement cost increases curvilinearly at a decreasing rate. The total transport cost incurred in a production process can be illustrated by figure 3.1. In this diagram, it is assumed that there is a processing activity which uses only one raw material from site M and sells

FIGURE 3.1 THE TOTAL TRANSPORT COST FUNCTION



Source: Adapted from William Alonso, "Location Theory", in John Friedmann and William Alonso (ed.), Regional Policy, Readings in Theory and Applications (Cambridge, Mass.: MIT Press, 1975), p. 43.

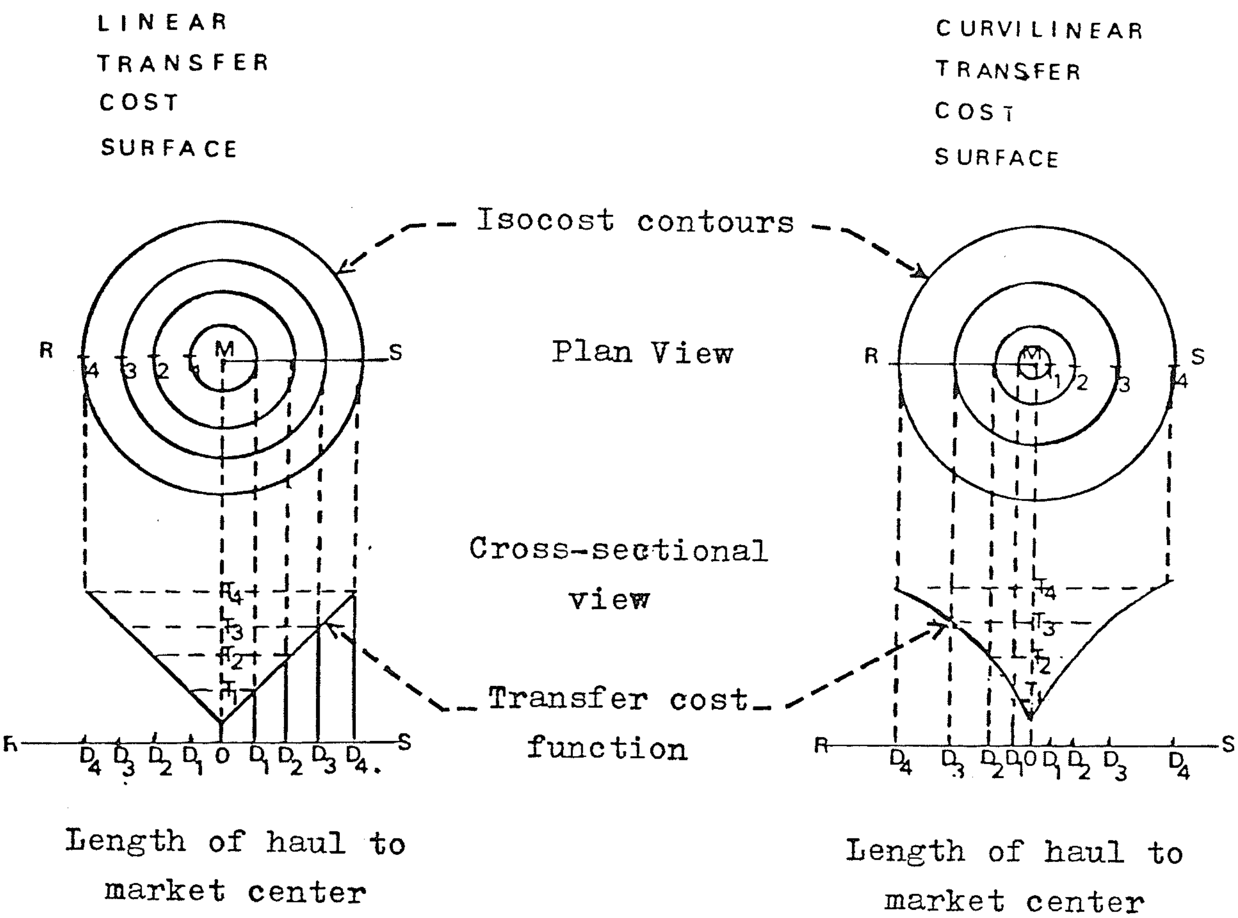
the product to one market located at C. Assuming that terminal cost for the raw material is the same everywhere, the terminal cost along MC can be indicated by a horizontal line ND. Assuming the movement cost for the raw material increases at a decreasing rate, the assembly costs for the points away from M can be indicated by the curve NP, which is the summation of the terminal cost and the movement cost in procurring the raw material. Assuming that the terminal cost for the finished product is the same as that of the raw material, and the rate of increase in the movement cost of the finished product is also the same as that of the raw material, the distribution costs for points away from C can be represented by the curve ED. If the production process takes place at M, the total transport cost incurred will be the sum of the assembly cost, MN and the distribution cost, ME, which is indicated as MX in the diagram. If the production process takes place at C, the total transport cost incurred will be the sum of the assembly cost, CP and the distribution cost, CD, which is indicated as CY in the diagram. The total transport costs at points between M and C can be represented by the curve XY, which is the vertical summation of the two curves representing the assembly costs and the distribution costs.

A way to illustrate the transport costs away from a point is to draw isotims which are actually iso-cost contours. Assuming that the production takes place at a point and the movement cost for the product is linear the isotims are shown as equally spaced concentric circles. These are shown in the left-hand-side of figure 3.2. However, if the movement cost is curvilinear, increasing at a decreasing rate, the isotims become a series of concentric circles with increasing distance between successive circles away from the centre, as shown in right-hand-side of figure 3.2.

The Effect of Transport Cost on Industrial Location

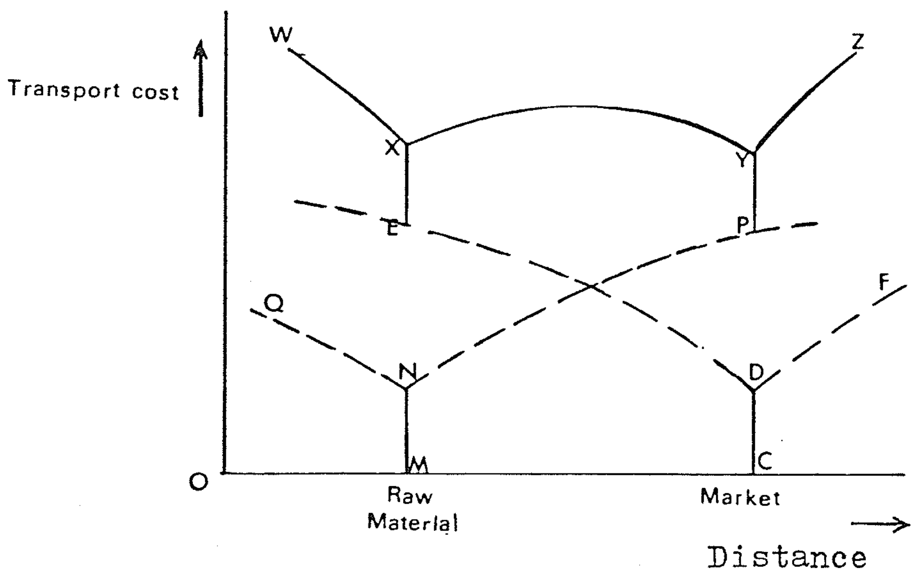
According to Weber and the least cost theorists, resources can be divided into two main categories — localized and ubiquitous. Localized resources exist only at a few concentrated locations while ubiquitous resources are generally available everywhere. Production process can be either weight losing, weight gaining or of a type that involve no change in weight. In the second case, the weight-gaining process, it is usually because ubiquitous materials are used. It is these changes in weight that affect the location of production. Assume that there is just one localised input material site M and one separated market site C in the production process as shown in figure 3.3. Furthermore, although not essential to the theoretical framework, for simplification assume that the processing costs are identical everywhere and for every unit of production. The freight rates on the raw material and the product per unit weight are also assumed to be equal and the transfer cost functions are curvilinear (which is usually the case in the real world). Given these assumptions, the differences in the total costs incurred in different locations are determined solely by the differences in transportation costs. If the

FIGURE 3.2 THE PLAN SURFACE VIEW AND THE CROSS SECTIONAL VIEW OF TRANSFER COST



Source: Raymond G. Bressler, Jr. and Richard A. King, Markets, Prices, and Interregional Trade (New York: John Wiley and Sons, Inc., 1970); p. 112.

FIGURE 3.3 THE LEAST COST LOCATION IN A PRODUCTION PROCESS WHICH IS NEITHER WEIGHT GAINING NOR WEIGHT LOSING



production process is neither weight gaining nor weight losing, the costs incurred in assemblying the raw materials in points along OT can be represented by the curve QNP while the costs incurred in distributing the finished product can be represented by the curve EDF. Consequently, the combined costs of transferring one ton of the raw material and one ton of the finished product can be represented by the curve WXYZ. As indicated by the curve WXYZ, the production process will minimize the transportation costs if it is held at either the raw material site M and the market site C.

However, with respect to a weight losing process, say two tons of the raw material are required to produce one ton of the finished product, then the result would be as shown in figure 3.4a. Combining the assembly cost curve Q'N'P' and the distribution cost curve E'D'F' produces a total transport cost curve W'X'Y'Z'. As indicated by this curve (W'X'Y'Z'), the raw material site, M will be the least-cost site. On the other hand, in a weight-gaining process, as shown in figure 3.4b, the total transport cost curve indicates that the least-cost location is at the market site, C.

The relationship between the nature of the production process (whether it is weight gaining or weight losing), and the transport costs can be expressed by simple algebraic equations as follows:

Let Wp = Weight per unit of finished product;

Wr = Weight of the localized raw material used to produce one unit of the finished product;

FIGURE 3.4a THE LEAST COST LOCATION IN A WEIGHT LOSING PROCESS

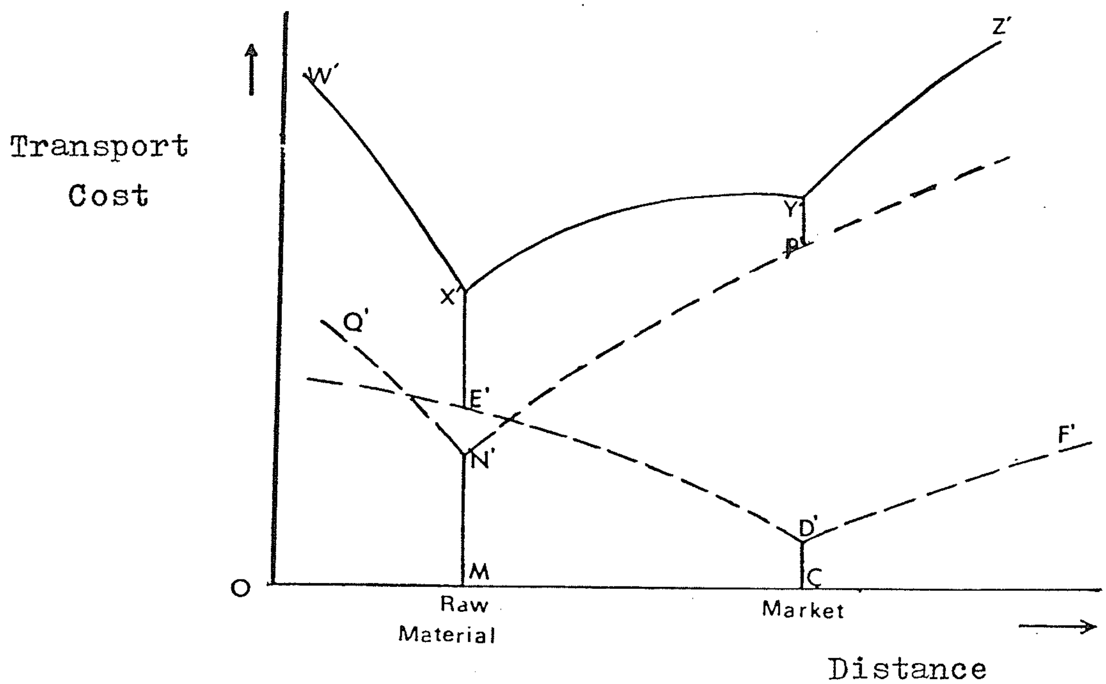
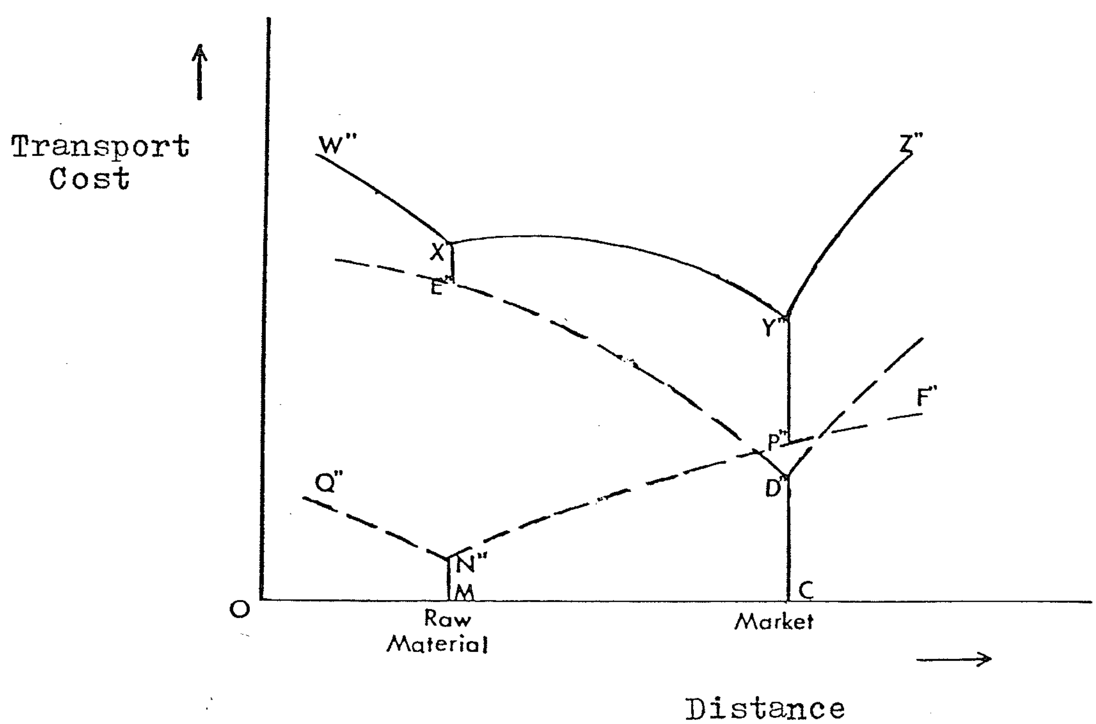


FIGURE 3.4b THE LEAST COST LOCATION IN A WEIGHT GAINING PROCESS



Tp = Transfer cost function of the finished product;

Tr = Transfer cost function of the localized raw material.

If $WrTr > WpTp$;

or $Tr/Tp > Wp/Wr$;

it will cost more to ship the raw material to the market site and to produce there than to produce at the raw material site and ship the product to the market.

If $WrTr < WpTp$;

or $Tr/Tp < Wp/Wr$;

it will cost more to produce at the raw material site and to ship the product to the market than to ship the raw material to the market site and produce there.

And if $WrTr = WpTp$;

or $Tr/Tp = Wp/Wr$;

then the transport cost involved in the production process will be the same at both the raw material site and the market site.[4]

When more than one raw material or market sites are involved, the last-cost location(s) can be found by drawing siodapanes. This method first draws the isotims which are the iso-cost contours showing the costs in shipping the materials from the raw material sites and the products from the market sites over space. Then the lines connecting points of equal total

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4. See R. G. Bressler and R. A. King, Markets, Prices and Inter-Regional Trade (New York: Wiley, 1970); p. 356.

costs in assemblying and distributing cost are drawn. The resulting contours are called the isodapanes. If the assemblying cost and the distribution cost are equal, the situation will be as shown in figure 3.5. But more likely, the assembly cost is often not the same as the distribution cost. Then the situation will be as that shown in figure 3.6.[5]

The Role of Other Cost Factors in Location of Production

Recent writers have recognised that transport cost is just one of the many elements in the total cost incurred in production over space. Harry Richardson[6], for example, divided average cost over space into average basic cost and average locational cost. According to him, basic cost is the minimum cost of producing a given output irrespective of the location of the plant while locational cost is the "spatial premiums in the costs of production factors over the basic minimum and/or the additional costs incurred in bringing factors, such as raw materials, to the factory location."[7] Hence the difference in labour costs, capital costs, power costs and even incentives to managers to work in unattractive locations among different

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5. For a mathematical treatment of the problem, see William Alonso, "A Reformulation of Classical Location Theory and its Relation to Rent Theory", Regional Science Association Papers, Vol. 19, 1967; p. 24.

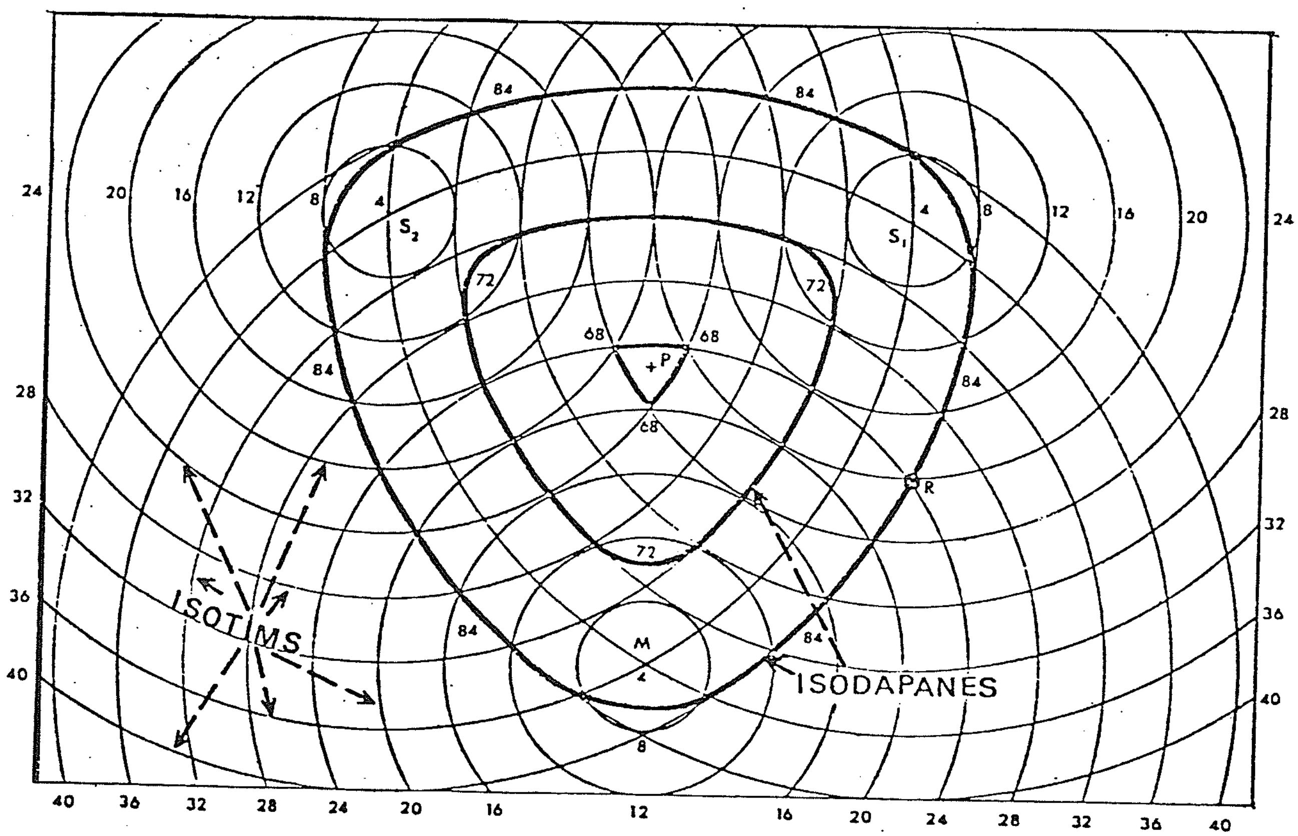
6. Harry Richardson, Regional Economics (London: Camelot Press, 1969).

7. Ibid., p. 286.

FIGURE 3.5

TOTAL TRANSPORTATION COSTS IN TWO-

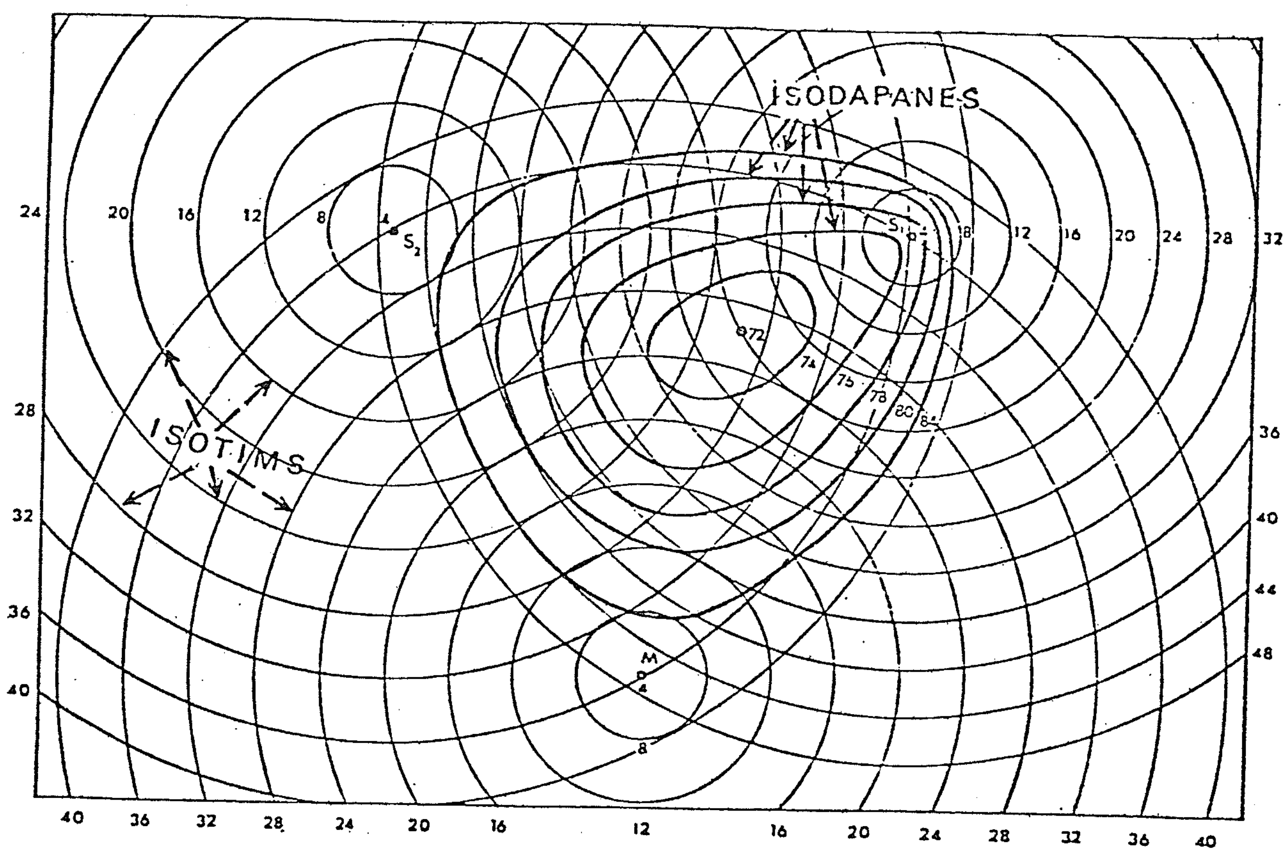
DIMENSIONAL SPACE WITH EQUAL TRANSPORTION COSTS



Source: Gerald Karaska, "The Partial Equilibrium Approach to Location Theory, Graphic Solutions" in G. J. Karaska and E. F. Bramhall (ed.) Locational Analysis for Manufacturing (Cambridge, Mass.: M. I. T. Press, 1969): p. 31.

FIGURE 3.6

TOTAL TRANSPORTATION COST IN TWO-DIMENSIONAL SPACE WITH UNEQUAL TRANSPORTIONAL COSTS



Source: Gerald Karaska, "The Partial Equilibrium Approach to Location Theory, Graphic Solutions", in G. J. Karaska and D. F. Bramhall (ed.), Locational Analysis for Manufacturing (Cambridge, Mass.: M. I. T. Press, 1969); p. 32.

locations ought to be included in the production cost as well.[8]

However, as one starts to study the production costs one must also start considering the possibility of substitution of input factors. In locations of high labour cost, for example, it may be possible to substitute capital for labour. Also, if more than one raw material is needed to produce the product, and these materials are substitutable, at least to a certain degree, than there can be varying combinations of the raw materials used in different locations. Hence, there are possibilities of having more than one optimum location. Scale economics can also influence the location, as a non-homogeneous production can lead to different input combinations as the scale increases. These problems were first pointed out by Leon Moses[9] and then further developed by N. Sasashita,[10] Michael Bradfield,[11] David L. Emerson,[12] and Robert S. Woodward.[13]

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8. Ibid..

9. Leon Moses, "Location and the Theory of Production", Quarterly Journal of Economics, 72(1958), pp. 249-272.

10. N. Sakashita, "Production Function, Demand Function and Location Theory of the Firm", Papers, Regional Science Association, 20(1967), pp. 109-122.

11. Michael Bradfield, "A Note on Location and the Theory on Production", Journal of Regional Science, 13(1973), pp. 335-347.

12. David L. Emerson, "Optimum Firm Location and the Theory of Production", Journal of Regional Science, 13(1973), pp. 335-347.

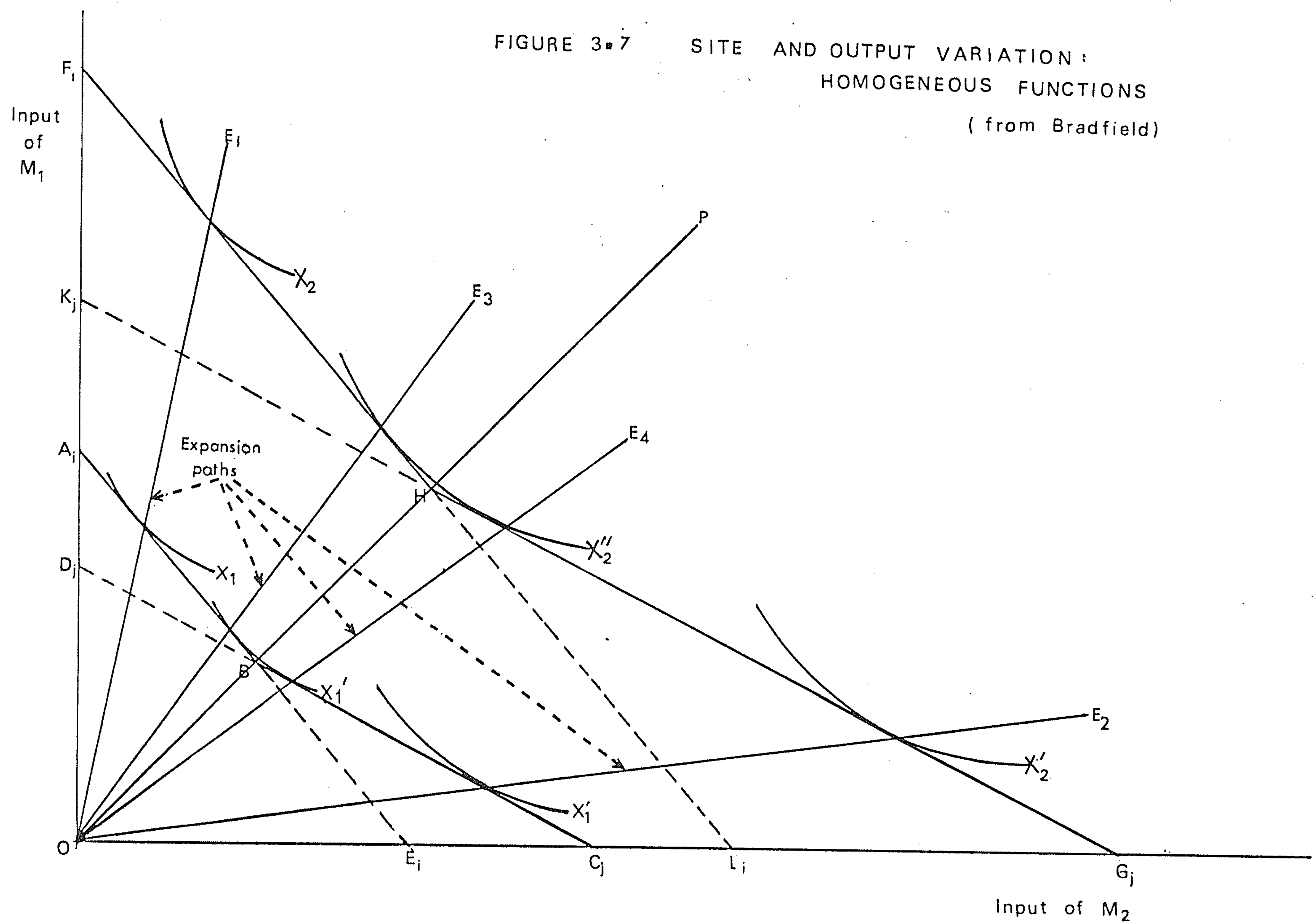
13. Robert S. Woodward, "The Iso-Outlay Function and Variable Transport Costs", Journal of Regional Science, 13(1973), pp. 349-355.

Based on the suggestions by Moses and Bradfield, the relationship between location theory and production theory can be illustrated with the help of figure 3.7.

In figure 3.7, assume that a product X requires two inputs, M_1 and M_2 respectively located at sites i and j. Transport costs are therefore incurred in bringing M_1 to j and M_2 to i. Hence the same cost outlay will purchase different combinations of M_1 and M_2 at i and j. Consequently, the marginal rates of factor subsititution in i and j are different. Assuming that the inputs — M_1 and M_2 are mutually substitutable, with the same amount of cost outlay, site i will use more of M_1 and less M_2, and site j will use more of M_2 and less of M_1. This can be represented by V-shaped iso-cost lines A_iBC_j and F_iHG_j as shown in the diagram. A 45 degree line OBHP cuts through the iso-cost curves. Northwest of OBHP represents the cost combination in site i and southeast of OBHP represents the cost combination in in site j. With a homogeneous production function, since the isoquants are parallel with respect to one another, the expansion path which is the locus of their tangency with the iso-cost lines is a straight line radiated from the origin. In most situations, if there is only one technique in production, the expansion path will be either in the cost combination optimal to site i or site j. As shown in the diagram, if the production technique is X with isoquants X_1 and X_2, the expansion path OE_1 will always indicate that site i is the least cost location. Conversely, if the production technique is X' with isoquants X'_1 and X'_2, the

FIGURE 3.7 SITE AND OUTPUT VARIATION: HOMOGENEOUS FUNCTIONS

(from Bradfield)

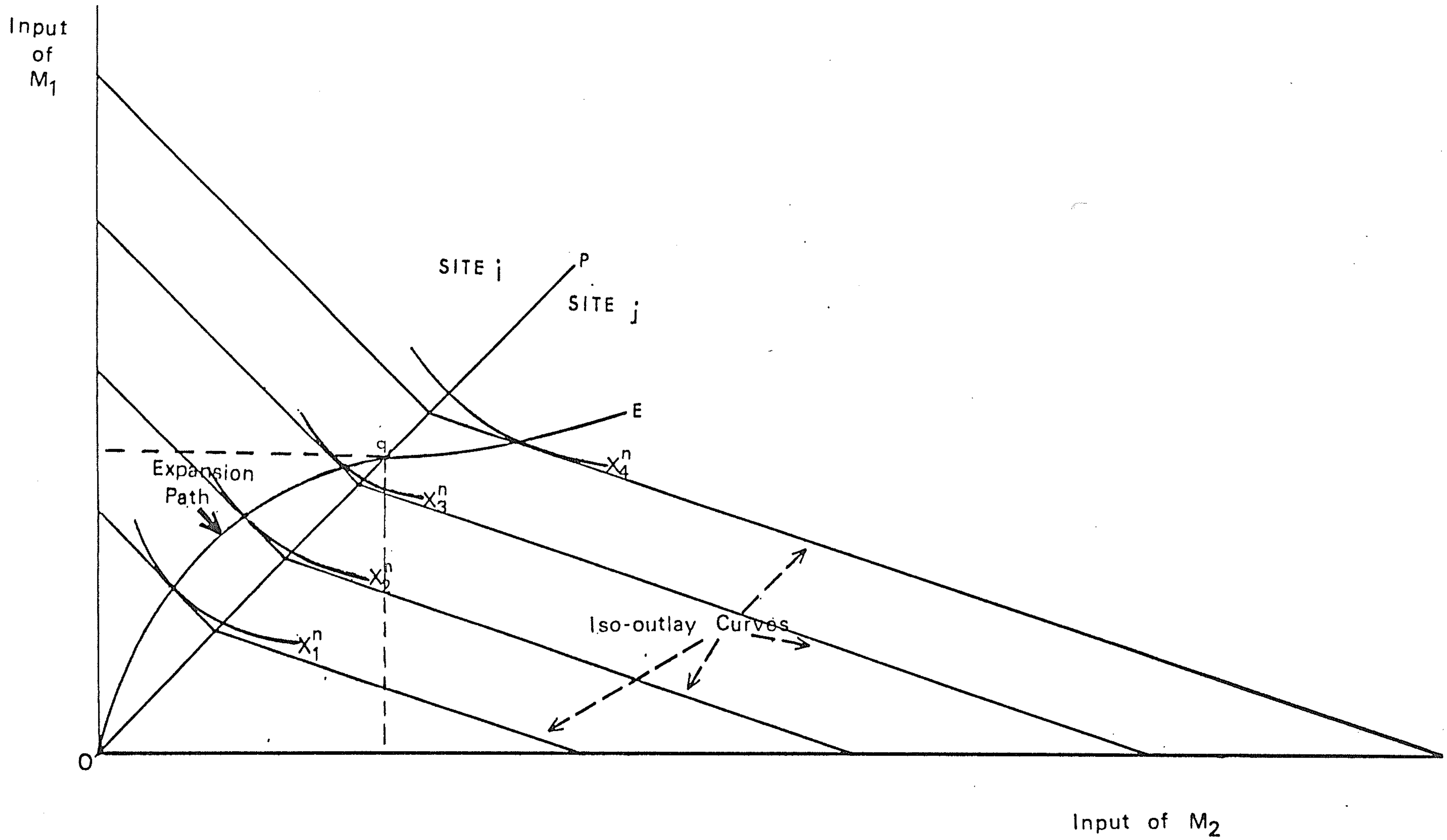


expansion path will always be on the side of site j. In rare occasions, however, when the production technique has isoquants such as $X"_1$ and $X"_2$ which are each tangent to the sio-cost lines at both sides of the line OBHP, there are two expansion paths such as OE_3 and OE_4 as shown in the diagram. As a result, both site i and site j are least cost locations.

Nonetheless, in the real world situation, there is a high possibility that a product can be produced by an array of techniques which is made possible (and practical) by the different cost combinations at different locations. If all three production techniques, X, X' and X" as in figure 3.7 are available, and if the returns to scale in all three techniques are equal, then the producer can produce at either site i or site j by just varying the techniques. However, the situation is different if returns to scale in different techniques are different, which is often the case in the real world. Assume that technique X in figure 3.7 is homogeneous of degree h and X' is homogeneous of degree h' and h is greater than h'. If X_1 is equal to X'_1, the producer who just wants to produce at that level may produce at either site i or site j. However, an increase in outlay will mean that X_2 is larger than X'_2 and the producer looking for expansion will prefer site i.

However, in the real world situation, the production function may not be homogeneous. Then a situation such as that illustrated in figure 3.8 may occur. Here the production function has an initially increasing and eventually decreasing returns to

FIGURE 3.8 SITE AND OUTPUT VARIATION: NON-HOMOGENEOUS PRODUCTION FUNCTION



scale. And as shown in the diagram, the expansion path is not a straight line. Up to a point, say q units, the expansion path will stay at the side indicating site i is the least cost site. Beyond that, the expansion path will stay at the side indicating site j as the least cost site.

INTERREGIONAL TRADE AND REGIONAL SPECIALISATION OF PRODUCTION

Besides the fact that in the real world usually more than one production technique is available, most literature on location theory either explicitly or implicitly follows Weber's assumption that the raw material sites and the markets are localized and seperated from each other. While this assumption may be true for extractive industries they are not that true for many others. Agricultural and food processing industries, for example, would have their raw materials produced in various regions in the country and the demand for their products, though concentrated in a few locations, spread out unevenly. Each region would have some production of the products but the spatial patterns of supply of raw materials do not usually correspond with the spatial patterns of demand for the products. In order to examine the optimal levels of regional specialization and interregional trade, it is necessary to study aspects of the theory of interregional trade related to the theory of location of production.

Trade Theory and Location Theory

It was Beril Ohlin who linked the theories of trade, production and location together by examing the differences in factor endowment between regions (or nations).[14] He assumed that endowment of various factors of production in a region was different from the others. A region which was richly endowed with a certain factor of production, and can therefore obtain that factor cheaper than the other regions would have a comparative cost advantage in producing commodities which require intensive use of that factor of production. Consequently, the region would concentrate on producing such commodities.

Ohlin's model can be illustrated by comparing the opportunity cost curves of two regions as illustrated in figure 3.9. An opportunity cost curve "shows the cost of producing one commodity in terms of the foregone opportunity of producing the other".[15] In the diagram it is assumed that there are two regions, X and Y, and there are two commodities, A and B, the production of A requires intensive use of factor F while the production of B does not and region X is richly endowed with F while Y is not. Assuming that the prices of other factors of production are equal, X needs to sacrifise less of producing B in producing a unit of A

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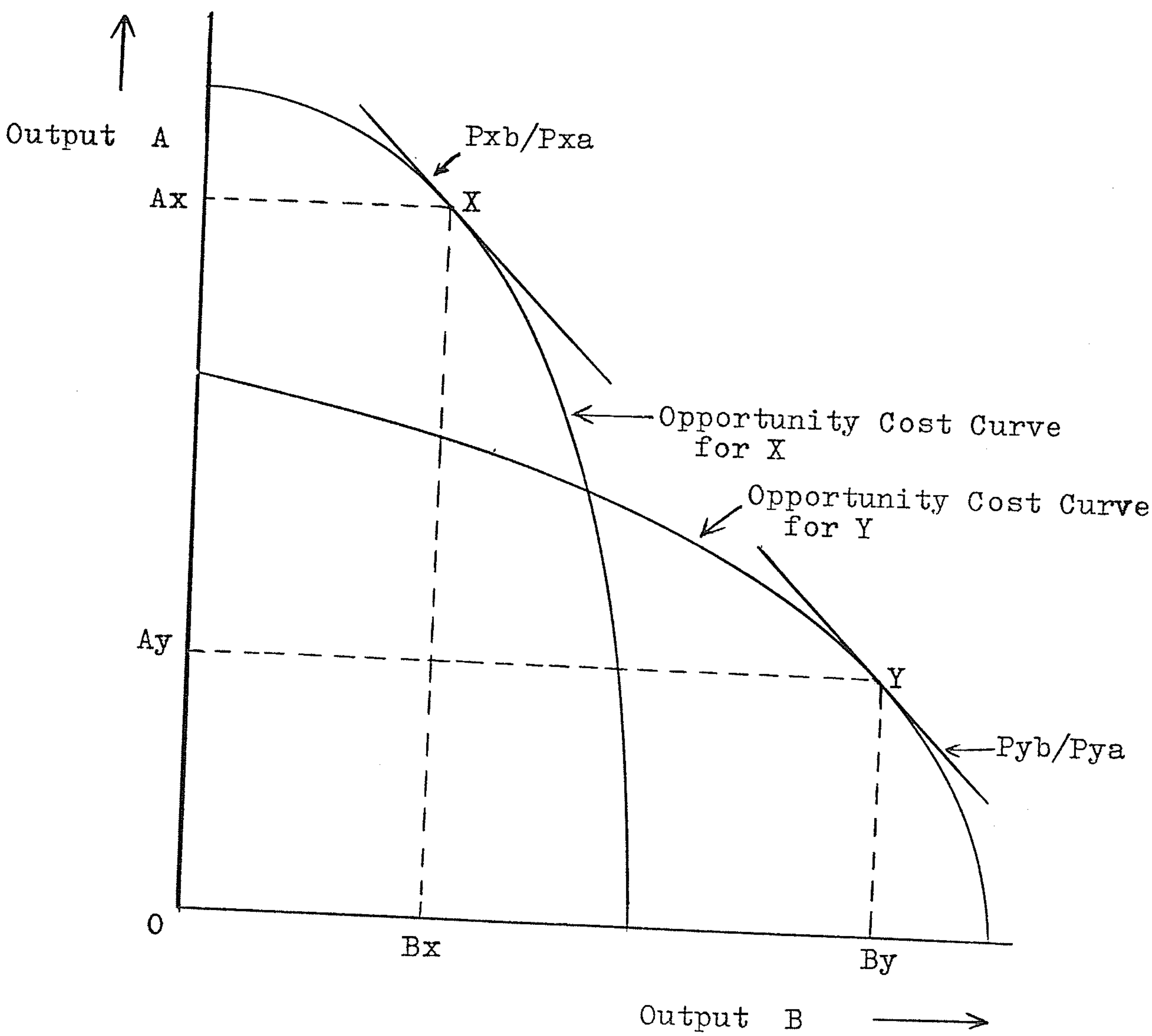
14. Beril Ohlin, Interregional and International Trade, revised edition (Cambridge: Harvard University Press, 1967).

15. Bressler and King, op. cit., p. 246.

FIGURE 3.9 THE OPPORTUNITY COST CURVES AND REGIONAL SPECIALIZATION OF PRODUCTION OF REGIONS X AND Y



than in the case of Y. Consequently, the opportunity cost curves of X and Y will be as shown in the diagram. Assuming there is no transfer cost involved, and regions X and Y are allowed to trade freely, the end result will be equalization in price ratios between A and B in both regions where Pxb/Pxa = Pyb/Pya. Region X will produce Ax of A commodity A and Bx of Commodity B while region Y will produce Ay of commodity A and By of commodity B. Consequently, X will concentrate on producing A while Y will concentrate on producing B.

The model illustrated in figure 3.9, does not take into account of regional demand of the commodities. While region X may be producing more of A but its demand may also be higher than Y. Hence it does not necessary follow that X must export A to Y. It also has not taken transfer cost into consideration.[16] However, it indicates the strong influence of factor endowment on regional specialization on production.

Total Cost Involved in Regional Specialization and Interregional Trade

Logan and King[17] has developed an illustrative model for regional production and interregional trade. Their model is in fact to look for the levels of production by region which

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16. Ohlin has discussed the influence of demand and supply and transfer cost on trade and regional production but they are beyond the scope of this these.

17. S. H. Logan and G. A. King, "Size and Factors Affecting California's Beef Slaughter Plants", Hilgardia, 36(1964-65), p. 139-88.

will result in the lowest total cost involved in the country. Their model assumes that the raw materials are available everywhere though the supplies of raw materials do not correspond with the demand for the product. Consequently, their model is more applicable in studying agricultural and food processing industries. With some modifications, their model is presented in the following paragraphs.

Assuming a country has two regions and there is no international trade, so that trade has to be between the two regions. For simplicity, it is assumed that in the production of a certain product, there is no difference in the c. i. f. price of raw materials, assembly cost, distribution cost and costs for other inputs between the two regions, and there is no transport cost incurred in movement within a region. Assuming that the transport cost for the raw materials (assembly cost) for each unit of the product produced is twice the transport cost of the product (distribution cost) the situation can be illustrated by figures 3.10a and b. As shown in the diagrams, demand for the product is OD' in region 1 and OD" in region 2. However, region 1 has raw materials available to produce OS' of the product while region 2 has raw materials available to produce only OS". If equilibrium situation prevails the total supply of the product in the country, OTs is equal to the total demand of the product, OTd; or

$$OS' + OS'' = OTs,$$

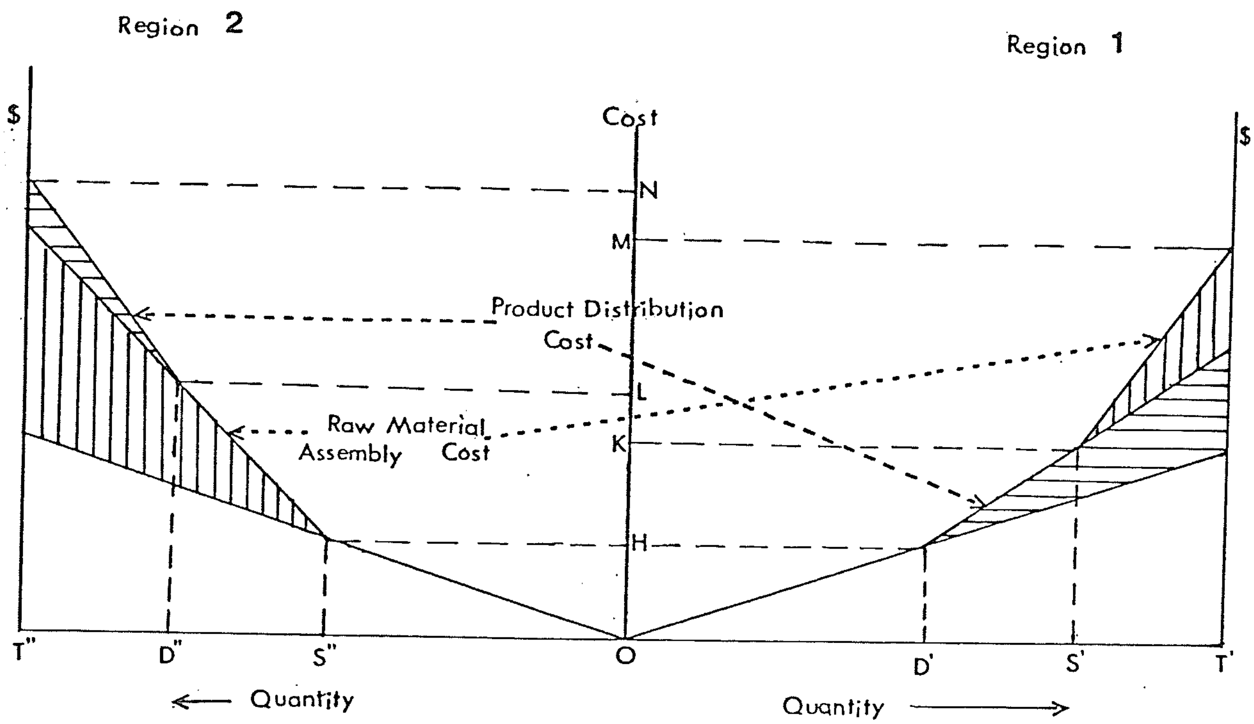
$$OD' + OD'' = OTd,$$

and

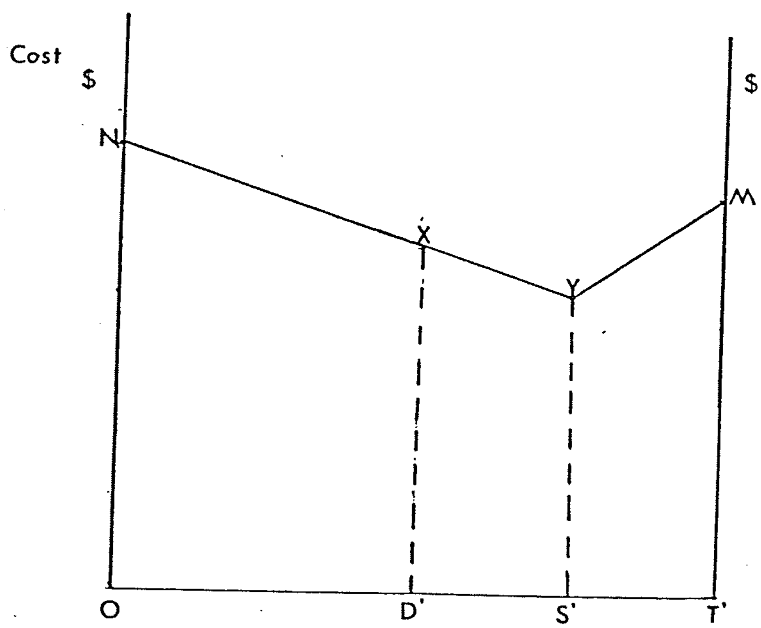
$$OTs = OTd.$$

FIGURES 3.10a and 3.10b

3.10a



3.10b



COST-MINIMIZING REGIONAL LEVEL OF PRODUCTION AND INTER-REGIONAL TRADE, WITH ASSEMBLY COST GREATER THAN DISTRIBUTION COST PER UNIT PRODUCT.

Consequently, the surplus in region 1, D'S' is equal to the deficit in region 2, D"S".

Either regions 1 and 2 can both produce the product from the raw materials produced by within its boundaries of the two regions could engage in trade and import the product. If both regions use up their raw materials to produce the product the result will be region 1 producing OS' and region 2 producing OS". Region 1 will export D'S' of the product to region 2. As shown in figure 3.10a, total cost involved in the country will be OH, the processing cost in region 2, and OK, the processing cost in region 1 plus distribution cost of the production from region 1 to region 2. And OH + OK is equal to S'Y in figure 3.10b.

Region 2 may, instead of importing the final product from region 1, import the raw materials and produce enough product to satisfy its own demand. Hence region 1 will just produce OD' to satisfy its own demand and region 2 will produce OD", of which, D"S" depends on imported raw materials from region 1. The total cost involved in the country will be OH + OL = D'X (in figure 3.10b).

It is also possible for region 1 to produce all the products with taw materials imported from region 2 to supplement its own supply of raw materials. Then the total cost involved will be OM = T'M (in figure 3.10b). Region 2 may also produce all the products with imported raw materials from region 1 to supplement its own supply. Then the total cost involved will be ON (in both figure 3a and b). However it can be seen from figure 3.10b, the least cost combination will be region 1 producing OS' and region

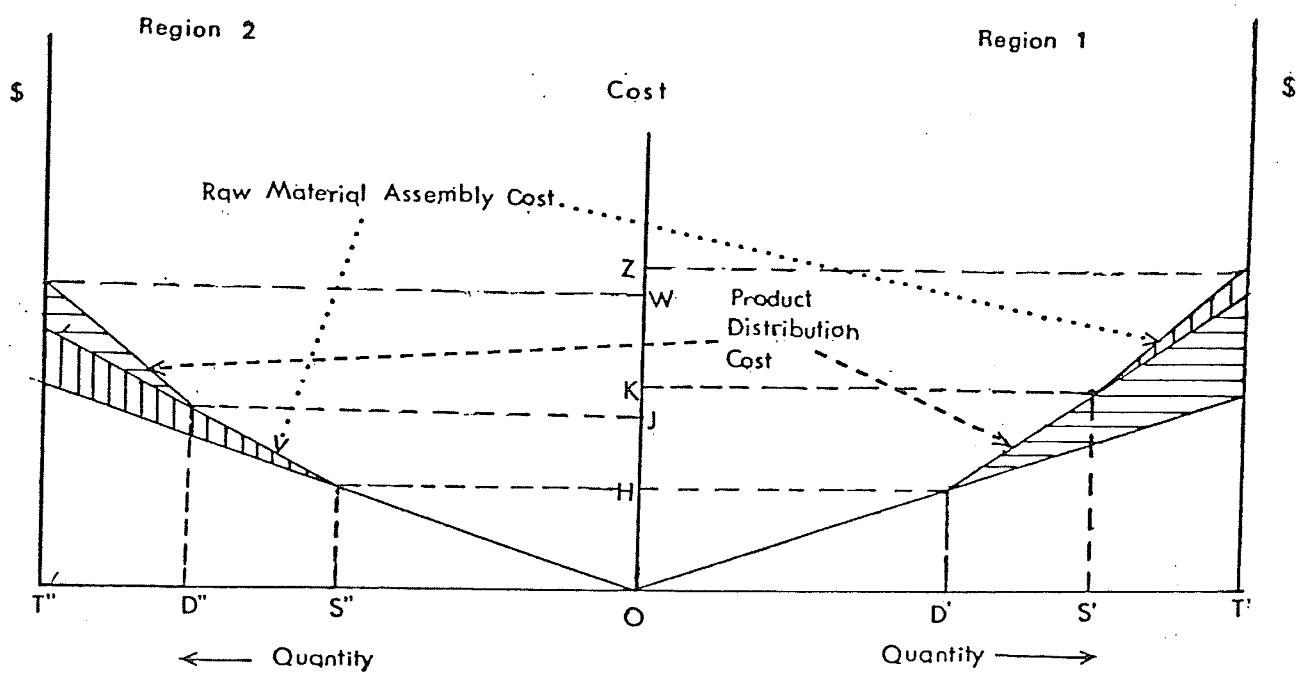
2 producing OS". It means that each of the two regions uses up its own supply of raw materials and the region with surplus raw materials and therefore surplus production export the product to the region with a deficit in the product.

However, the situation changes if the assembly cost is less than the distribution cost. If the assembly cost is now just a quarter of the rate as depicted in figure 3.10a, while the distribution cost remains unchanged, the assembly cost for each unit of the product produced is now half of the distribution cost. The situation is illustrated in figures 3.11a and b. Under this situation, if region 1 produces OS' and region 2 produces OS", and region 1 exports D'S' of the product to region 2, the total cost involved will be OH + OK = S'Y (in figure 3.11b). This is the same as in the previous situation illustrated in figures 3.9a and b. However, if region 1 just produces OD' and exports raw materials to region 2 so that the latter can produce OD" to satisfy all its demand for the product, total cost involved will be OH + OJ = D'V (in figure 3.11b). If region 1 produces all the product, the total cost will be OZ = T'Z (in figure 3.11b) and if region 2 produces all the product, total cost will be OW. Consequently, as shown in the diagrams, the least cost combination is where the total cost involved in D'V which means both regions produce to satisfy their own demand of the product, with region 2, the region deficient in the raw materials importing the raw materials instead of the products.

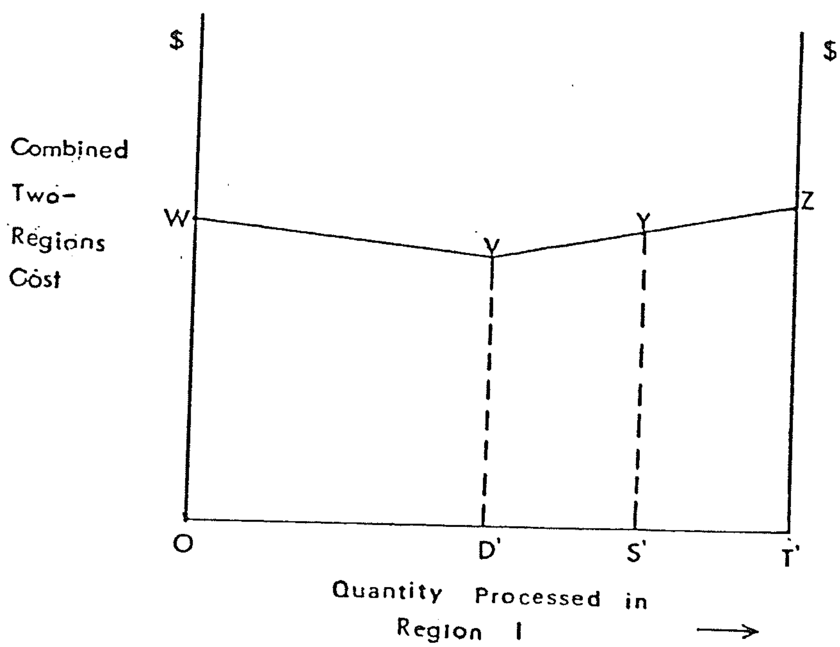
One can relax the assumptions of identical input costs,

FIGURES 3.11 a and b

3.11a



3.11b



COST-MINIMIZING REGIONAL LEVEL OF PRODUCTION AND INTER-REGIONAL TRADE, WITH ASSEMBLY COST LESS THAN DISTRIBUTION COST PER UNIT PRODUCT.

transport costs, the homogeneity of production function, and the restriction on only one production technique and come out with different results. In the real world, it is more likely that the processing costs between regions are not identical. The c. i. f. prices of raw materials in each region are also likely to different as they will be affected by the market of the raw materials. The transport costs may also be different and there is usually more than one production technique available. Different factors will either offset one another or exaggerate the optimality of a region. Furthermore, the location for the raw materials may not be fixed. If the cost in obtaining raw materials by importing them from other regions becomes more expensive, it may encourage local production or extraction of the raw material which will become more economical in comparision with imports. Without given conditions and constraints, therefore, there is no *a priori* reason to presuppose which region will be preferred in producing more or all of the total output.

THE EFFECTS OF FREIGHT SUBSIDY OF FEED GRAINS ON LOCATION OF LIVESTOCK AND MEAT PRODUCTION

With an understanding of the basic theories of location, one can analyse the effects of an input-subsidy on the location of industry. Here the effects of feed freight subsidies on the location of the meat packing industries can be analysed theoretically.

The freight rates of feed grains in Canada for domestic feeding purposes have been under two kinds of subsidies: the Statutory Grain Rates and the Feed Freight Assistance Program. The Statutory Grain Rates are, strictly speaking not a subsidy. However, as the Federal Government grants money each year to the railways as compensation for the non-compensatory rates, the Statutory Grain Rates have the same effects as a subsidy on industrial location.

Discussions on regional specialization earlier in this chapter has shown that factor endowment has a strong influence on regional specialization of production. Since the Prairies are endowed with relative abundance of feed grains vis-a-vis Eastern Canada and B. C., it is conceivable that the Prairies have a comparative advantage in livestock and meat production. However, it has often been argued that the feed freight subsidy, by encouraging export of feed grains from the Prairies, has eroded this advantage of the Prairies and encouraged livestock and meat production in the non-Prairie regions.

From the discussion on location theory, one can see that the freight subsidy on input can affect the optimal location of processing industry. The simplest analytical technique can be used to illustrate this point. It is usually agreed that it takes at least four to five pounds of grains to produce one pound of pork and the amount of grains required for beef is even greater. However, because it is usually more expensive to trade meat than grains as meat needs special storage facilities during transport it is conceivable that the freight cost for meat would be higher than that of grains. Let us assume, therefore, that the freight rates for meat are twice as high as those for feed grains and assuming that all other costs involved are equal in both the raw material site and the market site, the relationship in simple mathematical form would be as follows:

$Wr = 5$, $Wp = 1$,

$Tr = 1$, $Tp = 2$;

whereas Wr = Weight of grains required to produce one unit of meat,

Wp = Weight per unit of meat,

Tr = Transfer cost function of grains,

Tp = Transfer cost function of meat.

Hence $WrTr > WpTp$ and it is cheaper to process at the raw material site and to ship the product to the market than vice versa.

However, if a subsidy on the grains reduces the freight rates on grains by over 60%, then $Tr = 0.4$ and $WrTr < WpTp$. A subsidy of this order would, therefore, shift the production process to the market site. As Western Canada is the grain producing area in Canada and Eastern Canada is the main market for meat, the argument has often been used to suggest that the subsidized grain freight rates have shifted the livestock and meat processing industries from the place they should be most optimally located, that is, in the Prairies, to Eastern Canada. As noted in the previous chapter, studies have been recently completed — one by the Canadian Transport Commission [18] and the other by the Canadian Federation of Agriculture.[19] Both studies only compared the transport costs, and both suggested, though by no means conclusively, that the subsidization did make it cheaper to ship grains to the East rather than shipping meat there from the West. Assuming implicitly that the prices of feed grains paid by Eastern livestock producers had been completely affected by the Statutory Grain Rates and the Feed Freight Assistance Program, the Canadian Federation of Agriculture study estimated that the Subsidization had reduced the price of "index 100 hogs" by $1.41 per hundredweight. However, as mentioned previously, it should be noted that most Eastern cattle, especially those in Ontario, are corn-fed. Hence the cost of Western grains in the East may not have a direct influence.

Furthermore, as mentioned earlier, one cannot count on the transport costs alone. The processing cost together with the possibilities of factor and input substitution have to be considered. Also, these two studies, notably the one by Canadian Federation of Agriculture, did not consider the fact that Eastern Canada has local production of grains itself.

If we lump both livestock production cost which includes

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18. Canadian Transport Commission, <u>Transportation Factors and the Canadian Livestock and Meat Industries</u> (Ottawa: Canadian Transport Commission, 1975).

19. Canadian Federation of Agriculture, <u>The Effect of the New Feed Grains Policy (August 1976) on the Equity of the Relative Transportation Costs of Feed Grains, Livestock and Meat in Canada</u>, Report given on behalf of the Canadian Federation of Agriculture and Canadian Pork Council, 1976.

the cost for feed and livestock slaughtering cost together with the processing costs for satisfying demand for meat in each of the regions, the situation will be similiar to that depicted in figures 3.10 a and b (presented earlier). Here Western Canada with surplus supply of grains can be represented by region 1 and Eastern Canada with a greater demand for meat than its own production of grains can produce can be represented by region 2. Assume the processing costs in both regions are identical and that the costs for assemblying the grains and distributing the meat are equal in both directions and that it costs less, when nothing hampers with the freight rates, to ship meat than to ship the grains required in meat production with these assumption, the least cost situation is that Western Canada produces OS' amount of meat and Eastern Canada produces OS". Both Eastern Canada and Western Canada utilize their own feed grains to produce meat. As Eastern Canada cannot supply enough grains to produce all the meat it demands, it imports meat from Western Canada.

However, with subsidization of the assembly cost in obtaining feed grains from the West to the East so that it is now more expensive to ship meat than the grains required to produce the meat, the situation is then like that depicted in figures 3.11a and b (presented earlier). The least cost combination will then be Western Canada producing OD' amount of meat and Eastern Canada producing OD". Both regions will be self-sufficient in meat production. However, Eastern Canada will import feed grains instead of meat from Western Canada.

Nonetheless, a problem in analysing the effects of freight subsidization of grains on location of meat processing is that the process involves an intermediate product — livestock. The analysis based on Logan and King's model has not taken livestock production into account. The effects of subsidized grain freight rates on interregional price differentials and interregional trade of grains, livestock and meat and the implications for location of livestock and meat production can be illustrated by "back-to-back" diagrams as shown in figures 3.12a and b. The left-hand-side of the diagrams represents Eastern Canada — the deficit region in grains, and the right-hand-side of the diagrams represents Western Canada which has a surplus in grains. Figure 3.12a illustrates the effect of freight subsidy on regional production of grains and interregional trade of feed grains for livestock production. Figure 3.12b illustrates the indirect effect of the feed freight subsidy on regional production and interregional trade of meat.

Had there been no trade between Eastern and Western Canada, the price of grains in Western Canada would be much lower than in Eastern Canada because of supply and demand situations in both regions. Assume that there is no regulation on trade (such as that exercised by the Wheat Board) and that a free market prevails. Then the equilibrium would occur at the price where price of grains in Eastern Canada is equal to price of grains in Western Canada plus transport (including handling) cost in bringing the grains from Western Canada to Eastern Canada. Assume that the transport cost for grains is t as shown in figure 3.12a. The

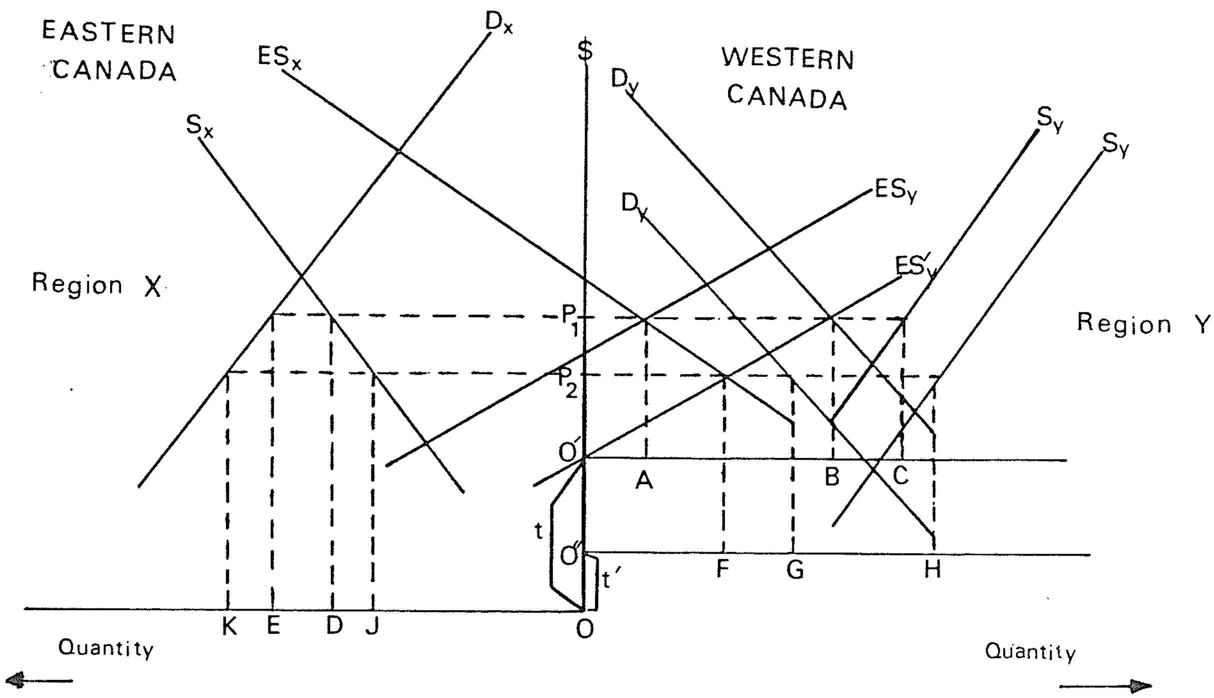

FIGURE 3.12 a EFFECT OF FREIGHT SUBSIDY ON REGIONAL PRODUCTION AND INTER-REGIONAL TRADE OF FEED GRAINS

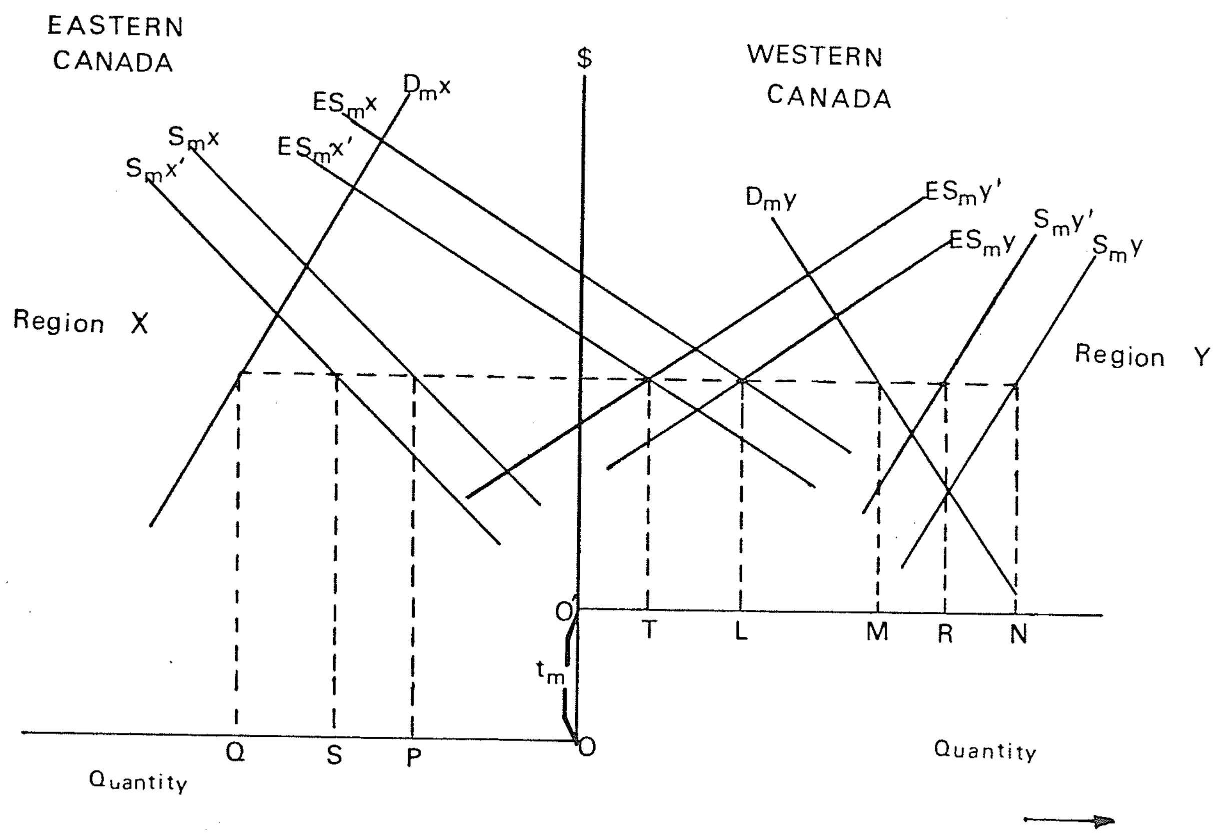

FIGURE 3.12 b EFFECT OF GRAIN FREIGHT SUBSIDY ON REGIONAL PRODUCTION AND INTER-REGIONAL TRADE OF MEAT

amount by which the quantity of grains offered for sale exceeds (or less than) the quantity purchased or demand at various levels of price in each region is represented by the excess demand curve (ESx and ESy in the diagram). The intercept of the excess supply curves indicates the equilibrium price as it points out where the amount of grain surplus in Western Canada is equal to the amount of grain deficit in Eastern Canada. Thus as shown in figure 3.12a, for a transport cost of t the equilibrium c. i. f. price would be at p_1 and OA' amount of grains would be shipped from Western Canada to Eastern Canada. Western Canada would produce O'C amount of feed grains and use up to O'B itself. Eastern Canada would produce OJ amount of feed grains and utilized OE amount of grains to produce livestock.

The situation changes if transport cost is subsidized such that it is now reduced to t'. The excess supply curve for Western Canada ES'y would now intercept the excess supply curve for Eastern Canada ESx at a c. i. f. price of p_2 with an amount of O"F being shipped to X. Grain production in Western Canada would be increased to O"H but the amount used by Western Canada itself would be reduced to O"G. On the other hand, Eastern Canada would reduce its production of feed grains to OJ but with increased import of grains from Western Canada, its total utilization of feed grains would be increased to OK. Consequently, there is a reduction of livestock production in Western Canada but an increase in livestock production Eastern Canada.

However, the effect does not end with livestock production.

Most livestock produced are slaughtered within the province. In hog production, less than one percent of hogs produced in Western Canada moved live to Eastern Canada in 1974. With respect to cattle and calves, it was about sixteen percent.[20] Thus one can safely assume that the supply of livestock for slaughter in Western Canada, at least with respect to hogs, would be reduced by the subsidy. Conversely, the supply of livestock for slaughter in Eastern Canada would be increased. The result would be as shown in figure 3.12b. Assuming that without the subsidy the supply curve of livestock for meat processing in Western Canada would have been Smy, with the subsidy on grains and the reduction in livestock production in Western Canada the supply curve would shift leftwards to Smy'. On the other hand, the supply curve in Eastern Canada, because of increased livestock production, would shift to Smx' which is an increase. Assuming that the increase in Eastern Canada equals the decrease in Western Canada, the total amount of meat produced in both regions would be the same but Western Canada will produce O'R amount of meat which is RN less than what would have been produced had there been no subsidy. Western Canada would export O'T (=MR) amount of meat to Eastern Canada as against exporting O'L (=MN), had there been no subsidy. On the other hand, Eastern Canada would increase its meat production from OP to OS, and reduce its import from QP (=OL) to SP (=O'T). It is possible that the increase in meat production in Eastern Canada

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20. Statistics Canada, Cat. 23-202, 1974.

does not equal to the decrease in Western Canada due to differences in the importance of grains in the ration for livestock feeding. However, the direction of changes in livestock and meat production would be the same as discussed above.

The foregoing diagrammatic analysis does lend support to the view that freight subsidies on feed grains have reduced livestock production and hence meat processing in Western Canada and encourages Western Canada to export feed grains instead of meat while livestock production and meat processing in Eastern Canada have benefitted from the subsidies. However, a diagrammatic analysis alone cannot give a more precise estimate of the effects. Furthermore, a two-regions case is certainly oversimplified. The above diagrammatic anlysis only provides us with a priori reasoning to establish an hypothesis. A spatial equilibrium model using empirical data is necessary to further explore the problem in greater detail.

CHAPTER FOUR

FORMULATION OF THE MODEL

THE HYPOTHESIS

Based on the theoretical discussion in chapter three, it appears that subsidization of feed grain movement has distorted the natural comparative advantage of the Prairies in livestock production. It is, therefore, hypothesised as follows:

1. Subsidization of feed grain movement has encouraged livestock and meat production in the non-Prairie regions at the expense of the Prairies and has resulted in encouraging the non-Prairie regions to import feed grains, rather than meat from the Prairies.

2. Elimination of the subsidies on feed grain movement from the Prairies would ceteris paribus, lead to increases in livestock and meat production in the Prairies and decreases in livestock and meat production in the non-Prairie regions.[1]

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1. It is realised that the subsidization of feed grain movement has been in force for so long a time it has also affected other factors influcing livestock and meat production. These factors include location of breeding herds, location of feed grain production, industrial structure of the feed and meat industries and tradition of the farmers. These factors cannot be changed in a short while and may persist even with the elimination of the feed freight subsidies. Consequently, the elimination of freight subsidy on feed grains is only a necessary, but not sufficient reason for increasing livestock and meat production in the Prairies and decreasing them in the non-Prairie regions.

3. Subsidization of grain movement has increased the total cost of livestock and meat production to the nation as a whole.

DESCRIPTION OF THE MODEL

A linear programming model was formulated to examine the hypotheses. The model formulated is basically an adaptation and simplification of earlier works by Wilson,[2] and Graham and Winter.[3] The model connects the process of using feed grains as an input for livestock production and the process of converting livestock into meat as well as with the transportation of grains, livestock and meat. The problem to be solved is to determine the effects, if any, of changing the freight rates of grains on the optimal locational pattern of livestock and meat production. The model basically seeks to determine the least cost combination with respect to regional production in the production process of converting grains and forages into livestock and then from livestock to meat. By simulating the costs of grains at various levels of the freight subsidy, the model compares the total cost invovled in each situation with those of other situations.

The model concentrates on the production and distribution

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2. A.G. Wilson, The Impact of the Feed Freight Subsidy on the Location of livestock Production, Unpublished Ph. D. dissertation, University of Manitoba, 1978.

3. J. D. Graham and G. R. Winter, "A Spatial Model for Analysis of the Canadian Livestock Feed and Livestock Product Sectors". Chapter 10 in G. R. Winter, Protein Effiency in Canada (montreal: Canadian Livestock Feed Board, 1974), pp. 309-23.

of beef and pork and does not consider the production of poultry products, dairy products, veal and mutton and lamb. The production of poultry and dairy products is usually more market-oriented and is less affected by changes in freight subsidies. Production of veal depends much on production of dairy cattle which is highly market-oriented and protected by institutional factors governing the production of dairy products. Mutton and lamb production are of lesser importance in Canada.

Diagrammatic Illustration of the Model

The model may be illustrated by using diagrams 4.1 and 4.2. Diagram 4.1 illustrates the interaction between feed grains, forages, other inputs in livestock production,[4] livestock and meat in a region. Diagram 4.2 show specifically the inter-relationships between different classes of cattle, dairy products, veal, fed beef and non-fed beef.

As illustrated in diagram 4.1, the production process of producing livestock for slaughter into meat can be divided into three stages — the input stage, the intermediate stage, and the output stage. At the input stage there are the feed grains, forages and other inputs in livestock production as shown respectively in boxes 1, 2 and 3. Feed grain supply to a region included locally produced feed grains, which is represented by LG_i in the model (the suffix i is a letter representing a region). From this local

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4. Other inputs for livestock production include pasture, capital costs, interest, labour and feed supplements.

Diagram 4.1 Inter-relationships Among Feed Grains, Livestock and Meat, One Region Case

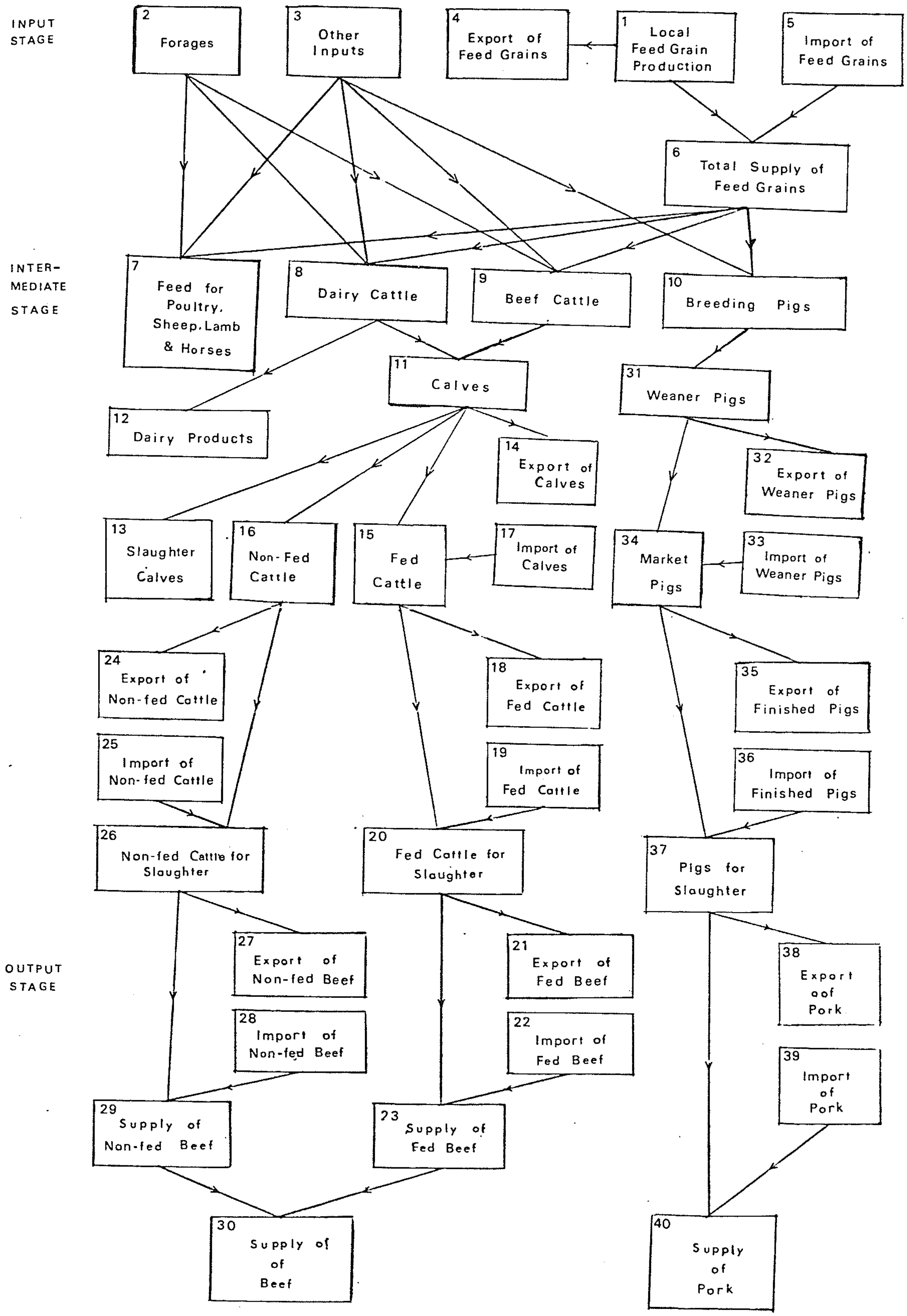
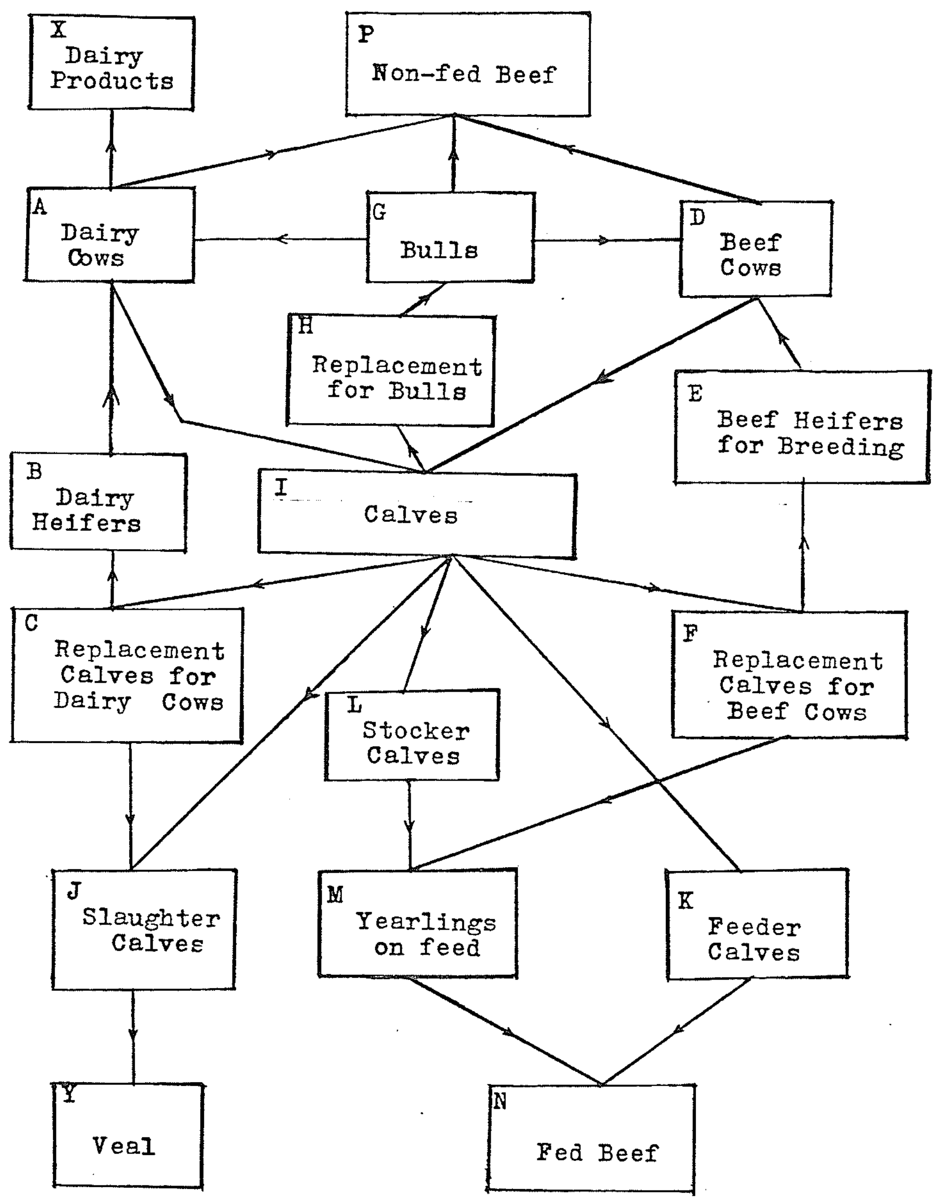


Diagram 4.2 Inter-relationships Between Different Classes of Cattle and Cattle Products



supply of feed grains one has to subtract the quantity of feed grains exported to other regions (box 4) which is represented by TG_{ij} in the model (the letter j represents other regions). Regions deficient in feed grains have to import feed grains from other region (box 5). This is represented by TG_{ji} in the model. Hence the total supply of feed grains to a region (box 6) is equal to $LG_i - TG_{ij} + TG_{ji}$.

Besides feed grains, forages and other inputs are also required as inputs for livestock production. In the model they are assumed to be supplied within the region. Inter-regional movement of forages is relatively small and inter-regional movement of other inputs is beyond the scope of this study. Forage supply in a region is represented by R_i. The amount of other inputs required for each type of livestock production is expressed as a cost coefficient for each production process.

The inputs are used to produce the intermediate products. The relationships between feed grains forages and each type of livestock production are described in further details later in this chapter. The production of poultry, sheep, lamb and horses is not considered in the model. The amount of feed inputs needed for their production (box 7) is subtracted from the total supply of feed grains in each region. The remaining feed grains are assumed to be available for consumption by dairy cattle, beef cattle, and pigs.

The inter-relationships among classes of cattle are further illustrated in diagram 4.2. The model distinguishes between breeding herds and their replacements, cattle on feed, and unweaned calves. The breeding herd for dairy cattle includes dairy cows (box A in diagram 4.2), represented in the model by $MILKCOW_i$, dairy heifers (box B), represented by $MILKHEI_i$, and female weaned dairy calves reserved for replacement of breeding herd (box C), represented by $MILKCALF_i$. Similarly, breeding herd for beef cattle included beef cows (box D), represented by $BEEFCOW_i$, beef heifers for replacement purpose (box E), represented by $BEEFHEI_i$, and weaned female beef calves reserved for replacement purpose (box F), represented by $BEEFCALF_i$. In addition, there are bulls (box G). Bulls serving dairying cows and beef cows are not distinguished in the model and are represented by $BULL_i$. Weaned calves reserved as replacements for bulls (box H) are represented by $BULCALF_i$.

Going back to diagram 4.1, both dairy cattle (box 8) and beef cattle (box 9) produce calves (box 11 in diagram 4.1 and box I in diagram 4.2). The model does not distinguish between beef from dairy cattle and beef from beef cattle and hence it does not distinguish calves from dairy origin or from beef origin. All calves before weaning are represented in the model by $CALF_i$. Dairy cattle produce dairy products (box 12 in diagram 4.1 and box X in diagram 4.2) which are not considered in the model.

Calves will either be slaughtered (box 13 in diagram 4.1 and box J in diagram 4.2), or exported to other regions (box 14 in diagram 4.1), or eventually be fed (box 15), or become non-fed cattle (box 16). Non-fed cattle are those that are kept for replacement purposes. Slaughtered calves produce veal (box Y in diagram 4.2) which is not considered in the model. The number of weaned calves and unweaned calves in a region marketed for slaughter are deducted from the total number of weaned calves which are not reserved as replacement calves. It is also assumed that a region will supply itself with the replacement herds. Fed cattle includes those weaned calves available for feeding shortly after weaning (box K in diagram 4.2), as represented by $CALFFD_i$; or those put in the stocker program (box L) and fattened as yearlings (box M), which are represented by $CATTSK_i$ and $CATTED_i$ respectively. Excess replacement calves which are not used as breeding cows will be killed (mostly female dairy calves, as in box J), or be fattened as yearlings (mostly female beef calves, as in box M). The movements of calves to be fed in other regions is represented by $TCALFD_{ij}$, while calves to be fed in the same region are represented in the model by $TCALFD_{ii}$. Similarly, movements of yearlings to be fattened in other regions are represented by $TCATFD_{ij}$. However, yearlings to be fed in the same region are not specifically identified but can be calculated from equations showing relationship between stocker calves and feeder cattle.

Finished feeder cattle will eventually be slaughtered. The region may export some of its finished cattle (box 18 in diagram 4.1), or have to import fed cattle from other regions for slaughter (box 19). Movements of finished cattle from one region to other regions are represented by $TCATSL_{ij}$. The total number of finished feeder cattle slaughtered in a region (box 20), which includes finished feeder cattle supplied locally and those imported for slaughter, is represented by $SLCATTL_i$.

Culled bulls and cows constitute the non-fed cattle slaughtered. Culled replacement heifers are included in the culled cows. Some non-fed cattle may be exported (box 24). The region may, on the other hand, import non-fed cattle for slaughter (box 25). Total supply of non-fed cattle, therefore, includes local supply of non-fed cattle and ijport of non-fed cattle from other regions (box 26). Movements of bulls from one region to the other regions are represented by $TBULSL_{ij}$. The total number of bulls slaughtered in a region is represented by $SLBULL_i$. Movements of cows from one region to the other regions are represented by $TCOWSL_{ij}$. The total number of culled cows in a region is represented by $SLCOW_i$.

Meat from fed cattle is designated as fed beef (box N in diagram 4.2) while meat from non-fed cattle are designated as non-fed beef (box P). Some fed beef produced in a region may be exported (box 21 in diagram 4.1), or the region may have to import fed beef (box 22). The imported fed beef, together with local supply of fed beef, form the total fed beef supply to the region (box 23). The movements of fed beef from one region to the other regions are represented by $TFEBEF_{ij}$. Similarly, non-fed beef produced in a region may be exported (box 27) or consumed locally. The region may also have to import non-fed beef (box 28). Total supply of non-fed beef to a region includes the local supply of non-fed beef and the imported non-fed beef (box 29). The movements of non-fed beef from one region to other regions are represented by $TNFBEF_{ij}$.

The production process in hogs is much simpler than that in cattle. Because only a relatively small number of boars is needed in servicing the sows, and unlike cattle, the nutrient requirements of boars and sows are not that different, both sows and boars are grouped together as breeding herd for pigs (box 10 in diagram 4.1) represented by $PIGBHD_i$ in the model. The breeding pigs produce weaner pigs (box 31). Weaner pigs may be exported (box 32) or be fed locally within the region. The region may also import weaner pigs (box 33). Imported weaner pigs for feeding plus the local supply of weaner pigs form the total supply of market pigs (box 34).

Due to the much shorter lifespan of pigs, as compared to cattle, and similar nutrition requirement for pigs designated for replacement of breeding pigs and pigs raised for market as slaughter pigs, there is no special category for replacements needed in each region for the breeding herd in the model. However, the number of replacements needed in each region is included in equations showing relationships between pigs produced for market and pigs produced for replacement. Pigs produced for marketing for slaughter are, for convenience, termed as "market pigs" and are represented by $PIGMKT_i$. Some finished market pigs may be exported (box 35). On the other hand, the region may have to import market pigs for slaughter (box 36). Imported market pigs, together with local supply of market pigs for slaughter form the total supply of market pigs for slaughter in a region. This is represented by $SLPIGMT_i$ in the model. Culled breeding pigs are not specifically identified in the model but are included in equations representing total requirement and production of pork in a region. Culled breeding pigs and slaughtered market pigs in a region formed the total number of pigs slaughtered (box 37). Movements of pork from one region to other regions are represented by $TPORK_{IJ}$.

Consequently, in the final stage of the model, supply of beef to a region (box 30) includes both fed beef and non-fed beef. Both fed beef and non-fed beef included local production in the region and for the beef deficit regions, imported beef from other regions. Similarly, supply of pork to a region includes local production of pork and pork imported from other regions.

As mentioned previously in this chapter, the objective of the mathematical model formulated in this study is to find the minimum cost involved in all the stages of the production processes in cattle and hogs. This would indicate with each given set of prices of feed grains and grain transportation, the regional levels of production of cattle, hogs, beef and pork and the patterns of inter-regional transportation of grains, cattle, hogs, beef and pork.

BASIC ASSUMPTIONS OF THE MODEL

The following assumptions were made in developing the model:

1. Canada was divided into seven regions. Prince Edward Island, Nova Scotia and New Brunswick were combined as one region —

the Maritimes while each of the other provinces, except Newfoundland, was treated as a region. Newfoundland was not considered in the study because of the data required for the study were not available. Similarly, Yukon Territories and North West Territories were not considered for lack of data and their relatively negliglible number of livestock. Each region was considered as a point in space and the most populous center in each region, which indicates the center of meat consumption, was chosen to represent the region. However, there was one exception to this rule. Calgary, rather than Edmonton, was chosen to represent Alberta because while Calgary has a somewhat smaller population, it is much closer than Edmonton to the centers of livestock production in the province. It was assumed that there is no transportation cost within a region.[5]

The centers chosen were Halifax for the Martitimes, Montreal for Quebec, Toronto for Ontario, Winnipeg for Manitoba, Regina for Saskatchewan, Calgary for Alberta and Vancouver for B. C..

2. The crop year 1976-77 was taken as the base year for analysis, because, as mentioned preciously, it was from this year onwards that the present Feed Grains Policy and the new Feed Freight Assistance Program took Effect. The life cycles of the animals naturally do not coincide with a crop year. However, assuming that the mix of age and classes was constant throughout the year, the

5. This assumption is mainly for simplification purpose. Admittedly there are transportation costs within a region. However, it would be a major task by itself to estimate transportation costs of grains, livestock and meat within every region.

production process of each type of livestock was converted to an equivalent of what would happen within the base year period.[6]

3. All cost activities were assumed to be constant at the given level in the base year.

4. The spatial patterns of production of poultry, sheep and other grain-consuming animals not considered in the study were assumed to be constant at the given level in the base year.

5. It was assumed that there is no difference between the same kind of meat product produced at different locations and there is no difference between the meat of fed steers and heirfers, and between non-fed cattle of different types.

6. Feed grains were assumed to be mutually substitutable and their price relationship were assumed to be based on their respective nutritional values.

7. Perfect competition was assumed to exist at all levels of the production processes.

MATHEMATICAL FORMULATION OF THE MODEL

As would be recalled from previous discussion in the chapter, the model aims to minimize the total cost involved in transforming feed grains and forages into cattle and hogs, and then into beef and pork. Consequently, the objective function is to minimize the cost in each and every region in obtaining feed

6. For example, in both cattle and hog production, some of the breeding herds would have to be culled in the crop year. The model assumes that the age of the breeding herds and the replacement herds are evenly distributed and when one of the breeding herds is culled, one animal from the replacement herds will replace it immediately.

grains for cattle and hog production, which includes the cost of local supply of feed grains and imported feed grains; the cost of forages; the cost of producing calves; the cost of transporting feeder calves; the cost of putting the calves in the stocker program; the cost of transporting yearlings for fattening; the cost of feeding feeder calves; the cost of feeding yearlings; the cost of transporting finished cattle; the cost of transporting cows for cull; the cost of transporting bulls for cull; the cost of transporting fed beef; the cost of transporting non-fed beef; the cost of producing breeding pigs; the cost of transporting weaned pigs; the cost of producing market pigs; the cost of transporting slaughter pigs and the cost of transporting pork. Based on the concentual and diagrammatical discussion of the inter-relationships as well as the assumptions noted above, the mathematical model is presented as below:

The model minimizes the objective function OBJF:

$$\sum_i a_i LG_i + \sum_i \sum_j b_{ij} TG_{ij} + \sum_i c_i R_i + \sum_i d_i CALF_i$$

$$+ \sum_i \sum_j e_{ij} TCALFD_{ij} + \sum_i f_i CATTSK_i + \sum_i \sum_j g_{ij} TCATFD_{ij}$$

$$+ \sum_i h_i CALFFD_i + \sum_i k_i CATTFD_i + \sum_i \sum_j l_{ij} TCATSL_{IJ}$$

$$+ \sum_i \sum_j m_{ij} TCOWSL_{ij} + \sum_i \sum_j n_{ij} TBULSL_{ij}$$

$$+ \sum_i \sum_j q_{ij} TFEBEF_{ij} + \sum_i \sum_j r_{ij} TNFBEF_{ij} + \sum_i s_i PIGBHD_i$$

$$+ \sum_i \sum_j t_{ij} THOGWN_{ij} + \sum_i u_i PIGMKT_i + \sum_i \sum_j THOGSL_{ij}$$

$$+ \sum_i \sum_j TPORK_{ij}$$

Subject to the following constraints:

$FEDGRN_{i=1,4,5}$ (Feed Grain Requirement for Regions 1, 4, 5)

$$LG_i + \sum_j TG_{ji} - \sum_j TG_{ij} - 1.25\ MILKCOW_i - 0.72\ MILKHEI_i$$
$$-0.7425\ MILCALF_i - 0.125\ BEEFCOW_i - 0.2\ BEEFHEI_i$$
$$-0.3\ BEFCALF_i - 0.65\ BULL_i - 0.4\ BULCALF_i - 1.25\ CALFFD_i$$
$$-0.3\ CATTSK_i - 0.85\ CATTFD_i - 1.15\ PIGBHD_i$$
$$-0.275\ PIGMKT_i \geq 0$$

$FEDGRN_{i=6,7,8,9}$ (Feed Grain Requirement for Regions 6, 7, 8, 9)

$$LG_i + \sum_j TG_{ji} - \sum_j TG_{ij} - 1.675\ MILKCOW_i - 0.72\ MILKHEI_i$$
$$- 0.7425\ MILCALF_i - 0.125\ BEEFCOW_i - 0.2\ BEEFHEI_i$$
$$- 0.3\ BEEFCALF_i - 0.65\ BULL_i - 0.4\ BULCALF_i$$
$$- 1.61\ CALFFD_i - 0.3\ CATTSK_i - 1.1\ CATTFD_i - 1.15\ PIGBHD_i$$
$$- 0.275\ PIGMKT_i \geq 0$$

$ROUGHA_{i=1,4,5}$ (Forage Requirement for Regions 1, 4, 5)

$$R_i - 4.055\ MILKCOW_i - 1.65\ MILKHEI_i - 1.65\ MILCALF_i$$
$$- 2.5\ BEEFCOW_i - 2.5\ BEEFHEI_i - 1.2\ BEFCALF_i - 4.05\ BULL_i$$
$$- 1.2\ BULCALF_i - 1.25\ CALFFD_i - 1.211\ CATTSK_i$$
$$- 0.85\ CATTFD_i \geq 0$$

$ROUGHA_{i=6,7,8,9}$ (Forage Requirement for Regions 6, 7, 8, 9)

$$R_i - 3.375\ MILKCOW_i - 1.65\ MILKHEI_i - 1.65\ MILCALF_i$$
$$- 2.5\ BEEFCOW_i - 2.5\ BEEFHEI_i - 1.2\ BEFCALF_i - 4.05\ BULL_i$$
$$- 1.2\ BULCALF_i - 0.69\ CALFFD_i - 1.211\ CATTSK_i$$
$$- 0.4675\ CATTFD_i \geq 0$$

$LOGRAIN_i$ (Local Grain Production at region i)

$LG_i \leq$ Given amount of feed grain produced in region i minus the amount consumed by poultry and livestock other than cattle and pigs.

$NUDACOW_i$ (Number of Dairy Cows at region i)

$MILKCOW_i$ = Given number of dairy cows in region i.

$NUDAHEI_i$ (Number of Dairy Heifers at Region i)

$MILKHEI_i$ = Given number of dairy heifers in region i.

$NUDACAF_i$ (Number of Replacement Calves for Dairy Purpose at Region i)

$$- 1.25\ MILKHEI_i + MILCALF_i \geq 0$$

$NUMBCOW_i$ (Number of Beef Cows at Region i)

$BEEFCOW_i$ = Given number of beef cows in region i)

$BCOWHEI_i$ (Ratio Between Beef Cows and Beef Heifer for Replacement at region i)

$$- 0.19\ BEEFCOW_i + BEEFHEI_i \geq 0$$

$NUBECAF_i$ (Number of Replacement Calves for Beef Cows at Region i)

$$- 1.25\ BEEFHEI_i + BEFCALF_i \geq 0$$

$NUMBULL_i$ (Number of Bulls at Region i)

$BULL_i$ = Given number of bulls in region i

$COWCALF_i$ (Number of Calves Born at Region i)

$$- 0.9\ MILKCOW_i - 0.9\ BEEFCOW_i + CALF_i \geq 0$$

$CALFMKT_i$ (Number of Calves Marketed at Region i)

$$- 0.8\ MILCALF_i - BEFCALF_i - 1.0\ BULCALF_i + 0.99\ CALF_i$$

$$- \sum_j TCALFD_{ij} - CATTSK_i$$

$\geq$ Number of calves marketed for slaughter and export

$BULREPL_i$ (Ratio Between Bulls and Calves Reserved for Replacement of Bulls at Region i)

$- BULL_i \;+\; 0.27\ BULCALF_i \qquad \geq \quad 0$

$CALFEED_i$ (Number of Feeder Calves in Feedlots at Region i)

$TCALFD_{ii} \;+\; \sum_j TCALFD_{ji} \;-\; CALFFD_i \qquad \geq \quad 0$

$STOCFIN_i$ (Number of Stocker Cattle to be Finished at Region i)

$0.2\ BEFCALF_i \;+\; 0.99\ CATTSK_i \;-\; \sum_j TCATFD_{ij}$

$+ \sum_j TCATED_{ji} \;-\; CATTFD_i \qquad \geq \quad 0$

$CATTFIN_i$ (Number of Finished Feeder Cattle at Region i)

$0.98\ CALFFD_i \;+ 0.99\ CATTFD_i \;-\; \sum_j TCATSL_{ij}$

$+ \sum_j TCATSL_{ji} \;-\; SLCATTL_i \qquad \geq \quad 0$

$SLAUCOW_i$ (Cows for Slaughter at Region i)

$- 0.23\ MILKCOW_i \;-\; 0.18\ BEEFCOW_i \;-\; \sum_j TCOWSL_{ij}$

$+ \sum_j TCOWSL_{ji} \;+\; SLCOW_i \qquad \leq \quad 0$

$SLAUBUL_i$ (Bulls for Slaughter at Region i)

$- 0.2647\ BULL_i \;-\; \sum_j TBULSL_{ij} \;+\; \sum_j TBULSL_{ji}$

$+ SLBULL_i \qquad \leq \quad 0$

$CAPACAT_i$ (Total Slaughter of Cattle at Region i)

$SLCATTL_i \;+ SLCOW_i \;+ SLBULL_i$

$\leq$ Given capacity for cattle slaughter in region i.

$BEEFPRD_i$ (Beef Production and requirement at Region i)

$0.58 SLCATTL_i \;+ 0.525\ SLCOW_i \;+\; 0.75\ SLBULL_i \;-\; \sum_j TFEBEF_{ij}$

$+ \sum_j TFEBEF_{ji} \;-\; \sum_j TNFBEF_{ij} \;+\; \sum_j TNFBEF_{ji}$

$\geq$ Beef requirement at region i.

$FEDBEEF_i$ (Demand for Fed Beef at Region i)

$0.58\ SLCATTL_i \;-\; \sum_j TFEBEF_{ij} \;+\; \sum_j TFEBEF_{ji}$

$\geq$ 70% of beef requirement at region i.

$NFEDBEF_i$ (Demand for Non-fed Beef at Region i)

$0.525\ SLCOW_i + 0.75\ SLBULL_i - \sum_j TNFBEF_{ij} + \sum_j TNFBEF_{ji}$

$\geq$ 25% of beef requirement at region i.

$NUMPIBH_i$ (Number of Breeding Herd for Pigs at Region i)

$PIGBHD_i$ = Given number of basic herd of pigs in region i.

$PIMABAS_i$ (Ratio Between Breeding Pigs and Market Pigs at region i)

$14.0\ PIGBHD_i - \sum_j THOGWN_{ij} + \sum_j THOGWN_{ji} - PIGMKT_i \geq 0$

$PIGLEFT_i$ (Pigs for Slaughter and Replacement at Region i)

$- 0.5\ PIGBHD_i + 0.94\ PIGMKT_i - \sum_j THOGSL_{ij} + \sum_j THOGSL_{ji}$

$-SLPIGMT_i \geq 0$

$CAPAPIG_i$ (Total Pig Slaughter at Region i)

$0.4899\ PIGBHD_i + SLPIGMT_i$

$\leq$ Capacity of pig slaughter at region i.

$PORKPRD_i$ (Requirement and Production of Pork at Region i)

$0.1117\ PIGBHD_i + 0.13\ SLPIGMT_i - \sum_j TPORK_{ij} + \sum_j TPORK_{ji}$

$\geq$ Pork requirement at region i.

For

i = 1, 4 .... 7.

j = 1, 4 .... 7.

$i \neq j$.

Whereas:

LG_i = Local feed grain supply at region i.

TG_{ij} = Shipment (export) of feed grains from region i to region j.

Tg_{ji} = Shipment (import) of feed grains from region j to region i.

R_i = Froage Supply at region i.

$CALF_i$ = Number of calves at region i.

$TCALFD_{ji}$ = Shipment (export) of feeder calves from region i to region j.

$TCALFD_{ji}$ = Shipment (import) of feeder calves from region j to region i.

$TCALFD_{ii}$ = Feeder calves produced at region i staying on region i for feeding.

$CATTSK_i$ = Stocker calves at region i.

$CALFFD_i$ = Calves on feed at region i.

$TCATFD_{ij}$ = Shipment (export) of feeder cattle from region i to region j.

$TCATFD_{ji}$ = Shipment (import) of feeder cattle from region j to region i.

$CATTFD_i$ = Cattle (yearlings) on feed at region i.

$TCATSL_{ij}$ = Shipment (export) of finished feeder cattle from region i to region j.

$TCATSL_{ji}$ = Shipment (import) of finished feeder cattle from region j to region i.

$SLCATTL_i$ = Finished feeder cattle slaughtered at region i.

$MILKCOW_i$ = Milkcows at region i.

$MILKHEI_i$ = Milk heifers at region i.

$MILCALF_i$ = Female replacement calves for dairy production at region i.

$BEEFCOW_i$ = Beef cows at region i.

$BEEFHEI_i$ = Beef heifers (for replacement purpose) at region i.

$BEFCALF_i$ = Female replacement calves for beef cattle production at region i.

$BULL_i$ = Bulls at region i.

$BULCALF_i$ = Male replacement calves for bulls.

$TCOWSL_{ij}$ = Shipment (export) of cows for cull from region i to region j.

$TCOWSL_{ji}$ = Shipment (import) of cows fro cull from region j to region i.

$SLCOW_{i}$ = Cows slaughtered at region i.

$TBULSL_{ij}$ = Shipment (export) of bulls for cull from region i to region j.

$TBULSL_{ji}$ = Shipment (import) of bulls for cull from region j to region i.

$SLBULL_{i}$ = Bulls slaughtered at region i.

$TFEBEF_{ij}$ = Shipment (export) of fed beef from region i to region j.

$TFEBEF_{ji}$ = Shipment (import) of fed beef from region j to region i.

$TNFBEF_{ij}$ = Shipment (export) of non-fed beef from region i to region j.

$TNFBEF_{ji}$ = Shipment (import) of non-fed beef from region j to region i.

$PIGBHD_{i}$ = Breeding herd of pigs at region i.

$THOGWN_{ij}$ = Shipment (export) of weaned pigs from region i to region j.

$THOGWN_{ji}$ = Shipment (import) of weaned pigs from region j to region i.

$PIGMKT_{i}$ = Market pigs at region i.

$THOGSL_{ij}$ = Shipment (export) of market pigs for slaughter from region i to region j.

$THOGSL_{ji}$ = Shipment (import) of market pigs for slaughter from region j to region i.

$SLPIGMT_{i}$ = Market Pigs slaughtered at region i.

$TPORK_{ij}$ = Shipment (export) of pork from region i to region j.

$TPORK_{ji}$ = Shipment (import) of pork from region j to region i.

a, b, c .... t, u, v = Cost coefficients for the corresponding activities respectively. The cost coefficients for $CALF_i$, $CALFFD_i$, $CATTFD_i$, $PIGBHD_i$ and $PIGMKT_i$ denote costs other than the cost of feed grains and forage consumption for these animals. The cost for $CALF_i$ also includes costs other than feed grains and forage for basic herd and replacement herd production.

The numerals for i and j denote the different regions:

1 = Atlantic Provinces (Nova Scotia, P. E. I. and New Brunswick),

4 = Quebec, 5 = Ontario, 6 = Manitoba,

7 = Saskatchewan, 8 = Alberta, 9 = B. C..[7]

In the process of data collection and determination of coefficients, some other assumptions (besides the basic assumptions) had to be made. They are discussed below while explaning the data used in the model. The model is admittedly of only partial or even particular equilibrium in nature.

Alternative Situations

To compare the different spatial patterns resulting from

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7. Originally, the model was designed to have Nova Scotia, P. E. I. and New Brunswick as separate regions. Hence the numbers 1, 2 and 3 were assigned to each of these three provinces. It was the lack of data that caused combining these three provinces into one region. Hence number 1 was used to denote these three provinces together. Number 2 and 3 were left vacant so that with sufficient data for each of these provinces, each of them could be studied separately without affecting the numerical symbols used to represent the other provinces.

changes in grain freight subsidy, the model analysed alternative situations. First, there were the BUY and OWN conditions. The BUY condition simulated the situations under which the Prairie livestock producers had to buy grains from elevators. The OWN condition simulated the situations under which the Prairie livestock producers fed their own grains to their livestock. As a result, elevator charges were included in the cost of grains in the Prairies under the BUY condition but they were not included in the cost of grains in the Prairies under the OWN condition.

Under each of these two conditions, there were four different situations simulating the grain prices and grain freight rates at different levels of grain freight subsidy.[8] These four situations were: (1) The initial situation under the old F.F.A.P.; (2) The situation under the new F.F.A.P.; (3) The situation under the new F.F.A.P. with the elimination of Statutory Grain Rates;[9] and (4) The situation under which both F.F.A.P. and Statutory Grain Rates were eliminated.

For the last three situations, certain restrictions on

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8. In the study, the term "grain freight subsidy" was used to include subsidization of grain freight rates in the form of both the F.F.A.P. and the Statutory Grain Rates. Changes in the levels of grain freight subsidy would affect not only the transportation costs of grains from the Prairies and Ontario to other parts of Canada but also the prices of grains in the Prairies.

9. In the study, the pharse "elimination of Statutory Grain Rates" refers to elimination of the Statutory Grain Rates; the feed grains exported from the Prairies for domestic uses were assumed to be moved under cost-of-service rates. The cost-of-service rates would be equal to the average variable cost of the railways in moving the grains.

the constraints were relaxed to simulate possible changes in a region's capacity to produce both livestock and meat production which would occur as a result of the changes in grain freight subsidy. First, constraints on the basic herd — beef cows in cattle and breeding pigs were relaxed. Each region was allowed to reduce its basic herds by any amount or to increase them by ten percent.[10] Then the constaints on slaughter capacities for cattle and pits were also relaxed and no restriction was stipulated on the number of cattle and pigs for each region to slaughter.[11]

For simplification, each of the different situations was identified by numbers 1 to 4 and letters a to f. The numbers 1, 2, 3 and 4 were used to denote the four cost situations due to changes in the level of grain freight subsidy corresponding

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10. The purpose of relaxing these constraints was basically to look for the trend in relocation of basic herds rather than to predict the exact production pattern that would emerge. There are limitations in physical resources such as forage availablity, attitudes to changes by farmers which should be considered in predicting the exact production pattern in each region that would emerge in the long run.

The number of basic herds at the initial stage of the model was actually not being utilized most efficiently and there were excess capacities in some regions. The relaxation allowed to predict the trend in rationalizing the spatial pattern of production that would take place in one or two years. Admittedly, ten percent is an arbitrary figure. It was chosen just to limit changes in the spatial pattern so that they would not affect factors other than grain supply in livestock production.

11. The purpose of this relaxation of constraints was to estimate the effects of limitations of slaughter capacities in a region on the spatial pattern of cattle and hog production and the interaction between slaughter capacities and the changes in grain freight subsidy. It was assumed that unlike livestock farmers, the entrepreneurs in the meat processing industry can enlarge the meat packing capacities indefinitely with no limitation in physical resources.

respectively to the situations under the old F.F.A.P., the new F.F.A.P., the new F.F.A.P. with elimination of the Statutory Grain Rates, and the complete elimination of both F.F.A.P. and Statutory Grain Rates. The letters a and b were used to represent the short run situations (without relaxation of constraints on basic herds and slaughter capacity) under the BUY and OWN condition respectively. Latter c was used to represent the situations under the BUY condition with relaxation of the constraints on basic herds. Letter d was used to represent the situations under the BUY condition with relaxation of the constraints on both basic herds and slaughter capacities. Letter e was used to represent the situations under the OWN condition with the constraints on basic herds relaxed. Letter f was used to represent the situations under the OWN condition with contraints on basic herds and slaughter capacities both relaxed.

A total of twenty alternative situations were built in the model.

DETERMINATION OF COEFFICIENTS IN THE OBJECTIVE FUNCTION

Price of Grains

Since May 1976, feed grain pricing in Canada has been based on the cost of U. S. corn landed at Montreal. Canadian feed grains are priced at their nutritional values in relation to corn.[12]

Grain prices in the 1976-77 crop year were used in the model. It did not mean that the grain prices in 1976-77 were necessarily in equilibrium or prices indicating the normal situation. The use of 1976-77 prices can be justified on this following grounds: (1) it was from this year onwards that the new feed grain policy and new F.F.A.P. took effect. With the new feed grain policy, the regional differences in grain prices were more reflective of differences in grain transportation costs. (2) grain prices was particularly high from 1973 to 1976 and it was from 1976-77 onwards that the prices declined; and (3) while the prices in the late seventies may be more indicative of the equilibrium situation, they are not available at the time of the study.

In the model, the price of No. 1 feed barley was used to represent the price of grains at all regions except for Ontario because barley is the dominant feed grain in Western Canada and the major imported grain in Eastern Canada.[13] For Ontario, however, the price for No. 2 yellow corn at Chatham was used due to its dominant position at that province.[14]

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12. See Appendix 1-A and H. Garth Coffin. "The Case for Formula Pricing of Canada's Feed Grains", Paper presented at the Canadian Agricultural Economics Society Worshop in Banff, March 14-15, 1977.

13. The dominant feed grain used in Quebec and the Maritimes is oats, and it usually has a price higher than barley on a nutritional basis.

14. The prices of barley and corn was based on the 1976-77 annual average figures published in Canada Department of Agriculture, Market Commentary, Grains and Oilseeds, December '77 (Ottawa: Canada Department of Agriculture, 1977), table 8, p. 29.

In actual practice, prices of feed wheat, barley and corn are generally quite closely related to their respectively nutritional value. However, prices of feed oats are often higher than its relative nutritional value. The use of barley price to represent feed grain prices would, therefore, tend to underestimate feed grain prices in Quebec and the Maritimes, since oats is more important than barley in these regions.

The price of barley in each region was determined by estimating its farm-gate price based on the published price in Thunder Bay. The price in Thunder Bay was based, in turn, on the price at Montreal less transportation and handling between Thunder Bay and Montreal. To estimate prices of locally produced grains in the Maritimes and Quebec, it was assumed that the grains produced locally can be sold at a price equal to the price of imported Western grains and hence the opportunity cost for using the grains would be the price of imported Western grains less handling charges at the receiving end. The price of imported Western barley was estimated by adding freight and handling charges from Thunder Bay to the Maritimes and Quebec.

For the Prairie region, it was assumed that a livestock producer there can have the option to either grow his own grains and feed them to his livestock or he can feed his livestock with grains purchased from the elevators. If he buys grain from the elevators, the price he pays will be equal to the price of grains at Thunder Bay less transportation cost from his location to Thunder Bay which includes the Prairie elevator charges. However, if he feeds the grains he grows to the livestock, the cost for the grains to him will be the opportunity cost for not selling the grains to the elevators, which should be equal to the price for grains at Thunder Bay less transportation and handling charges to Thunder Bay. Both options for the Prairie livestock producers have been estimated. The price at B. C. was estimated by adding the transportation charges from Calgary to Vancouver to the price at Calgary. The price of grains by region under different situations of the model, expressed in barley ton equivalent, are shown in appendix table 2.1.

Transportation Costs and Handling Costs for Grains

Transportation of barley from the Prairies to Thunder Bay is under the Statutory Grain Rates. The Prairie handling charges used in the model were based on estimation by the Saskatchewan Department of Agriculture.[15] The transportation and handling costs from Thunder Bay to Eastern points and from Calgary to Vancouver were provided by officials in the Canadian Livestock Feed Board to the author. The Canadian Livestock Feed Board also provided to the author the data on freight subsidy under the old F.F.A.P. prior to August 1976 and the new F.F.A.P. after May 1977.[16]

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15. Saskatchewan Department of Agriculture, SDA Data Manual (Product Prices), (Regina: Economics and Farm Management Section, Saskatchewan Department of Agriculture, 1976).

16. Some changes were made between August 1976 and February 1977 in the new F.F.A.P.. In most of B. C. and a few regions in the East, the amount of subsidy was initially reduced from the levels prior to August 1976 but were later restored to approximately the former levels. The rates of subsidy in May 1977 were used in the model.

As to the freight rates under the Statutory Grain Rates, it was assumed that a freight charge of three times the present rates would have to be introduced if the rates were to be cost-recovering in 1976-77, based on the estimation by Carl Snavely.[17]

The input data on transportation cost are shown in appendix table 2.2.

Forage Costs

The farm prices of tame hay were used to represent the prices of forages. The physical volume of other forage crops were expressed as tame hay equivalent based on their nutritional values. The prices of tame hay on a provincial basis were published by Statistics Canada. At the time of the study, however, only the prices up to 1974-75 were published.[18] Preliminary estimates for farm prices of tame hay were available for 1976-77 for Alberta and Ontario.[19] Based on these estimates, the farm prices for

17. Carl Snavely, "Freight Rates Costs in Perspective", Speech given at the Meat-Grain Interface Conference sponsored by the University of Saskatchewan, February 2, 1976, Winnipeg. Anavely's estimation was based on the overall average of the total movement of grains moved under the Statutory Grain Rates. They might not be applicable to any particular route or direction. However, since no breakdown of cost by routes or distance was available, the overall average figure provided by Snavely had to be used.

18. Statistics Canada, Quarterly Bulletin of Agricultural Statistics, January - March 1977, Cat. 21-003. (Ottawa: The Minister of Industry, Trade and Commerce, 1977), pp. 17-31.

19. Data supplied to the author by departments of agriculture of Ontario and Alberta.

tame hay for other provinces were extrapolated. The input data for cost of forage by region are shown in appendix table 2.3.

Costs of Other Inputs in Livestock Production

Costs of other inputs in livestock production such as pasture, capital costs and interests were considered to be equal in all parts of Canada. The cost data published by provincial departments of agricultures in Saskatchewan and Manitoba[20] were used for estimating the costs for other inputs.

Provinces would probably show variations in the costs of other inputs. Some attempts have been made to estimate the variations. While cost studies in livestock production exist for different provinces, they are based on differing assumptions. Therefore, a study of the variation on costs other than feed grains and forages is a major study in itself and was considered beyond the confines of this study.

In this study, the costs for basic and replacement herds for cattle were included in the costs of calves born. The data for costs of other inputs in livestock production are shown in appendix table 2.4.

Cost of Transporting Live Animals

Cost data on transportation of live animals were provided

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20. Saskatchewan Department of Agriculture, SDA Data Manual (Hog), (Regina: Farm Management Section, Saskatchewan Department of Agriculture, 1975); and Manitoba Department of Agriculture, Stablilizing Manitoba's Beef Industry (Winnipeg: Manitoba Department of Agriculture, 1975), p. 7.

to the author by the Canadian Freight Association, Western Tariff Association, Canadian Transportation Tariff Association and Canadian Pacific Limited. In selecting the data used in the model, it was assumed that the most economical rates were taken by the shippers. The cost data used in the model are shown in appendix table 2.5.

Cost in Livestock Slaughter

Attempt were made to collect data on costs of livestock slaughter. However, data on this aspect were found especially lacking. The only data known to the author were Canada Packer's presentation to the Joint Committee of the Senate and House of Commons on Consumer Credit in 1966.[21] However, these data were obviously outdated. Moreover, they were based on Toronto only. Hence they were not used in the study. Consequently, this study followed the same assumption as used by Arthur Wilson in 1968 — that slaughter costs would be offset by returns from by-products.[22] Admittedly, there could be errors resulting from this assumption. However, the assumption had to be used because there are no data available on slaughter costs.

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21. See V. W. Yorgason, Canada's Livestock-Meat System (Ottawa: Agricultural Economics Research Council of Canada, 1973), pp. 61-62.

22. Wilson, *op. cit.*, p. 141.

Transportation Costs for Meat

The cost in shipping meat by trucks were used in the study as truck have become the major carriers of meat in inter-regional trade in Canada. The data on meat shipment costs were based on rates provided to the author by the Canadian Tariff Bureau Association and the Western Transportation Association. The most commonly used rates were adopted Pork was usually transported in packages while beef was mostly shipped in the form of hanging meat. Consequently, the costs of shipping pork and beef were different with pork movement being cheaper than movement of beef. The cost data used in the model are shown in appendix table 2.6.

RESOURCE RESTRICTIONS

Grains Available for Feeding Purpose

Unpublished estimates for the amount of wheat, barley, oats and rye used for feeding purpose from 1965-66 to 1974-75 were obtained from Statistics Canada. The national estimates for feed use of wheat, barley, rye and corn for 1976-77 have been published by the Canada Grains Council.[23] The average feed use of wheat, barley, oats and rye produced in each region itself and imported under the F.F.A.P. from 1970-71 to 1974-75 were calculated

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23. Canada Grains Council, Canadian Grain Industry, Statistics Handbook 1977 (Winnipeg: Canada Grains Council, 1978), table 11, pp. 29-32.

and extrapolated to 1976-77 based on the data on grain production by province.

Data on feed use of corn and mixed grains produced locally in each region were more difficult to obtain. To the author's knowledge, published estimates on regional feed use of corn and mixed grains are only available in Winter's work.[24] However, Winter's estimates were based on 1970-71 data. Furthermore, according to Winter's estimation, feed use of mixed grains in some regions exceeded its production, import, and carry over from previous years. For Canada as a whole, Winter's estimation showed that feed use of mixed grains was very close to 100 percent of the production. There is no clue in Winter's study on how he arrived at his estimates. Consequently, this study had to assume that since mixed grains were produced almost entirely for feeding purposes, allowing for seeds and loss in dockage, 95 percent of the mixed grains produced in each region were used in feeding.

Data sources for estimating the feed use of corn produced in each region were just as lacking. This was complicated by the use of corn in breweries and other forms of human consumption. However, there have always been substantial imports of U. S. corn into each of the corn-producing provinces. Since the production of corn in Manitoba and Quebec is mainly for feed purposes, it was assumed that 90 percent of the corn produced in

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24. G. R. Winter, <u>Protein Efficiency in Canada</u>, table 58, pp. 127-135.

these two provinces was used as feed, allowing the remaining ten percent for seed and other usages such as breweries and other human needs. The remaining corn consumed as feed in Canada, apart from that imported from the U. S., was assumed to have originated from Ontario.

The national output of millfeeds and the quantities of millfeeds and screenings shipped under the F.F.A.P. were available in government publications.[25] The Hall Commission has also published data on production of screenings for the Prairie region as a whole.[26] George Winter has estimated the amounts of millfeeds and screenings produced and fed by each province in 1971.[27] Assuming that the percentages of millfeeds and screenings consumed relative to production remained constant from 1970-71 to 1976-77, and guided by the mentioned published sources, the provincial feed use of millfeeds and screenings produced locally were extrapolated from 1970-71 to 1976-77.

Another major contributor to feed supply was the import of U. S. corn. Data on import of U. S. corn by province were supplied to the author by officials in the Canadian Livestock Feed Board and were included as part of the local grain supply, since international trade in grains was not considered in the model.

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25. Canadian Livestock Feed Board, Annual Report, Crop Year 1976/77 (Montreal: Canadian Livestock Feed Board, 1978), table 12, p. 34 and appendix table iii, p. 47.

26. Commission on Grain Handling and Transportation, Report, Vol. I, pp. 153-59.

27. Winter, op. cit., pp. 127-35.

The grains were converted into barley equivalent according to nutrition values based on conversion factors used by Kulshreshtha. However, the value of grain corn used in this study has been revised downwards, following the advice provided by the animal scientists in Manitoba. The figures are shown in table 4.1.

The amount of feed grain consumed by sheep and lambs, horses, chicken and other poultry in each region were then subtracted from the regional supply of feed grains, and they are assumed not to be affected by changes in grain freight rates. The amount in each category was computed by multiplying the average number of each type of animal and poultry with the feed grain consumption of each unit in the category. The average number of sheep and lamb in each province was based on semi-annual surveys by Statistics Canada.[28] The numbers for horses, chicken and poultry were based on the 1976 census.[29] The feed grain consumption of each unit of animal and poultry used in estimating the total amount of grains consumed by animals and poultry not considered in the model was based on the coefficients used by the Canadian Livestock Feed Board[30] and on consultations with animal scientists

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28. Statistics Canada, Report on Livestock Surveys, Cattle, Sheep, January 1977 and July 1977, Cat. 23-004 (Ottawa: The Minister of Industry, Trade and Commerce, 1977).

29. Statistics Canada, 1976 Census of Agriculture, Cat. 96-852 (Ottawa: The Minister of Industry, Trade and Commerce, 1977).

30. Canadian Livestock Feed Board, Annual Report, Crop Year 1974-75 (Montreal: Canadian Livestock Feed Board, 1976), table 1, p. 13.

Table 4.1

Conversion Factors for Various Feeds into Barley Equivalent

(on a per unit weight basis)

Feed	Conversion Factors
Grain Corn	1,0500
Oats	0.9043
Barley	1,0000
Mixed Grains	1,0092
Wheat	1,0705
By-Product Feed	1,0000
Fodder Corn	0.2330
Tame Hay	0.6250

Source: Based on data used by Surendra N. Kulshreshtha. See Surendra N. Kulshreshtha, Prospects for Livestock Feed Grains Economy and Prairie Producers (Saskatoon: Extension Division, University of Saskatchewan, 1975), Table VII, p. 8.

in Manitoba. A unit of sheep and lamb was taken to consume 0.04 ton of grains in barley equivalent a year. A unit of horse was taken to consume 1.25 ton while a unit of chicken and poultry was taken to consume 0.03 ton of grains in barley equivalent. The amount of feed grains available by region (in tons of barley equivalent) are shown in appendix table 2.7.

Basic Herds and Replacements

Basic herds are the breeding herds of animals. Any female cattle two years old or older were considered to be breeding cattle. The average of breeding cattle in January 1 and July 1 of the crop year was calculated and used in the model. An underlying assumption was that there was no difference between breeding animals that are culled and the animals replacing them. The number of bulls and dairy heifers were considered to be constant within the crop year. However, the number of beef heifers kept as replacement was assumed to be a function of beef cows. The relevant data required are readily available in Statistics Canada publications.[31]

Breeding herds for pigs are also published by Statistics Canada.[32] As in cattle, the average of January 1 and July 1 in the crop year was used for each region. Since the number of

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31. Statistics Canada, Report on Livestock Surveys, Cattle, Sheep January 1, 1977 and July 1, 1977, Cat. 23-004.

32. Statistics Canada, Report on Livestock Surveys, Pigs January 1, 1977 and July 1, 1977, Cat. 23-005 (Ottawa: The Minister of Industry, Trade and Commerce, 1977).

boars relative to sows was very small, the number of boars was included together with the sows to form the basic herd of pigs in each region.

Numbers of basic herds in both cattle and pig production by region are shown in appendix table 2.8.

Capacity for Slaughter

The weekly capacity for federally inspected slaughter in 1974-75 for both cattle and pigs by region was published in a Food Prices Review Board study.[33] The figures were multiplied by fifty to obtain the annual capacity, assuming that there was no change from 1974-75 to the base year 1976-77. To that figure in each region was added the average of uninspected slaughter and farm kill from 1971 to 1976. The figures on uninspected slaughter and farm kill were published by Statistics Canada.[34] Admittedly, the capacity for uninspected slaughter and farm kill in each region would be larger than the five year average. However, it is also rare for slaughtering plants to reach full capacity. This would more than offset the under-estimation in uninspected slaughter and farm kill.

The data on capacity are shown in appendix table 2.9.

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33. J. L. Morris and D. C. Iler, Meat Processing Capacity in Canada (Ottawa: Food Prices Review Board, 1975), p. 4.

34. Statistics Canada, Quarterly Bulletin of Agricultural Statistics, January - March 1977, Cat. 21-003 (Ottawa: The Minister of Industry, Trade and Commerce, 1977), pp. 45-48.

Demand for Beef and Pork

Figures on per capita consumption of beef and pork for 1976 and 1977 were available in published sources.[35] Since per capita consumption estimates by region were only available for 1968,[36] they were considered to be outdated and were, therefore, not used in the model. Hence the national figures, averaging those of 1976 and 1977, were used in estimating provincial consumption, which was arrived by multiplying the national per capita consumption by the provincial population.[37]

With respect to beef consumption, a distinction was made between beef from cattle which has undergone the feeding process and beef from cattle which has not undergone the feeding process. The former type of beef was short-termed "fed-beef" and it is generally sold as primal cuts. The latter type of beef was short-termed "non-fed beef" and it is mainly sold as manufactured beef. There are non-fed steers and heifers but they are relatively unimportant in number and data for them are lacking. Consequently, they were not considered in the study. As to the ratio between fed beef and non-fed beef, very little

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35. Statistics Canada, Livestock and Animal Products Statistics, 1977, Cat. 23-203 (Ottawa: The Minister of Industry, Trade and Commerce, 1978), pp. 66-69.

36. Dominion Bureau of Statistics, Family Food Expenditure in Canada, 1969, Vol. I (Ottawa: Information Canada, 1971).

37. The decision to use the national figures rather than extrapolating the 1968 figures for each region was made after consulting people in the livestock industry such as Mr. Glen McGlaughlin of the Saskatchewan Wheat Pool.

published work has been done on this aspect. The only ratio used in research seems to be the one that was used by Richard Anderson.[38] However, Anderson did not specify the basis for the ratio he used, which was 72.5 percent for fed beef and the remaining percentage for non-fed beef. In this study a minimum of 70.0 percent of beef consumed in each region was assumed to be from fed cattle while a minimum of 25 percent was assumed to be from non-fed cattle. This allowed for some flexibility in distribution of fed and non-fed beef in different regions. When summed up nationally, the ratio of fed beef came to be very close to the percentage of grades A and B beef produced in Canada.

The consumption of beef and pork by region as used in the model is shown in appendix table 2.10.

Number of Calves Slaughtered or Exported

The number of calves slaughtered or exported would produce veal, therefore, it would not contribute to the production of beef in Canada. The number of calves marketed for slaughter by province was calculated on the basis of data published by Canada Department of Agriculture.[39] To this figure was added the number of calves exported by province as published by Canada Department

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38. Richard S. Anderson, "Meats and Meat Marketings on a North-South Axis", Paper presented at the Winnipeg Chamber of Commerce Agriculture Seminar on Meats and Meat Marketing, March 21, 1977, Winnipeg, Manitoba.

39. Canada Department of Agriculture, Livestock and Meat Trade Report, relevant issues (Ottawa: Canada Department of Agriculture).

of Agriculture[40] and the estimate on farm kill of calves supplied to the author by Statistics Canada.

The number of calves slaughtered and exported in each region is shown in appendix table 2.11.

International Trade in Live Cattle, Pigs and Meat

For the past few years, Canada has been a net exporter of cattle and pigs and a net importer of beef and pork. It is generally known that much of the feeder cattle exported from Canada were fed and slaughtered in the U. S. and shipped back to Canada as beef.[41] However, international trade in cattle and pigs was beyond the scope of this study. A study on international trade in cattle, hogs, beef and pork would have to be studied in a North American context. Data on provincial import of cattle, hogs, beef and pork are not available. Consequently, the study assumed that all cattle and pigs fed in Canada will be slaughtered in Canada will be slaughtered in Canada and there was no international trade in meat. Admittedly, this assumption would result in slightly over-estimating the meat production in Western Canada. Most likely, it would be the meat deficit regions in Eastern Canada that would import most of the meat from the U. S.. The import of U. S. meat into Eastern Canada would reduce the demand of Western Canadian meat in Eastern Canada.

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40. Ibid..

41. Anderson, op. cit., p. 2.

DETERMINATION OF COEFFICIENTS IN THE MATRIX

Annual Consumption of Grains and Forages by Animals

The coefficients for consumption of grains and forages used in the matrix indicate the respective annual consumption of grains and forages by a unit of particular class of livestock. Most of the coefficients used were based on recomendations of the Faculty of Agriculture, University of Manitoba.[42] The coefficients used by the Canadian Livestock Feed Board in their calculation of grain consumption[43] were used as guide-lines in selecting the appropriate figures used in this study. The animal scientists at the University of Manitoba were also consulted by the author. As noted earlier, the annual grain consumption figures were converted into barley ton equivalent. Similarly, the annual forage consumption figures were converted into tame hay equivalent. It is generally known that both due to tradition and easy availability, grain consumption by cattle is higher in Western Canada than in Eastern Canada. This is especially evident on daity cattle and feeder cattle. In this study a coefficient of 1.25 was used for daity cattle in Eastern Canada and 1.675 for dairy

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42. T. J. Devlin, J. R. Ingalis, W. M. Palmer, M. E. Seale, S. C. Stothers and E. W. Stringam, "Livestock Production", Chapter 9 in the University of Manitoba, Principles and Practices of Commerical Farming, Fourth Edition, (Winnipeg: Faculty of Agriculture, University of Manitoba, 1974), pp. 322-91.

43. Canadian Livestock Feed Board, Annual Report, Crop Year 1974-75, table 1, p. 13.

in Eastern Canada and 1.675 for dairy cattle in Western Canada based respectively on recommendations by the Canadian Livestock Feed Board[44] and the Faculty of Agriculture at the University of Manitoba.[45] With respect to feeder calves and cattle, after consultations with officials in the Canadian Livestock Feed Board and animal scientists in Manitoba, the study assumed that feeder calves and cattle take a 70 percent grain ration and for Eastern Canada the ratio between grains and forages for feeding was assumed to be 50:50. Consequently, the coefficients used in the model for feeding a calf to slaughter in Western and Eastern Canada were respectively 1.25 and 1.61. The coefficients used for feeding a yearling cattle to slaughter in Western and Eastern Canada were respectively 0.85 and 1.1. There were corresponding differences forage consumption between dairy and feeder calves and cattle in Western and Eastern Canada. The consumption of grains and forages for other classes of cattle and hogs were assumed to be the same throughout Canada as the factors used by the Canadian Livestock Feed Board in calculating feed grain consumption in Eastern Canada are quite consistence with the rations recommended by the agriculture faculty in University of Manitoba. The coefficients were shown in the equations $FEDGRN_i$ and $ROUGHA_i$ in the model.

In hogs, a market pig was assumed to exist for half a year. The coefficient, therefore, only denoted the consumption

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44. Ibid..

45. Faculty of Agriculture, University of Manitoba, Principles and Practices of Commerical Farming, pp. 365-91.

in half a year.

Rationship Between Different Classes of Animals and the Dressing Ratios

The coefficients used in the model indicating the relationship among different classes of cattle were mostly estimated on the basis of information from Principles and Practices of Commercial farming.[46] The ratio used for number of calves per cow was 0.9. It is higher than the commonly used ratio of 0.85. However, it should be noted that the number of cows upon which the ratio was based is the average figure for a year and some of the cows which had given birth were culled during winter and were not yet replaced. Unpublished data supplied to the author by Statistics Canada on the number of calves born per year and a subsequent inquiry to officials in Statistics Canada led to the selection of this higher figure of 0.9.

It was assumed that calves would be weaned at 450 pounds and, except for the replacement herds, they would either go to feedlots or be put in the stocker program. The stocker calves would be fattened until they reached 700 pounds. No distinction was made between steers and heifers, or feeder cattle of beef or dairy origin, though it was assumed that most of the excess dairy calves, both male and female, would be included in the slaughter calves. The slaughter weight for fed cattle was assumed to be 1,050 pounds after consultation with informed persons

46. Ibid., pp. 345-91.

in the industry.

With regard to the culling and replacemtn of basic herd in beef cattle, the ratios used are again on the Principle and Practices of Commercial Farming[47] and Winter's Protein Efficiency in Canada.[48] Based on these two sources, it was assumed that a beef cow will be kept in service for five to six years and be culled. Consequently, one-fifth to one-sixth of beef cows would be culled annually. The study takes the figure of 18 percent as an average figure for beef cows being culled in each region. Taking into account of natural deaths, the ratio of beef cows to the beef replacement heifers in the model was 1: 0.19.

Generally, over 25 percent of female beef calves must be retained for replacement in order to maintain a constant size of cow herd.[49] The model assumes that the number had to be at least 25 percent more than that of beef heifers for replacement. This amounted to over 28.75 percent of female beef calves. This means that one-fifth of beef calves retained would not be used as replacement heifers but would be fattened as yearlings.

With respect to dairy cattle, usually around one quarter of dairy cows had to be culled each year and about 70

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47. Ibid..

48. George Winter, op. cit., table 3.7, p. 69.

49. Faculty of Agriculture, University of Manitoba, op. cit., p. 368.

percent of female dairy calves have to be retained for replacement in order to maintain a constant herd.[50] The model assumes that besides natural deaths, 23 percent of dairy cows would be slaughtered annually. The study also assumed that female dairy calves reserved for replacement must be at least 25 percent more than the number of dairy heifers in each region, which was about 70 percent. However, since dairy heifers are not popular for use in feeding it was assumed that excess replacement calves for dairy cows would be slaughtered.

For bulls, the study followed Winter's estimate and assumed that 26.47 percent of bulls would be slaughtered annually.[51] Taking into account of natural deaths, the study assumed that the number of male calves reserved for replacement of bulls must be at least 27 percent of the number of bulls.

After consultation with officials in the Canada Department of Agriculture, the weight of cows for slaughter was assumed to be 1,050 pounds and that of bulls used in the model was 1,500 pounds.

In pig production it was assumed that two litters of piglets were produced each year and the number of weaned pigs produced each year by a breeding pig used in the model was 14.

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50. _Ibid_., p. 388.

51. Winter, _op_. _cit_., table 3.7, p. 69. The figure 0.2647 was used by Winter as a "conversion factor" to calculate the turnover of bulls and production of meat from bulls.

It was also assumed that a pig weighed 25 pounds at weaning and except for replacement for breeding pigs, the weaned pigs would become market pigs and be fed until 200 pounds and would then be slaughtered.[52] It was also assumed that a breeding pig would be kept in service for about two years. Following the estimation used by Winter, the study assumed that 48.99 percent of breeding pigs would be slaughtered each year.[53] Taking into account of the natural deaths, the model assumes that half of the breeding herd of pigs had to be replaced annually.

The dressing ratios used in the model for each class of animals were based on published sources[54] as well as consultations with people in the industry. It was assumed that a fed cattle produced 580 pounds of beef, a cow 525 pounds and a bull 750 pounds. In pigs, a finished market pig would yield 130 pounds of pork and a culled breeding pig 228 pounds.

All units of weights for live animals and meat were expressed in tons in the model.

The death rates of animals were also determined from information provided in publications of Saskatchewan Department

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52. Saskatchewan Department of Agriculture, SDA Data Manual (Hog).

53. Winter, op. cit..

54. Winter, op. cit., and Daniel Richard, Farm to Retail Price Spreads for Beef in Canada, Research Report Number 2 for the Commission of Inquiry into the Marketing of Beef and Veal (Ottawa: Canada Department of Agriculture, 1976), table 1, p. 7.

of Agriculture[55] and a study conducted by Canada Department of Agriculture.[56] It was assumed that two percents of feeder calves, one percent of stocker calves, one percent of feeder yearlings, six percent of market pigs and two percent of breeding pigs would die each year. The death of basic herds was included implicitly in the selection of replacement rates, which included allowance for death.

Inter-regional Movements

Inter-regional movements of grains, feeder calves and yearlings, excess replacement herd, fed and non-fed cattle for slaughter, finished pigs for slaughter, beef and pork were allowed in the model to take place between most regions. However, movement of weaner pigs was only allowed between Ontario and Quebec. There is little movement of weaner pigs between other regions and the high shrinkage of weaner pigs travelling over long distance does not make movement of weaner pigs over long distance recommendable.

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55. Saskatchewan Department of Agriculture, SDA Data Manual (Hog) and SDA Data Manual (Beef Cattle).

56. W. Y. Yang, A Statistical Analysis of Death Rates of Farm Animals in Canada (Ottawa: Research Division, Economics Branch, Canada Department of Agriculture, 1969).

CHAPTER FIVE

ANALYSIS OF THE EMPIRICAL RESULTS

INTRODUCTION

As noted earlier, the objectives of the empirical model put forward in chapter four is to find out the optimal spatial production patterns of cattle, hogs, beef and pork, their inter-regional movements and the total cost[1] involved under varying levels of grain freight subsidy. By comparing the results of the model under different levels of grain freight subsidy, the effects of the changes in grain freight subsidy on the spatial production pattern of cattle, hogs, beef and pork, their inter-regional movements and the total cost involved can be analysed.

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1. The term "total cost involved" used in this chapter refers to the cost in Canada as a whole, under the optimal spatial pattern of production of cattle, pigs, beef and pork and the inter-regional movement of feed grains, cattle, pigs, beef and pork. The cost includes the cost of local supply of feed grains and transportation of feed grains, the cost in forages, the cost in producing calves and transporting feeder calves, the cost of putting the calves in the stocker program, the cost of transporting yearlings for fattening, the cost of feeding feeder calves, the cost of feeding yearlings, the cost of transporting finished cattle, the cost of transporting cows and bulls for cull, the cost of transporting fed and non-fed beef, the cost of producing breeding pigs, the cost of transporting weaned pigs, the cost of producing market pigs, the cost of transporting slaughter pigs and the cost of transporting pork.

A comparison of the results indicates that the reduction of grain freight subsidy would encourage the production of cattle, pigs, beef and pork in the Prairies rather than in the non-Prairie regions. Consequently, there would be changes in the pattern of inter-regional movements of feed grains, cattle, pigs, beef and pork. The reduction of grain freight subsidy would also reduce the total cost involved in the feed grain-livestock-meat system, especially when changes in regional production capacities are allowed.

The reaction of each region to the changes in grain freight subsidy with regard to production of cattle, beef, pigs and pork could be understood by comparing different alternative situations in the model.

THE INITIAL SITUATION

The BUY Condition (Model la)

Model la refers to the condition when the Prairie livestock producers buy grains from elevators with the old F.F.A.P. and the Statutory Grain Rates in effect.

Under this condition, as shown in Appendix Table 3.9, there was no feeding of calves in Quebec and B. C., though these two regions fed their own excess replacement heifers (Appendix Table 3.10). As indicated in Appendix Table 3.7, Alberta had over a third of all Canada's cattle on feed, followed closely by Ontario.

As to the inter-regional movements of feeding calves, as shown in Appendix Table 3.7, Ontario was the largest recipent of feeder calves imported[2] from other regions, namely, the Maritimes, Quebec, Saskatchewan and Alberta. Ontario's import constitued over 45 percent of the total movement of feeder calves in Canada. Alberta also imported all the feeder calves produced in B. C.. On the other hand, Saskatchewan was the origin of about 60 percent of total number of feeder claves exported to other regions. About 70 percent of Saskatchewan's export of feeder calves went to Manitoba.

There was no movement of feeder yearlings under this condition.

There was also no movement of slaughter cattle. As to the total number of cattle slaughter, Alberta was the largest beef producing and cattle slaughtering region. It slaughtered nearly a third of Canada's cattle (Appendix Table 3.15) and produced nearly a third of Canada's beef (Appendix Table 3.16). The second largest beef-producing region was Ontario, producing 29 percent of Canada's beef. Manitoba was third with 21 percent.

Movements of beef are shown in Appendix Tables 3.18, 3.19 and 3.20. All the non-Prairie regions were beef-deficit regions and the Prairie region had to supply them with beef. Alberta was the largest exporter of beef, contributing a little

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2. The terms "export", "import" and "movement" in this chapter refer to inter-regional export, import and movement within Canada respectively, unless otherwise specified in the context.

over one half of the total beef exports (Appendix Table 3.20) and nearly 54 percent of all fed beef export of the Prairie provinces. Over half of Alberta's beef produced was shipped to Quebec, which constituted 38 percent of Quebec's beef consumption. The second largest market for Alberta was B. C. which took 42 percent of Alberta's beef export and depended on Alberta for 85 percent for its consumption. Manitoba also contributed 38 percent of the total beef export and almost all of its export (93 percent) was fed beef. The markets for Manitoba, in the order of quantity involved, were Quebec, Ontario and the Maritimes. Saskatchewan's export mainly consisted of non-fed beef (86 percent) and its largest market was Ontario.

With respect to the weaner pig production, although excess capacity was experienced in both Manitoba and Saskatchewan, it was most serious in Manitoba. The high cost of moving pigs relative to pork inhibited the inter-regional movement of live pigs except the movement of weaner pigs from Ontario to Quebec. The availability of freight subsidized grains made it more economical for Quebec to import both weaner pigs and grains for feeding and slaughter in the province than to import the equivalent quantity of pork from the Prairies. Moreover, the limited pig slaughter capacity in Ontario limited the number of finished pigs Ontario could produce and, therefore, it exported pigs to Quebec for feeding.

Along with its problem of over capacity in pig production, Manitoba also utilized less than a sixth of its pig slaughter capacity (as shown in Appendix Table 3.29). Alberta only utilized slightly over a third of its capacity. Ontario, however, did not have enough slaughter capacity for pigs.

As for the movement of pork (as shown in Appendix Table 3.31), Ontario was also a pork surplus province and it joined the Prairie provinces in pork export. Again, Alberta was the largest exporter of pork, exporting solely to B. C.. Saskatchewan was the second largest exporter, shipping practically all of its surplus to B. C.. Hence B. C. was the largest importer of pork. Manitoba split its export between Quebec and the Maritimes while Ontario exported solely to Quebec. Total inter-regional trade of pork was only 15 percent of the total inter-regional trade of beef, though pork consumption in Canada was nearly half of beef.

The feed grain movement under this buy condition amounted to nearly 2.3 million tons.[3] Over three quarter of it went to Quebec from the Prairies, one-eighth to B. C., and that to the Martimes constitued the rest.

The total cost involved amounted to $4.8 billion, as shown in Appendix Table 3.1.

The OWN Condition (Model lb)

Model lb was the same as in Model la except that the Prairie livestock producers fed their livestock with the grains

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3. The term "tons" when referred to feed grains in this study refers to tons of grain in barley equivalent, unless otherwise indicated.

they produced themselves. By so doing, the cost differential between the Prairie livestock producers and their counterpart in the non-prairie regions was enlarged, in favour of the Prairie producers.

Due to the enlarged cost differential in livestock production, cattle feeding activities in the non-Prairie regions were less than those in model 1a (as shown in Appendix Table 3.11). The Maritimes and Quebec both shipped all of their feeder calves to Ontario for feeding (Appendix Table 3.7) and Quebec exported all of its excess replacement heifers as well (Appendix Table 3.8).

Alberta, however, as shown in Appendix Table 3.7, retained more of its feeder calves and exported much less to Ontario for feeding. Consequently, compared to Model 1a, Alberta's leading position in cattle production was further strengthened as it produced 37 percent of the nation's fed cattle. Ontario's share was slightly less than that in Model 1a (Appendix Table 3.11).

As in Model 1a, there was no movement of slaughter cattle under this condition. Because of having no or very small number of feeder cattle, cattle slaughtered in the Maritimes, Quebec and B. C. were completely or mostly non-fed cattle. As shown in Appendix Table 3.16, Alberta produced about a third of the nation's beef and over half of it was exported to other regions. Almost a third of Alberta's beef produced was shipped to Quebec. Ontario produced 29 percent of the nation's beef but with its large population it had to import beef from Manitoba and Saskatchewan, as shown in Appendix Table 3.20. The largest beef importing region was Quebec, which relied on imports for over four-fifths of its beef requirement. All its fed beef requirements had to be imported.

In contrast to Model 1a, there was no movement of weaner pigs. Consequently, as shown in Appendix Table 3.23, Quebec's market pig production was six percent less than that in Model 1a. The production in B. C. was also 16 percent less than that in Model 1a. Both Manitoba and Saskatchewan had larger weaner and market pig production. There was no movement of pigs for slaughter. With the increased pig production, Manitoba's pig slaughter exceeded that in Model 1a by nearly 110 thousand heads and Saskatchewan exceeded that in Model 1a by over 16 thousand heads, as shown in Appendix Table 3.29. On the other hand, Quebec's pig slaughter under this condition was about seven percent less than that in Model 1a. Consequently, Quebec had to import a larger quantity of pork from Manitoba and Saskatchewan. There was also a larger export of pork from Saskatchewan to B. C., as shown in Appendix Table 3.31. However, as shown in Appendix Table 3.29, Manitoba still utilized only 27 percent of its pig slaughter capacity.

There was a smaller quantity of grains shipped into the Maritimes and Quebec than in Model 1a. The total movement of feed grains was a little over 2.1 million tons, about six percent less than that in Model 1a. The total cost involved was $4.8 billion, which was over $26 million less than that in Model 1a, as shown in Appendix Table 3.1.

THE INTRODUCTION OF THE NEW F.F.A.P.

The various spatial patterns of livestock production resulting from the introduction of the F.F.A.P. were simulated by Models 2a to 2f. The short run effects, with no change in basic herds and slaughter capacities, were analysed by comparing Models 1a with 2a and Models 1b with 2b for the BUY and OWN conditions respectively. Comparing the results of Models 2c with those of 2a indicated the effects under the BUY condition with the basic herds restriction relaxed. Comparing the results of Model 2c with that of Model 2d further indicated the changes under the BUY condition that would occur if the restrictions on slaughter capacities were to be lifted. Comparing the results of Models 2b, 2e and 2f indicated the effects of relaxing the same constraints under the OWN condition.

The BUY Condition

No change in basic herds and slaughter capacities (Model 2a). With no change in the distribution of basic herds and slaughter capacities, all region except Saskatchewan and B. C. were affected by the changes in grain freight rates. The enlarged cost advantage in Alberta encouraged more beef to be produced there for export to Quebec. Hence as shown in Appendix Table 3.7, Alberta's feeder calf movement to Ontario sharply declined to only about a quarter of that in Model 1a. Consequently, Alberta's share of the cattle on feed in this situation rose to 37 percent of the total cattle on feed in Canada.

With price of feed grains reduced by $6 per ton,[4] Manitoba's cattle feeding cost was reduced. It encouraged the Maritimes to import more beef from Manitoba instead of producing their own feed calves with grains imported from the Prairies. Consequently, all the Maritimes' feeder calves were shipped to Ontario for feeding (Appendix Table 3.7). The spatial pattern in cattle and beef production, as well as regional movement of beef was identical to that in Model 1b.

As to pig production, compared with Model 1a, Manitoba's share increased due to reduced feed cost. Consequently, Manitoba could export more pork to Quebec. There was no movement of weaner pig to Quebec as it became cheaper for Quebec to import pork than to import weaner pigs as well as the feed grains required to feed them. Consequently, Quebec's pork production, compared to Model 1a, declined by six percent.

The drop in livestock production in Quebec and the Maritimes led to a decrease in their grain import. The reduced cattle feeding activity enabled Ontario to export its surplus corn to the Maritimes. Consequently, as shown in Appendix Table 3.2, feed grain movement between the Maritimex and the Prairies was reduced by over 40 percent. There was also a three percent drop in the total inter-regional movement of feed grains.

With respect to total cost involved, the decrease was

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4. Manitoba would reduce its cost in finishing a feeder calf by $6 x 1.61 (amount of feed grains consumed in a year) = $9.66, while other cost factors remained constant.

over $38 million, not including the savings in subsidy payment. This represented a 0.8 percent drop in cost (Appendix Table 3.1).

Changes in basic herds allowed (Model 2c). With the relaxation of constraints on basic herds, every region was allowed to increase its number of basic herds by ten percent or to reduce it by any amount. As shown in Appendix Table 3.5, the Maritimes and B. C. ceased to produce beef cows while Quebec's beef cows dropped drastically from over 227,500 to just over 5,200. The number of beef cows in the other regions, however, rose by ten percent as compared to Model 2a. With respect to breeding pigs, as shown in Appendix Table 3.22, all regions except Quebec increased by ten percent while Quebec dropped by a third. The changes in basic herds obviously accompanied by changes in spatial pattern of feeder cattle and pig production.

As shown in Appendix Tables 3.7 and 3.8, with their output of calves reduced, the Maritimes were able to feed all their feeder calves but continued to export excess replacement heifers to Ontario. Ontario's import of feeder calves and heifers from Quebec was reduced from that in Model 2a by over 70 percent as output of heifers in Quebec declined. Nonetheless, as shown in Appendix Table 3.9, with increased import of calves from Saskatchewan, Ontario's reduction in the share of the nation's cattle feeding was only one percent less than that in Model 2a. Manitoba's share dropped by over two percent as its feed grains had to be diverted to pig production. Cattle feeding in Saskatchewan also dropped as the capacity for slaughtering the finished cattle was further restricted with increase of beef cows for cull. With the increase in calf procution, Alberta's share of cattle feeding rose by over three percent.

As in Model 2a, there was no movement of slaughter cattle. With the increased output of beef in Alberta, more beef were exported from Alberta to Quebec, which now depended on Alberta for over three-fifths of its beef requirement (Appendix Table 3.18), especially all of its fed beef requirement. On the other hand, the export from Manitoba dropped, due to the province's reduction in beef production.

The reduction in cattle feeding in Saskatchewan and Manitoba together with the relaxation of the restriction on the basic herds enabled these two provinces to fully utilize their capacity in pig production. Quebec was the only region with a reduction in breeding pigs and its drop was nearly a third of what it had in Model 2a (Appendix Table 3.22). Consequently, its weaner pig production declined. However, as the pig production in Ontario outnumbered its slaughter capacity and the transport costs of weaner pigs and grains together did not favour movement of weaner pigs into Quebec for feeding in this situation, Ontario had to feed all its weaner pigs produced and ship finished pigs which it could not slaughter because of the limited slaughter capacity to Quebec. Nonetheless, Quebec's share of the nation's pig slaughter dropped from 25 percent in Model 2a to 18 percent, though it still held the second place in pig slaughter in Canada. As shown in Appendix Table 3.29, the largest increase in pig slaughter was in Manitoba whose share increased from eight percent in Model 2a to 12 percent. The drop in production in Quebec led to more pork being imported from Manitoba and Saskatchewan by Quebec. Manitoba provided over a fifth of Quebec's pork consumption. The Maritimes and B. C. imported less pork as they produced more pork themselves than in Model 2a. As it was cheaper for B. C. to import pork from Alberta than from Saskatchewan, with the increase in pork production in Alberta, B. C. imported more pork from Alberta and less from Saskatchewan. As shown in Appendix Table 3.31, total pork movement increased by over a third from that of Model 2a, largely due to the increased movements to Quebec.

As livestock population in Ontario, Quebec, the Maritimes and B. C. declined, 17 percent less feed grains were shipped inter-regionally (Appendix Table 3.3). The imports of feed grains by Quebec and B.C. fell 18 and 20 percent respectively. There was a further reduction in the total cost involved from that in Model 2a by $59 million, or a drop of over one percent, as shown in Appendix Table 3.2.

Unlimited slaughter capacities (Model 2d). Saskatchewan was the region most heavily affected by the relaxation of constraints on slaughter capacities. The number of cattle on feed in the province more than doubled that under Model 2a and it retained over half of its feeder calves and all of its excess replacement heifers for its own feeding. However, the low cost in moving cattle and calves from Saskatchewan to Manitoba enabled

Manitoba to obtain 44 percent of Saskatchewan's feeder calves for feeding. On the other hand, availablity of cheap Ontario corn enabled Ontario to import some Alberta calves and all the feeder calves from the Maritimes to compensate for the curtailment of import from Saskatchewan. Ontario still remained the second largest cattle feeding region though its share of the nation's cattle feeding dropped from 31 percent in Model 2c to 28 percent. Alberta's share also dropped by three percent because of export of feeder calves to Ontario and increased competition of beef export from Saskatchewan (Appendix Table 3.11).

As it was always cheaper to ship beef than to ship cattle, and since there was no limitation on slaughter capacity, there was no movement of slaughter cattle. Consequently, the increased feeding activity resulted in a doubling of the cattle slaughter in Saskatchewan, as shown in Appendix Table 3.15.

As shown in Appendix Tables 3.18, 3.19 and 3.20, Manitoba, with its reduced beef output, shipped all of its surplus beef to Quebec and Ontario. On the other hand, with increased beef output in Saskatchewan, Saskatchewan exported more beef than in Model 2c. Saskatchewan supplied all of the Maritimes' requirement for imported beef. Both Saskatchewan and Manitoba exported beef to Ontario and Quebec. The transport cost of beef from Manitoba to Quebec was $32.9 per thousand pounds and from Manitoba to Quebec was $33.0 whereas the cost from Saskatchewan to Quebec was $41.0 and from Saskatchewan to Ontario was $41.1. Consequently, an "indifferent situation" occurred in the movement of beef from Manitoba and Saskatchewan to Ontario and Quebec. For two equal quantities of beef movements exported to Ontario and Quebec from either Manitoba and Saskatchewan, it made no difference in the total cost involved in the model between (1) Manitoba sending a certain quantity of beef to Ontario, and Saskatchewan sending the same quantity to Quebec and (2) Saskatchewan sending the same quantity to Ontario, and Manitoba sending the same quantity to Quebec.

Due to its reduction in beef output, Alberta's beef export to Quebec dropped by 26 percent. On the other hand, the reduction of output in Ontario increased its dependency for imported beef, which rose from 22 percent of its total beef requirement in Model 2c to 29 percent. Total beef movement, due to increased import by Ontario, rose by over seven percent from Model 2a, as shown in Appendix Table 3.20.

With respect to pig and pork production, the relaxation of the restriction on pig slaughter capacity enabled Ontario to kill all the pigs it produced and hence it did not have to ship weaner pigs or slaughter pigs to Quebec. As a result, pig production in Ontario increased by five percent (Appendix Table 3.23). The same number of pigs added to Ontario was subtracted from Quebec. Consequently, the share of pig slaughter in Ontario rose to 44 percent of the nation's total from 40 percent in Model 2c. Export of pork from Ontario increased accordingly, Ontario supplied all the pork deficit in the Maritimes and 37 percent of the imported pork in Quebec. Quebec's pig slaughter reduced from 18 percent of the nation's in Model 2c to 12 percent and hence it had to import more pork from Ontario and Manitoba (Appendix Table 3.31). There was no change in the magnitude of movements away from Saskatchewan and Alberta from that in Model 2c.

With reduced pork production in Quebec, there was a nine percent decrease in the quantity of feed grains imported by Quebec (Appendix Table 3.3). The Maritimes also reduced their import by 26 percent because of curtailment of cattle feeding. The cost difference between Model 2c and Model 2d was over $1.6 million in favour of the latter (Appendix Table 3.2).

The OWN Condition

No change in basic herds and slaughter capacities (Model 2b). The effects of the change in F.F.A.P. were more phenomenal under the OWN condition than under the BUY condition. The difference in cost of livestock production between the Prairies and the East was further widened in favour of the Prairies.

With respect to cattle production, the widening of cost advantage in favour of Alberta vis-a-vis Ontario in cattle feeding enabled Alberta to feed all its calves instead of sending some of them to Ontario. Manitoba, on the other hand, had to divert a greater part of its feed grain supply to pig production and, therefore, it had to reduce its cattle feeding. Hence Saskatchewan had to export more feeder calves to Ontario. Consequently, the number of cattle on feed in Ontario only dropped slightly by less than two percent (Appendix Table 3.11).

There was no movement of slaughter cattle. Beef production in Alberta increased and rose to 34 percent of the nation's production. Manitoba's share, however, dropped from 21 percent to 20 percent (Appendix Table 3.16). Consequently, Manitoba's export dropped while Alberta's rose. Total inter-regional movement of beef was about one percent over that in Model 2a (Appendix 3.20).

There were many changes in pig and pork production. The enlarged cost difference between Manitoba and Quebec resulted in Manitoba fully utilizing its capacity in producing market pigs. Hence pig production in Manitoba expanded at the expense of Quebec. The same held true for pork production. As shown in Appendix Table 3.28, Quebec's share of the nation's pig slaughter dropped from 25 percent in Model 1b to 22 percent. Manitoba's share increased from seven percent to 11 percent. Hence there was a 175 percent increase of pork export from Manitoba to Quebec. B. C. also fully utilized its capacity in producing market pigs as the pork from Saskatchewan which used to export to B. C. was now exported to Quebec.

With the decrease in cattle and pig production, there was a six percent drop in Quebec's import of feed grains from that in Model 1b (Appendix Table 3.3). The increase in market pig production in B. C. led to a small increase in grain exported from Alberta to B. C.. There was a decrease in total grain movement by over four percent. The difference in cost from the condition in Model 1b was a reduction by nearly $39 million (Appendix Table 3.2).

Changes in basic herds allowed (Model 2e). The spatial pattern of cattle and pig production emerging from changes in the number of basic herds differed from that in Model 2b. The spatial pattern of beef cows was the same as in Model 2c (Appendix Table 3.5). As shown in Appendix Table 3.11, greater cattle feeding activities occurred in Saskatchewan and Alberta while those in Ontario and Manitoba declined from Model 2b. The Maritimes and B. C. had to ship all their feeder calves and yearlings to Ontario and Alberta respectively (Appendix Tables 3.7 and 3.8). Nonetheless, cattle feeding in Ontario declined from that in Model 2b because the supply of feeder calves from the East dwindled. Manitoba's import of calves from Saskatchewan also dropped by 17 percent from that in Model 2b and its number of cattle on feed declined. However, bounded by its limitation in cattle slaughter capacity, and with the increased output of finished cattle, Saskatchewan had to ship over two-fifths of its finished cattle to Ontario and Manitoba for slaughter (Appendix Table 3.15).

With the changes in spatial pattern of cattle production, as shown in Appendix Table 3.15, Alberta's share of the nation's cattle slaughter rose from 34 percent in Model 2b to 37 percent. Ontario's share, despite import of slaughter cattle, dropped slightly from 28 percent to 27 percent. On the other hand, with the increased import of slaughter cattle, Manitoba's share rose by two percent. The Maritimes, Quebec and B. C. had to depend entirely on import for fed beef. The inter-regional trade in beef, therefore, rose by 21 percent from that in Model 2b. The spatial pattern of beef movement also varied. As shown in Appendix Table 3.20 more of Alberta's beef was shipped into Quebec which now depended on Alberta for 53 percent of its beef requirement. Manitoba also exported more beef to the Maritimes.

As to pig production, as shown Appendix Table 3.23, again more pigs were produced in every region except Quebec when compared with Model 2b. Ontario had the greatest increase, but limited by its slaughter capacity it had to export finished pigs to Quebec for slaughter (Appendix Table 3.25). Hence while Quebec's market pig production dropped by 40 percent when compared with Model 2b, its decrease in pig slaughter was only 17 percent (Appendix Table 3.28).

The drop in Quebec's pork production led to an increase in inter-regional trade in pork which rose by a fifth from that in Model 2b. There was a 36 percent increase in Quebec's pork import from Saskatchewan and Manitoba. B. C.'s increase of import from Alberta also rose by a quarter. The Maritimes' import, however, dropped by 11 percent as their own production rose.

As shown in Appendix Table 3.3, export of grains from the Prairies to the Maritimes, Quebec and B. C. dropped from the levels in Model 2b due to the reduction of livestock population in those regions. The total feed grain movement dropped by a fifth from that in Model 2b. Greatest decrease was the export to

Quebec, which dropped in the order of nearly 226 thousand tons.

As shown in Appendix Table 3.2, the cost saving as compared with Model 2b was over $60 million.

Unlimited slaughter capacities (Model 2f). With limitations on slaughter capacities lifted, there was no change in the spatial pattern of beef cows, calves born and pigs from Model 2e. However, as shown in Appendix Table 3.11, Saskatchewan's cattle feeding was enlarged because the lifting of the limit on cattle slaughter enabled the province to slaughter more of its finished cattle. However, the low freight rates for moving calves from Saskatchewan to Manitoba still enabled Manitoba to import the same number of Saskatchewan's feeder calves as in Model 2e (Appendix Table 3.7). Nonetheless, Saskatchewan ceased to export feeder calves to Ontario and feed the calves itself. Consequently, Ontario's cattle feeding dropped by 14 percent from that in Model 2e despite import of calves from Alberta. Alberta's cattle feeding also dropped slaightly (Appendix Table 3.11).

As shown in Appendix Table 3.12, shipment of slaughter cattle disappered and hence Saskatchewan's share of cattle slaughter rose from nine percent of the nation's total slaughter in Model 2e to 17 percent. Consequently, the province's beef exports rose by 164 percent (Appendix Table 3.20). Over half of the export was sent to the Maritimes and the rest split between Ontario and Quebec. Manitoba's cattle slaughter dropped by seven percent (Appendix Table 3.15) from that in Model 2e as Saskatchewan no longer exported slaughter cattle to Manitoba.

With respect to pig slaughter, the relaxation of slaughter capacity limitation enabled Ontario to kill all the pigs it produced and hence inter-regional movement of slaughter pigs ceased. Consequently, pork export from Ontario to the Maritimes and Quebec increased. While maintaining the same level of output as in Model 2e, Manitoba had to give up its pork market in the Maritimes and shipped all of its exported pork to Quebec. It was because it was cheaper for the Maritimes to import pork from Ontario (Appendix Table 3.31).

The reduced feeding activities in Ontario enabled it to export corn to the Maritimes and captures the market from the Prairies (Appendix Table 3.3). The total movement of feed grains, however, remained unchanged from Model 2e. Cost saving as compared to Model 2e was $1.6 million.

EFFECTS OF REMOVAL OF THE STATUTORY GRAIN RATES

The BUY Condition

No change in basic herds and slaughter capacities (Model 3a). With a further increase in cost differences between the West and the East in livestock production, there was a further shift of livestock production to the West. Cattle feeding in Saskatchewan and Alberta was enlarged from that in Model 2a (Appendix Table 3.11). Alberta ceased to export feeder calves to Ontario and Saskatchewan's export was only 63 percent of that in Model 2a (Appendix Table 3.7). Manitoba's import of feeder calves from Saskatchewan declined by nine percent as Manitoba had to divert more of its grains for pig production. However, Manitoba's cattle slaughter capacity for cattle was still fully utilized as finished cattle from Saskatchewan was still shipped to Manitoba for slaughter (Appendix Table 3.12). Consequently, comparing with Model 2a, while Alberta's share of the nation's cattle slaughter rose slightly from 33 percent of the nation's to 34 percent, Ontario's share declined from 28 percent to 27 percent (Appendix Table 3.15). The share by Saskatchewan remained unchanged while its proportion of fed beef production increased.

As shown in Appendix Table 3.20, the pattern of inter-regional trade of beef changed correspondingly. The total movement increased over that in Model 2a by four percent. Manitoba's export remained constant. Saskatchewan, however, increased its export slightly. Compared to Model 2a, Alberta's export of beef to both Quebec and Ontario increased and it supplied, under this situation, two-thirds of Quebec's fed beef and 55 percent of Quebec's total beef consumption.

With respect to pig production, market pig production in Ontario, Manitoba and Saskatchewan rose from that in Model 2a while that in Quebec dropped by 16 percent (Appendix Table 3.23). However, pigs were shipped from Ontario to Quebec for slaughter. Compared with Model 2a, as shown in Appendix Table 3.26, Manitoba's share of pig slaughter rose from eight percent to nine percent while that of Saskatchewan's also rose slightly. Quebec's share, however, dropped by three percent. With the increased deficit in Quebec there was an increase in import of pork from Manitoba, as shown in Appendix Table 3.31. Total movement of pork rose by 19 percent over that in Model 2a.

As shown in Appendix Table 3.3, the reduction of live-stock population in Ontario enabled more Ontario grains to be exported to the Maritimes, reducing the flow of Prairie grains to that region. The decrease in pig population in Quebec also reduced its import of feed grains from the Prairies. Consequently, there was nine percent less feed grain export from the Prairies to the East than that in Model 2a. Total feed grain movement dropped by nearly five percent.

Compared with Model 2a, there was a reduction in total cost by $52 million (Appendix Table 3.2).

Changes in basic herds allowed (Model 3c). With restrictions on basic herds relaxed, the spatial distribution of beef cows and claves was changed to the same as in Model 2c (Appendix Tables 3.5 and 3.6). As shown in Appendix Table 3.11, with the increased cost advantage in the Prairies for cattle feeding, Alberta's cattle feeding further increased to 42 percent of the nation's share. Saskatchewan's cattle feeding also expanded despite the limitations on slaughter capacity. The cost advantage in Saskatchewan's cattle feeding outweighed the cost in shipping the slaughter cattle to Manitoba. Nonetheless, Saskatchewan still shipped about 70 percent of its feeder calves produced to Manitoba. On the other hand, Ontario's cattle on feed dropped to 28 percent of the nation's share (Appendix Table 3.11).

The increased beef output in Alberta enabled the province to become the dominant supplier of beef to Quebec. It supplied 58 percent of Quebec's beef requirement. Ontario's enlarged deficit led to increased beef import from Manitoba (Appendix Table 3.20).

With respect to pig production, the number of weaner pigs produced in Quebec dropped. Quebec's number of market pigs fell to only 13 percent of the nation's total as against 21 percent in model 3a and 17 percent in Model 2c (Appendix Table 3.23). The increase in the number of pigs in Ontario was equal to the number lost by Quebec. Yet, with its limited slaughter capacity, Ontario had to ship the increased slaughter pigs it produced (with amounted to ten percent of its production) to Quebec for slaughter. Nonetheless, compared to Model 3a, Quebec slaughtered over 300 thousand fewer pigs (Appendix Table 3.28). As a result, Quebec's pork import rose by 90 percent. Total movement of pork was a fifth higher than that in Model 3a and six percent higher than in Model 2c.

As shown in Appendix Table 3.3, the pattern of grain movement also had a markedly different pattern from that in Model 3a. The Prairies continued to supply all imported grain required by the Maritimes while Quebec's import from the Prairies again was 21 percent less than that in Model 3a and nine percent less than that in Model 2c. B. C.'s import also dropped. Total grain movement was 20 percent less than that in Model 3a and ten percent less than that in Model 2c.

As shown in Appendix Table 3.2, the cost difference between Model 3a and Model 3c was that of over $61 million in favour of the latter. The difference between Model 2c and Model 3c was over $54 million in favour of the latter.

Unlimited slaughter capacities (Model 3d). The spatial production pattern of beef cows and claves was the same as in Model 3c (Appendix Table 3.5 and 3.6). However, there were changes in the movement and regional production patterns of feeder cattle. The relaxation of slaughter capacity coupled with a reduction in the grain price in Saskatchewan enabled the province to feed all the feeder calves produced within the province. Hence the output of finished cattle as well as beef production rose dramatically. Saskatchewan's share of the nation's cattle feeding rose to 28 percent, second only to Alberta (Appendix Table 3.11), and it also had over a quarter of the nation's cattle slaughter (Appendix Table 3.15). With the curtailment of feeder calves imported from Saskatchewan, the output of Alberta's cattle and beef declined slightly but it still had two-fifths of the nation's output of finished cattle (Appendix Table 3.11) and 36 percent of the nation's beef production (Appendix Table 3.16). Conversely, as both feeder calves and finished cattle ceased to enter Manitoba, the province's share of the nation's beef product-ion dropped to less than half of that in Model 3c (Appendix Table 3.16). With the reduced output of finished cattle compared with Model 3c, Ontario's beef output also declined from 26 percent of the nation's output to 22 percent (Appendix Table 3.16).

The pattern of beef movement changes with the changes in regional production of beef. As shown in Appendix Table 5.20, Manitoba's export of beef was severely reduced. Conversely, the increased beef output enabled Saskatchewan to export beef to Ontario and Quebec and became the sole supplier of fed beef to the Maritimes. Alberta's share of Quebec's beef market declined slightly as its beef output dropped.

The pattern of market pig production was the same as in Model 3c. However, as Ontario could kill all the pigs it produced there was no movement of slaughter pigs (Appendix Table 3.25). The pattern of pork production and movement was the same as in Model 2d.

With the decline in cattle feeding activities in Ontario, Ontario's surplus corn were all shipped to the Maritimes, undercutting the locally produced grains in the Maritimes (Appendix Table 3.3). Consequently, compared to Model 2d and Model 3c the total feed grain movement increased by five percent.

As shown in Appendix Table 3.2, the total cost difference between this situation and Model 3c was $3 million in favour of this situation. Compared with Model 2d, there was a saving of close to $57 million in favour of this situation.

The OWN Condition

No change in basic herds and slaughter capacities (Model 3b). As shown in Appendix Table 3.11, the further increase in cost advantage in the Prairies encouraged even larger growth of feeding activities there. Export of feeder calves from Saskatchewan to Ontario ceased as it became cheaper for Saskatchewan to feed the calves itself or to export the càlves to Alberta for feeding. Consequently, Ontario's fed cattle output dropped by 15 percent when compared with Model 2d. The greatest benefactor, in terms of cattle production, was Alberta. With depressed grain cost, Alberta could even import feeder calves from Saskatchewan and send them to the East as beef. The import of calves from Saskatchewan was possible only because Saskatchewan's cattle feeding was limited by its slaughter capacity. As a result, as shown in Table 3.11, Alberta had its share of the nation's fed cattle output increased from 38 percent to 40 percent.

With an increase in its fed cattle output and its limited slaughter capacity, Saskatchewan had to export finished cattle to Manitoba for slaughter (Appendix Table 3.12). Ontario's share of the nation's beef output continued to drop from 29 percent in Model 2b to 25 percent. On the other hand, Alberta's share rose from 34 percent to 37 percent (Appendix Table 3.15).

With a further decrease in beef output in the beef-deficit regions, there was an increase in beef movement by nine percent over that in Model 2b (Appendix Table 3.26). The drop in Ontario's beef output was matched by a nearly twofold increase in Manitoba's export of beef to Ontario. However, Manitoba had to give way to Alberta in the Quebec market. Under this situation, Alberta supplied 78 percent of Quebec's fed beef requirement and

62 percent of Quebec's total beef requirement (Appendix Tables 3.18and 3.19).

There was no change in the production and movement of pigs and pork from that in Model 2a. With Ontario's cattle production reduced, it supplied all the feed grains deficit in the Maritimes with its corn, even replacing the locally produced feed grains there. Consequently, Prairie feed grain export to the Maritimes disappeared (Appendix Table 3.3).

As to cost reduction, total cost involved was $53 million less than that in Model 2b, a decrease of 11 percent (Appendix Table 3.2).

Changes in basic herds allowed (Model 3e). With restrictions on the distribution of basic herds relaxed, the spatial patterns of beef cows and calves born changed to the same levels as in Model 2e (Appendix Tables 3.8 and 3.9). The diminished supply of calves from Eastern Canada again reduced Ontario's share of the nation's feeder cattle to 22 percent. The enlarged cost advantage in Alberta enabled it to take in calves from Saskatchewan for feeding. This resulted in a decline in cattle feeding in Saskatchewan as it was more economical to ship the calves to Alberta for feeding and slaughter and then ship to the East as beef, than to finish them in Saskatchewan and to ship them to Manitoba for slaughter (Appendix Table 3.9).

Despite a small number of slaughter cattle shipped from Saskatchewan, the reduction in the output of finished cattle caused Ontario's beef output to drop from a quarter of the nation's share in Model 3b to 22 percent. On the other hand, Alberta had its share risen from 37 percent to 43 percent (Appendix Table 3.16). Associated with this change were changes in the beef movement, which had a 12 percent increase from that in Model 3b (Appendix Table 3.20). Again, Manitoba increased shipment to Ontario but it gave way to Alberta in the Quebec market. Alberta supplied, under this situation, over four-fifths of Quebec's beef requirement.

However, the spatial pattern in pig and pork production remained unchanged from that in Model 2e. As the patterns in Model 2b and 3b were the same, and the pattern in Model 2e was the same as in this situation, comparison between this situation and the situation in Model 3b was the same as the comparison between Models 2b and 2e discussed previously.

With respect to grain movement, the release of feed grains from Ontario enabled the province to supply the need of the Maritimes completely, replacing the locally produced feed grains. Feed grain movement from the Prairies to Quebec and B. C. declined from that in Model 3b because of a reduction in the number of livestock in these regions (Appendix Table 3.3).

Comparing the cost involved with that in Model 3b there was a reduction of $63 million. Comparing with Model 2e the reduction was over $56 million (Appendix Table 3.2).

Unlimited slaughter capacities allowed (Model 3f). Relaxation of the limitations on slaughter capacity brought no change in the spatial production pattern of beef cows and calves born from Model 3e (Appendix Tables 3.5 and 3.6). The distribution of cattle feeding and slaughter and the movement of beef were all identical with those in Model 3d. The same was also true of pig and pork production and movement. Hence when compared to the spatial pattern of cattle and beef production in Model 3e, the lifting of the limitation on cattle slaughter enabled Saskatchewan to feed all its output of feeder calves (Appendix Table 3.9). Therefore beef production in Saskatchewan increased dramatically by 184 percent while that in Alberta and Manitoba declined by eight and 24 percent respectively (Appendix Table 3.16). The magnitudes of production of pigs and pork were also the same as in Model 3d. The movement of grains was the same as in Model 3e.

Compared to Model 3e there was a cost reduction of $3.2 million. Compared with Model with Model 2f the reduction was $58 million (Appendix Table 3.2).

EFFECTS OF ELIMINATION OF ALL SUBSIDIES ON FEED GRAIN MOVEMENT

The BUY Condition

No change in basic herds and slaughter capacities (Model 4a). Under this situation, movement of feeder calves to Alberta to Ontario disappeared as Saskatchewan sent the calves to Alberta instead (Appendix Table 3.7). The lower grain price in

Alberta enabled the province to import the calves and ship beef to the East. Alberta's cattle production was further increased by B. C.'s shipping all its excess replacement heifers to Alberta (Appendix Table 3.8). Consequently, Alberta's share of the nation's fed cattle output rose from 38 percent in Model 3a to 41 percent in Model 4a (Appendix Table 3.11). With changes in the fed cattle output and with no change in the movement of slaughter cattle, Ontario's share of the nation's beef production further declined by two percent while that of Alberta increased by the same percentage (Appendix Table 3.16). However, the change in pattern of beef movement was that Alberta increased its export to Quebec while the other Prairie Provinces increased their export of beef to Ontario. Alberta also had to supply all the fed beef requirement in B. C. (Appendix Table 3.20).

The production and movement of pig and pork remained the same as in Model 3a. The decline in livestock production in Ontario enabled more corn to be shipped into the Maritimes, undercutting the locally produced grains as well as the export from the Prairies. Grain export from Alberta to B. C. was also reduced (Appendix Table 3.3).

The saving in cost as compared to Model 3a amounted to $7.7 million (Appendix Table 3.2).

<u>Changes in basic herds allowed (Model 4c)</u>. The spatial pattern of cattle and beef production was the same as in Model 3e. As in Model 4a, further reduction in grain prices in Alberta

induced Saskatchewan to stop shipping its feeder calves to Ontario but ship all of them to Alberta. Hence Alberta's feeder cattle industry grew even further and had 48 percent of all Canada's cattle on feed (Appendix Table 3.11). On the other hand, Ontario's share declined from 28 percent in Model 3c and 27 percent in Model 4a to 22 percent. Ontario's share of beef production fell behind that of Manitoba. Though Saskatchewan also sent a small number of finished cattle to Ontario for slaughter, its share in beef production dropped (Appendix Table 3.16).

The spatical pattern of pig and pork production was the same as in Model 3c. Its comparison with Model 4a in this aspect was same as that in comparing Models 3a and 3c.

In the case of grain movement, the availability of cheap Ontario corn resulted in the Maritimes region substituting Ontario corn for its own locally produced feed grains. Hence total grain movement increased but the export from the Prairies stayed the same as in Model 3c. Compared to Model 4a, total grain movement declined by 16 percent though the movement from Ontario to the Maritimes increased by a 32 percent (Appendix Table 3.3).

Total cost involved was $62.5 million less than that in Model 4a, a one percent reduction. Compared with Model 3c the reduction was $9 million (Appendix Table 3.2).

Unlimited slaughter capacities (Model 4d). The spatial pattern of cattle and beef production and movement was identical to that in Model 3d. Consequently, the comparision between Model 3c and Model 3d in cattle and beef was the same as in comparing this situation with Model 4c. However, with increased input cost in the Maritimes and a reduced shipment of Ontario pigs to Quebec for slaughter, Quebec was able to increase its pig production by nine percent with a three percent increase of grain import from the Prairies when compared with Model 4c (Appendix Tables 3.26, 3.3). By contrast, pig production in the Maritimes declined as it became more economical to import more pork from Ontario instead. While the total pork movement remained unchanged from that in Model 3d, there was less pork shipped from Ontario to Quebec and more to the Maritimes (Appendix Table 3.31). The cost involved was $3.2 million less than that in Model 4c and $9.3 million less than that in Model 3d (Appendix Table 3.2).

The OWN Condition

No change in basic herds and slaughter capacities (Model 4b). The impact in this situation was more than that in the BUY condition. As in Model 4a, the excess replacement heifers were shipped from B. C. to Alberta and there was less grain export and more beef export from Alberta to B. C. when compared to Model 3b (Appendix Table 3.3). However, it was also more economical for Ontario to increase its beef import and reduce its cattle feeding (Appendix Tables 3.11, 3.16). Consequently, its demand of feeder calves from the Maritimes dropped, resulting in the Maritimes having excess capacity in calf production. By contrast, the low grain cost in Alberta enabled the province to import more claves from B. C. (Appendix Table 3.7).

As a result, Ontario's share of the cattle slaughter fell from 25 percent in Model 3b to 23 percent while that of Alberta rose from 36 percent to 38 percent (Appendix Table 3.15). The beef movement also changed as more beef from Alberta was shipped to Quebec, supplying 69 percent of Quebec's total beef requirement. The drop in Ontario's beef output enabled a 23 percent increase in beef movement from Manitoba to Ontario when compared to Model 3b. Manitoba increased its export to Ontario by reducing its export to Quebec (Appendix Table 3.20).

The pattern of pig production and movement as well as the movement of pork was the same as in Model 4a. While there was an increase in pig production in Ontario and a decrease in Quebec as compared to Model 3b the pattern of pork production remained unchanged (Appendix Table 3.32). The release of grains from cattle feeding in Ontario enabled Ontario grain to outbid the local grain produced in the Maritimes. The grain exported from Alberta to B. C. was also less than that in Model 3b (Appendix Table 3.3). Total cost involved was $8 million less than that in Model 3b, a decrease of only 0.2 percent (Appendix Table 3.2).

<u>Changes in basic herds allowed (Model 4e)</u>. When restrictions on the basic herds were relaxed, the spatial pattern of production of cattle, beef, pigs and pork were identical to the corresponding patterns in Model 4b. Fed cattle output and cattle slaughter in Ontario were further decreased from those in Model 4b and there was a further increase in Alberta (Appendix Tables 3.11, 3.13). Consequently, there was a eight percent

increase in beef movement over that in Model 4b (Appendix Table 3.20). Compared to Model 4b, pork production in all regions except Quebec rose (Appendix Table 3.30). Consequently, there was a 36 percent increase in Quebec's pork imports, mainly from Manitoba (Appendix Table 3.31).

Grain movement was the same as in Model 3e. Ontario corn captured the entired feed grain market in the Maritimes (Appendix Table 3.3).

As to total cost involved, compared to Model 4b there was a reduction of over $64 million or a reduction of over one percent. Compared with Model 3e the reduction was over $9 million (Appendix Table 3.2).

Unlimited slaughter capacities (Model 4f). With the limitation on slaughter capacity lifted, the spatial pattern of feed grain, cattle, pig, beef and pork production as well as their movement was the same as in Model 4d. Consequently, comparison of these patterns between Models 4e and this situation was the same as between Models 4c and 4d.

As to the cost involved, compared to Model 4e, there was a reduction of $3.2 million. Compared to Model 3f the reduction was $9.2 million (Appendix Table 3.2).

SUMMARY OF RESULTS BY REGION

The Maritimes

The feeding of feeder calves in the Maritimes existed only under the BUY condition in Models 1a and 2c (Appendix Table 3.9). In all other situations, all feeder calves produced in the region were exported to Ontario (Appendix Table 3.7). The region fed its own excess replacement heifers in all the short run situations, unaffected by changes in grain costs. However, as there was no production of beef cows in the long run situations, there was no excess replacement heifers then (Appendix Table 3.10).

The dependence on imported beef increased with these changes. While in Model 1a the region provided 36 percent of its own beef, it provided for itself, except in Model 2c, only eight percent in all long run situations, all of which was non-fed beef (Appendix Table 3.16). Consequently, the utilization of cattle slaughter capacity dropped from 100 percent in Model 1a to 35 percent in other short run situations and finally to only 22 percent in the long run situations with the exception of Model 2c (Appendix Table 3.17).

There were also changes in the origin of beef imported by the Maritimes. Manitoba was the major exporter of beef to the Maritimes until Saskatchewan was allowed to expand its cattle slaughter capacity (Appendix Table 3.20).

With the pig slaughter capacity in Ontario restricted, the region's pig production was not adversely affected by changes in grain freight costs. In fact, production rose when the region was allowed to increase its basic herd. However, when Ontario was allowed to increase its pig slaughter capacity, Ontario's increased pork produced flowed into the Maritimes, outbidding the local production (Appendix Tables 3.23 and 3.31). Consequently, the Maritimes had to reduce its pig and production.

The Maritimes imported grain from the Prairies when Ontario was not able to export its corn. But with Ontario corn becoming available it competed and outbidded grain both exported from the Prairies and produced locally (Appendix Table 3.3).

Quebec

The only time cattle feeding occurred in the region was in Model 1a when its excess replacement heifers were fed locally rather than being exported to Ontario (Appendix Table 3.10). Beef cattle production disappeared altogether when basic herds in other regions increased. Consequently, the region was highly deficient in beef, especially fed beef (Appendix Table 3.21). For all situations analysed in this study, Alberta remained Quebec's main supplier of beef. The peak of Quebec's reliance on Alberta reached when Quebec had to import over from Alberta in Models 3e, 4c and 4e. Nonetheless, when cattle slaughter in Saskatchewan was allowed to increase by lifting the limit on slaughter capacity, Auebec lessened its dependence on Alberta by turning to Saskatchewan (Appendix Table 3.20).

The changes in grain freight subsidy had a more noticeable effect on pig and pork production in Quebec. While in Model 1a Quebec was able to fully utilize its pig production capacity and even import weaner pigs from Ontario for finishing, the movement, however, did not occur in all other situations and Quebec's pig production fell along with reduction in grain freight subsidy (Appendix Tables 3.23, 3.24). When other regions were allowed to enlarge their breeding herds, all did so at the expense of Quebec, which had its market pig production dropped to half of its initial level (Appendix Table 3.22). When Ontario could not slaughter all market pigs it produced due to limited slaughter capacity, it had to export pigs to Quebec for slaughter (Appendix Table 3.25). Yet with the restrictions on slaughter capacity lifted the movement of slaughter pigs to Quebec vanished and Quebec's pork production furhter declined (Appendix Table 3.30). There was, however, a slight respite with the elimination of subsidy on grain movement to the Maritimes. As the Maritimes region increased its demand for pork from Ontario and Ontario had to divert its pork export to the Maritimes (Appendix Table 3.31). Quebec increased its own pig and pork production (Appendix Table 3.30).

The change in pork production led to changes in the origin of pork shipped into Quebec. Manitoba's role as supplier for Quebec's pork requirement rose as Quebec's own supply dwindled (Appendix Table 3.31).

As the reduction of grain freight subsidy resulted in a decrease in Quebec's livestock production, Quebec's grain import from the Prairies dropped. However, there was a slight respite in its grain import in situations with complete elimination of subsidy on grain movement due to slight respite in its pig production (Appendix Table 3.3).

Ontario

Ontario's cattle and beef production declined along with the reduction in grain freight subsidy. This was not because of Ontario's need to import grain but rather due to the comparison between Ontario and the Prairies in their respective costs of cattle production which affected Ontario's import of feeder calves. Ontario imported feeder calves from Saskatchewan and Alberta at the initial situations under both the BUY and OWN conditions. However, as the cost of cattle production in the Prairies dropped, it became cheaper for the Prairies to retain their feeder calves and, consequently, send more beef to Ontario (Appendix Table 3.20). Ontario's import from Alberta disappeared with the elimination of Statutory Grain Rates and that from Saskatchewan with the complete elimination of grain freight subsidy. Furthermore, Saskatchewan stopped exporting calves to Ontario when its cattle slaughter capacity was allowed to expand without limit. Ontario also imported all the feeder calves produced from the Maritimes except in Models 1a and 2c when the Maritimes retained a majority under Model 1a and all of its feeder calves (Model 2c). It also imported the excess replacement heifers from Quebec except in Model 1a.

With all these variations, Ontario's position as a fed cattle producing region declined. Despite an increase in its own production of calves with relaxation of the constraint on basic herd, its production fell from almost a third of Canada's fed cattle to only 22 percent in the long run with the grain freight subsidy completely eliminated (Appendix Table 3.11). Consequently, Ontario's beef production declined from providing nearly 80 percent of its requirement in Models 1a and 1b to just 59 percent in 3d, 3f, 4d and 4f. Consequently, its beef import rose and utilization of cattle slaughter capacity fell from 85 percent to 63 percent accordingly (Appendix Table 3.17).

By contrast, pig production increased with the decrease in grain freight subsidy. With supply of cheap corn as feed, Ontario was the largest producer of market pigs and pork under all circumstances in the model. Its pig production grew with relaxation of the constraint on basic herd (Appendix Table 3.23). Consequently, it had to export a portion of its finished pigs to Quebec until the constraint on pig slaughter capacity was lifted (Appendix Table 3.25).

Ontario's grain export to the Maritimes increased along with its reduction in cattle feeding, as a drop in its grain consumption allowed the surplus corn to be exported. In fact, Ontario corn captured the Maritimes market by sucessfully replacing the grains previously supplied by the Prairies as well as local producers in the Maritimes.

Manitoba

Manitoba's cattle feeding fell with the decline in its own feed grain prices. The reason was Manitoba's limited grain supply. Pig and cattle completed for grain. Pigs being more efficient in converting grain input, increased with a decline in grain prices while cattle production declined (Appendix Tables 3.11 and 3.23). Furthermore, Manitoba depended on Saskatchewan for a large portion of its feeder calves and when Saskatchewan was able to feed the calves itself, Manitoba's supply of feeder calves was reduced (Appendix Table 3.11). Consequently, Manitoba's cattle production declined. Its beef production remained relatively stable until Saskatchewan had to send in cattle for slaughter (Appendix Table 3.16). However, once Saskatchewan was allowed to expand its slaughter capacity, Manitoba's beef production fell drastically.

By contrast, Manitoba's pig production rose from only having six percent of the nation's production in Model 1a to as high as nearly 12 percent (Appendix Table 3.26). Pork production increased accordingly (Appendix Table 3.30). Quebec was the major export market for Manitoba's pork (Appendix Table 3.31).

Since Manitoba was only self-sufficient in feed grain production, it was not a feed grain exporting region.

Saskatchewan

Saskatchewan's cattle production was hampered by the comparatively low cost in transporting cattle to Manitoba and its limitation in slaughter capacity. The limitation in slaughter capacity encouraged Saskatchewan to export feeder cattle to

Manitoba, Ontario and Alberta for feeding and slaughter cattle to Manitoba and Ontario (Appendix Table 3.12). Furthermore, low transport of calves caused the province to export a large portion of its feeder calves produced to Manitoba even with an unlimited slaughter capacity when the Statutory Grain Rates were still in force (Appendix Table 3.12).

Saskatchewan supplied non-fed beef to the Maritimes and Ontario even when its cattle slaughter was limited. With the limitation on slaughter capacity lifted along with the elimination of Statutory Grain Rates, Saskatchewan became the second largest beef producing and exporting region (Appendix Table 3.16).

Saskatchewan's pig production remained relatively stable though its production increased when its basic herd was allowed to expand (Appendix Table 3.23). Pork production corresponded closely with pig production as there was no import or export of pigs. B. C. and Quebec were the export market latter grew slightly as its local production fell with a decrease in grain freight subsidy.

Saskatchewan was a major exporter of grains to the Eastern provinces. Grain export declined with the reduction in livestock production in Eastern Canada and the availability of Ontario corn for export in the East (Appendix Table 3.3).

Alberta

Alberta's cattle production was most encouraged by the reduction of grain freight subsidy. The reduction in its grain cost enhanced the competitiveness of Alberta's beef in the Eastern market. However, its output reduced somewhat with increased production in Saskatchewan when the province was allowed to expand its cattle slaughter capacity (Appendix Table 3.11). Alberta was the major supplier of beef to Quebec. Its market in Ontario, however, was captured by Saskatchewan when the latter expanded its beef production. Nonetheless, Alberta remained the largest producer and exporter of beef among the regions (Appendix Table 3.16).

The fluctuation in Alberta's beef production was much due to the fluctuation in its levels of cattle import and export, though its own calf production expanded when its basic herd was allowed to expand (Appendix Table 3.6). Alberta exported feeder calves to Ontario in Models 1a, 2a, 1b, 2d and 2f. The movement only dropped with the elimination of the Statutory Grain Rates. If received feeder calves from B. C. under all circumstances in the model (Appendix Table 3.7). However, with its limited slaughter capacity, Saskatchewan exported some of its finished cattle to Alberta for slaughter in situations when the Statutory Grain Rates were eliminated (Appendix Table 3.12). This movement ceased with Saskatchewan being able to slaughter all its finished cattle.

Pig and pork production in Alberta was not affected by changes in grain freight rates though Alberta's share of pig output increased when its basic herd was allowed to increase. Alberta was the third largest pig and pork producing region

(Appendix Table 3.26).

Alberta also contributed to the grain exports to the Eastern but was the sole supplier of feed grain for cattle and pigs in B. C. (Appendix Table 3.3).

B. C.

B. C. had to depend on Alberta for grain supply for its cattle and pig production. Consequently, its cattle production was restricted to feeding of excess replacement heifers with freight subsidized grains. In the long run, it was not capable of producing beef cows and heifers and hence all beef cattle was eliminated (Appendix Table 3.11). Consequently, B. C. only produced non-fed beef from culled dairy herd and depended on Alberta for all fed beef requirement (Appendix Table 3.18).

B. C. only produced a little over one percent of the nation's pigs and pork (Appendix Table 3.30). However, the production was not affected by the reductions in grain freight subsidy. Pig production increased slaightly when the size of basic herd was allowed to expand. It received two thirds of its pork requirement from Alberta and Saskatchewan (Appendix Table 3.31).

All the feed grains imported by B. C. were from Alberta. The import fell with a reduction of B. C.'s cattle production in the long run situations (Appendix Table 3.3).

SUMMARY OF THE EFFECTS BY SECTOR

Grain Production

Grain production in Quebec and Ontario would not be affected by a reduction in the grain freight subsidy. However, as Ontario's own demand for feed grains continue to decrease with decreases in the level of subsidy, Ontario corn had to be exported to the Maritimes, taking advantage of the retention of feed freight subsidy in the Maritimes (Appendix Table 3.3). Grain producers in the Maritimes had to face competition from imported Ontario corn.

In the Prairies, the reduced demand for grains from the East resulting from a reduction in the grain freight subsidy was matched by an increase in the local demand for grain. In fact, as the Western livestock producers generally used more grain in feeding the volume of feed grains consumed in Canada increased. However, as the price the grain producers received was reduced with decrease in the subsidy and Statutory Grain Rates, their income from grains showed a decrease. However, if the affected producers would switch to mix farming of grains and livestock, their reduced income could be largely offset the reduced opportunity cost of feeding livestock with the farmers' own feed grains at lower prices and expanding livestock production on the mixed farms.

Livestock Production

While cattle production fell in the East along with the reduction in grain freight subsidy, the corresponding gain in the Prairie livestock production, however, was not uniform. The growth of cattle feeding with the reduction in grain freight subsidy was most evident. Saskatchewan's tendency to increase its cattle production was hampered by its limitation on cattle slaughter capacity and the low transportation cost of cattle to its neighbouring provinces. Since Manitoba was barely self-sufficient in its feed grains, the limited availability of feed grains caused cattle feeding in the province to fall as the grains had to be used in pig prouction (Appendix Table 3.11).

With respect to pig production as shown in Appendix Table 3.3, Quebec was most adversely affected by a reduction in the grain freight subsidy. Quebec's loss was, for the most part, Manitoba's gain. Pig production in the Maritimes also depended much on imported corn from Ontario and production dropped as grain freight subsidy of Ontario corn was eliminated. Ontario's pig production increased if its basic herd size was allowed to increase and the new F.F.A.P. was introduced. Saskatchewan, Alberta and B. C. showed relatively few changes in their pig production in response to changes in grain freight subsidy, although they would expand their production if their basic herds were allowed to increase. Of great importance were the differences in spatial patterns in response to changes in grain freight rates between the situations when the Prairie livestock producers used their own grains and when they had to buy grains from elevators. As already observed while discussing situations of Models 1a and lb in the earlier section of this chapter, there would be more livestock and meat production in the Prairies under OWN situation. Also, a reduction in grain freight subsidy further strengthened up the process of increasing livestock production in the Prairies. In Saskatchewan under the OWN situations, it became even more economical to feed cattle and then ship them out for slaughter than to export feeder calves (Appendix Table 3.11). On the other hand, Quebec was not able to import weaner pigs for feeding and compete with imported pork from the West (Appendix Table 3.21). However, the difference in spatial pattern between the OWN and BUY conditions disappeared as the cost difference between the East and West increased with every successive drop in the grain freight subsidy.

Meat Processing

The location of meat processing was closely related to the location of livestock production because it was usually cheaper to ship meat instead of live animals for slaughter. The only exception was when the slaughter capacity was less than the output of slaughter animals produced in the region as in the case of cattle in Saskatchewan and pigs in Ontario. Consequently, the general pattern was that the reduction of grain freight subsicy reduced beef and pork production in Eastern Canada while increased the production in the Prairies (Appendix Tables 3.16, 3.30).

By contrast, excess capacity was a problem in other regions. B. C. and the Maritimes used less than forty percent of their cattle slaughter capacity in all situations, though their capacities were already relatively small (Appendix Table 3.17). Excess capacity was more acute in pig slaughter, especially in the Prairies. As shown in Appendix Table 3.29, Manitoba had less than thirty percent of its pig slaughter capacity used up even at its peak production. Saskatchewan used less than half and Alberta less than forty percent at their respective peak levels. Quebec also used less than a third of its capacity when its pork production declined.

Transportation and Inter-regional Trade

Movement of feed grains. The above mentioned changes in spatial pattern of production caused changes in the patterns of transportation. As livestock production in Eastern Canada decreased. When the grain freight subsidy was completely eliminated in the long run situations, the import of Prairie grains by Eastern Canada was cut by almost a third from the initial situations under both the BUY and OWN conditions (Appendix Table 3.3). On the other hand, surplus Ontario corn resulting from a decline in cattle production in the province led to increased corn movement from Ontario to the Maritimes.

Movement of feeder calves. The movement of feeder calves continued to decrease with successively lower levels of grain freight subsidy (Appendix Table 3.7). While the Maritimes continued to supply feeder calves to Ontario and while B. C. exported her calves to Alberta in all situations, in the long run the numbers exported from both regions were much reduced. The direction of feeder calf movement from Saskatchewan showed some variations. Under situations when Saskatchewan's cattle slaughter capacity was limited, it exported its feeder calves to Ontario and Manitoba prior to the elimination of Statutory Grain Rates. However, with the elimination of Statutory Grain Rates, it diverted part of the movement to Ontario to Alberta and retained more calves for feeding within the region. Furthermore, even without a limit on slaughter capacity, the low transport cost of shipping feeder calves to Manitoba continued to enhance movement of calves from Saskatchewan to Manitoba until the Statutory Grain Rates were eliminated.

Movement of slaughter cattle. As shown in Appendix Table 3.12, the shipment of slaughter cattle again originated from Saskatchewan due to its limited slaughter capacity. The shipment of slaughter cattle increased with increased in the fed cattle production in the province. The movement disappeared with expansion of slaughter capacity in Saskatchewan.

Movement of weaner pigs. The shipment of weaner pigs only occurred from Ontario to Quebec under the BUY condition and when Ontario had used up its slaughter capacity (Appendix Table 3.24). It soon disappeared with reduction in the grain freight subsidy and Ontario shipped finished pigs to Quebec instead. The movement disappeared when Ontario's slaughter capacity was allowed to increase (Appendix Table 3.25).

Movement of beef. As meat production moved away from the major meat consuming areas with decreases in the grain freight subsidy, there were increases in movement of meat. In the case of beef, as shown in Appendix Table 3.20, the increase from Model 1a to Model 4a was 14 percent. The difference between Models 4a and 4d was 12 percent. Alberta was the largest exporter of beef and Quebec the largest importer. In fact, Alberta was the largest supplier of beef for Quebec. Saskatchewan's beef production was small in comparison with Alberta and Manitoba when its slaughter capacity was restricted. Its beef export soared with the limit on slaughter lifted and it became the second largest beef exporting region, not only taking much of the market from Manitoba but also a portion from Alberta.

Movement of pork. As shown in Appendix Table 3.31, movement of pork also increased with a decrease in grain freight subsidy. The rate of increase was even greater than corresponding increase in beef movement. Model 1a and Model 4d amounted to 88 percent. Nonetheless, total pork movement was never more than a quarter of total beef movement in the model. Ontario joined the Prairie provinces in becoming pork exporting region. In the short run situations, the greatest importing region was B. C., with Alberta as its major supplier. However, with a reduction in Quebec's pork production due to the curtailed import of slaughter pigs from Ontario (when Ontario was allowed to slaughter all its pigs), Quebec became the largest importing region, obtaining most of its pork from Manitoba.

Consumers

Assuming that the meat producers would pass on the benefits of lower costs to the consumers, at least in the long run, the consumers in both Western and Eastern Canada would benefit from reduced grain freight subsidy.

The cost of meat in the Prairies would be reduced with a reduction in the subsidy because of the cheaper feed grains. The total cost of producing a finished fed cattle in Saskatchewan was $487.29 in Model 1b. In Model 4b the cost dropped to $461.53. Consumers in Eastern Canada also benefited by taking advantage of the cheaper imported meat. In model 1b, it costed $124.74 to produce in Quebec a finished market pig with grain produced locally. Assuming a pig yields 130 pounds of pork, it costed $0.960 per pound. A market pig produced in Manitoba costed 0.933 per pound. However, transport cost for pork costed $0.03 per pound and hence a pound of pork costed $0.963 per pound when shipped from Manitoba to Quebec. However, when all grain freight subsidy was eliminated, a pound of pork produced in Quebec would cost $0.956. On the other hand, a pound in Manitoba would cost $0.905 and hence it costed $0.935 when it was shipped into Quebec. Consequently, the imported pork costed less than the locally produced pork and would, therefore, reduce the cost to the consumer.

However, the assumption of meat producer passing on the benefits of lower costs to the consumer is, admittedly, a dubious one. It is more likely that most, if not all of the benefits would go to the meat packers, the wholesalers and the retailers.

CHAPTER SIX

EVALUATION, CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY

SUMMARY OF RESULTS

The empirical results of the model indicate that the elimination of that subsidy, both in the form of F.F.A.P. and Statutory Grain Rates would enable the Prairies to make use of their natural advantage in livestock and meat production. It is also indicated that the subsidization of grain movement has increased the cost of livestock and meat to consumers and to the nation as a whole. Thus the elimination of the subsidy would reduce the total cost involved in the grain-livestock-meat sector of the economy.[1]

Specific Effects

Effect on the total cost involved. Under situations as prescribed in the model, a complete elimination of the subsidy would bring in the short run (basic herds and slaughter capacities

1. The term "total cost involved" used in this chapter as in chapter five, refers to the total cost involved in the feed grains-livestock-meat system of the economy.

remaining unchanged) a reduction of $98 million from the initial situation under the BUY condition (2.5 percent of the total cost involved) and $100 million under the OWN condition (three percent of the total cost involved), as shown in Appendix Table 3.2. These reductions did not include savings in subsidy payment and administrative costs of the subsidy programs.[2] Greatest savings would occur with the elimination of Statutory Grain Rates which would account for $52 million (53 percent) of the cost reduction in both the BUY and OWN conditions. By contrast, the change from old F.F.A.P. to new F.F.A.P. accounted for 39 percent of the cost reduction and the final elimination of even the new F.F.A.P. only accounted for eight percent of the reduction in total cost involved.

Further savings would occur with changes in basic herds and slaughter capacities in the long run. With all grain freight subsidy eliminated, the relaxation of limitations on basic herds (by ten percent) bought an additional saving of about $63 million. Lifting the limitations on slaughter capacities in addition to relaxing restrictions on basic herds brought a further saving of over $3 million. Consequently, compared to the initial situation, the total saving amounted to about $165 million.

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2. According to the annual report of the Canadian Livestock Feed Board in 1975/76, (Canadian Livestock Feed Board, Annual Report, Crop Year 1975/76, table 3, p. 15), subsidy payment in 1975/76 for the F.F.A.P. was $21 million. The shortfall in total grain revenue in moving grains under the Statutory Grain Rates (including grains for domestic human and livestock consumption, and grains for export), amounted to $141.3 million in 1974. See Carl Snavely, <u>The Commission on the Costs of Transporting Grain by Rail</u>, <u>Report</u>, Vol. I, p. 214 and Appendix p.

Effects on location of livestock and meat production and movement. However, it should also be noted that the response in terms of location of livestock and meat production towards changes in grain freight subsidy is far from showing a simple pattern. A reduction in livestock production in a region may alter the level of production of livestock and meat in several regions and, consequently, the pattern of trade among several regions. The empirical results also indicate that the Statutory Grain Rates are more important as a factor than the F.F.A.P. in affecting the spatial pattern of livestock and meat production. It is mainly because the level of subsidy given under the Statutory Grain Rates to the livestock feeders in Eastern Canada was higher than that of the F.F.A.P. even when the old F.F.A.P. was in effect.

The subsidization of grain movement has definitely encouraged pig production in Quebec at the expense of Ontario and Manitoba. Lifting the grain freight subsidy would reduce Quebec's production of weanling pigs and market pigs, especially in the long run when basic herds in other regions would increase. As grain freight subsidy from Ontario to the Maritimes remained under the new F.F.A.P., the subsidization of pig production in the Prairies continued and indirectly affected pig production in Quebec adversely. With a total withdrawal of the F.F.A.P., Ontario would have to divert some of the pork it shipped to Quebec to the Maritimes, thus enabling Quebec to produce more pigs and pork.

While the subsidization of grain movement enables

Quebec and the Maritimes to produce more fed cattle than they would have if there had been no grain freight subsidy, the chief beneificiary with regards to cattle production is Ontario. While Ontario does not dependent on imported feed grains, the inflated on-farm prices of feed grain in the Prairies resulting from the freight subsidy would reduce the ability of beef producers in the Prairies, (especially those in Alberta and Saskatchewan) to compete with Ontario. Consequently, lifting of the subsidy would encourage cattle feeding in Alberta and Saskatchewan at the expense of Ontario.

The model fails to identify the movement of yearling cattle for feeding except that of excess replacement heifers. However, the movement of this heifers can be used to indicate the direction of yearling movement. As yearlings require less grain they show a stronger tendency than feeder calves to stay at the consuming region. In the model, excess replacement heifers stayed in the Maritimes and B. C. despite that the feeder calves were being exported.

<u>Other factors besides grain freight subsidy affecting livestock and meat production</u>. The empirical results from the model also indicated that there are factors which influence the location of meat production but they are not affected by the grain freight subsidy. A considerable amount of beef produced is from non-fed cattle and their regional distribution is not even. Quebec has a disproportionally large number of dairy cattle. The factor of non-fed beef in total beef consumption and its

effects on regional beef production should not be overlooked.

The amount of grain available locally has an obvious effect on location of livestock production. In the model, livestock production in Quebec and B. C. was hampered by the lack of feed grains in those regions. While Manitoba is closer to the Eastern markets than the other Prairie provinces, its limitation of locally produced grain restricted further expansion of its livestock production.

Slaughter capacity also has a great influence on spatial pattern of livestock production. As indicated by the model, Saskatchewan's cattle production would have been much greater had its cattle slaughter capacity been allowed to expand. This, in turn, would have repercussions on livestock and meat production in Alberta and Manitoba. The same would be true for pig and pork production in Ontario, which would affect pork production in Quebec.

The effect of Ontario corn on livestock production in the East has been largely ignored by researchers in Western Canada. The model used in this study, however, showed that Ontario corn not only enabled Ontario to be self-sufficient in pig production but it also strengthened the economic viability of its cattle production. Furthermore, grain freight subsidy also enabled Ontario corn to be shipped to the Maritimes for livestock production there. Removal of the grain freight subsidy would eliminate cattle feeding and diminish pig production in the Maritimes.

The model also indicated that competition between cattle and pig production exists in those regions where grain supply is limited (as in Manitoba). Pig production is preferred due to its being more efficient in converting grain into meat.

The effect of the grain freight subsidy was much greater when the Prairie livestock producers had to buy grains from the elevators. This was because of the smaller cost difference between the Prairie and non-Prairie regions under the BUY condition than under the OWN condition when the Prairie livestock producers use their own grain for feeding. The acknowledgement of all these factors (which are not directly related to grain freight subsidy) does not lead to diminution of the effects caused by changes in grain freight subsidy. Rather, these factors, while not direcly related to grain freight subsidy, provide additional influences on the spatial pattern of livestock and meat production and movement. Consequently, their influences have to be taken into account while studying the effects of changing the levels of grain freight subsidy on location of livestock and meat production.

EVALUATION OF RESULTS

While the empirical results discussed in chapter five supported the hypothesis that subsidization of grain freight rates affects the spatial pattern of livestock and meat production, it should be noted that the pattern estimated by the model differed from the pattern that actually prevailed in several aspects. While some of the differences can be attributed to the fact that the real world does not always follow the optimal pattern, other factors such as theoretical background, data input and specification of the model can also cause differences between the patterns predicted by the model and the real world. Hence it is necessary to be aware of and in so far as possible, to account for the differences.

Deviation from the Actual Pattern

Feed grains. The estimated quantity of feed grains consumed in the initial situation was about ten percent less than the total amount of feed grains consumed by Canada as estimated by the Canadian Grain Commission as used for domestic feeding.[3] The feed grains available in Saskatchewan and Alberta were not used up entirely. Almost a quarter of feed grains available in these two provinces were not used (compare Appendix Table 3.3 with Appendix Table 3.13). While wastage certainly accounts for part of the deviation, there could also be an underestimation of grains consumed by the animals. The study by Winter also encountered a similiar problem and he failed to offer any explanation for the differences.[4]

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3. Canada Grains Council, Canadian Grains Industry Statistics Handbook 77 (Winnipeg: Canada Grains Council, 1978), table 11, pp. 29-30.

4. See G. R. Winter, Protein Efficiency in Canada (Montreal : Canadian Livestock Feed Board, 1975), p. 121.

Grain movement. Differences also occurred in the magnitude of grain movement. Quebec imported 1.3 million tons of feed grains under the old F.F.A.P. in 1975/76 and 1.15 million tons under the new F.F.A.P. in 1976/77.[5] However, the model estimated the import by Quebec as about 1.7 million tons under the old F.F.A.P. and about 1.65 million tons under the new F.F.A.P. (see Appendix Table 3.3). The over-estimation was probably due to a much larger use of non-grains as feed — such as potatoes and skim milk. On the other hand, actual feed grains consumption in the Maritimes was couble the estimated amount. The model also estimated that there was no feed grain import by Ontario under all circumstances while under the old F.F.A.P. in 1975/76, Ontario's net import of feed grains amounted to 371 thousand tons; and in 1976/77 under the new F.F.A.P., Ontario imported 170 thousand tons of feed grains and exported 163 thousand tons, resulting in a net import of seven thousand tons.[6] B. C.'s estimated feed grain import was very close to the actual. The total amount of feed grain movement under the old F.F.A.P. as estimated in the model was about 2.2 million tons while the estimated amount under the new F.F.A.P. was about 2.1 million tons (Appendix Table 3.3). The actual movement in 1975/76 was 2.4

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5. Canada Grains Council, op. cit., table 60, pp. 209-10. The term "ton" used in this chapter when describing grains refers to tons in barley equivalent, unless otherwise indicated.

6. Ibid..

million tons and in 1976/77 was 1.8 million tons.[7]

Feeder Cattle. With respect to feeder cattle, the greatest drawback of the model was that it indicated no cattle in the stocker-feeder program except for the excess replacement heifers. This is because the stocker-feeder program is more speculative in nature and an optimization model designed to minimize costs would only include feeding calves directly at weaning. Putting the calves through the stocker program would be more expensive.

Total number of cattle on feed. As the model estimated the total number of cattle on feed in the whole year while data published by Statistics Canada gave figures at a point in time,[8] the figures were not directly comparable. However, the estimated shares for all the regions, with the exception of Alberta, were markedly different from the spatial distribution as given by Statistics Canada. The share estimated for Manitoba was much larger whiel those for the other regions were much smaller. There was no cattle feeding activity estimated for Quebec but in actual fact while Quebec's cattle feeding activity lagged behind that of Ontario and the Prairie Provinces it had 105,000 cattle on feed in January 1976.[9] The deviation from the actual occurrence was

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7. Ibid.. Movement to Newfoundland was not included in the figures. It is possible that there was some movement of grains to areas not covered by the new F.F.A.P. and so was not included in the published data.

8. Statistics Canada, Report on Livestock Surveys-Cattle, Sheep, January 1, 1977 and Report on Livestock Surveys-Cattle, Sheep, July 1, 1977, Cat. 23-004.

9. Ibid..

also reflected in the movement of feeder calves and cattle.

Inter-regional movement of feeder calves and cattle. The absence of the stocker-program estimated by the model made comparison with actual movement difficult. This was further hampered by the inadequacy of the published data in Livestock Market Review,[10] which may not include all the actual movement. However, the estimated movement under both the old and the new F.F.A.P. did indicate, as shown in the published data, that B. C. sent most of its feeder calves and cattle to Alberta for feeding. Ontario received feeder calves and cattle from virtually all other regions, and Saskatchewan was a major exporter of feeder calves and cattle. Nonetheless, the size of the movement in different directions was markedly different.

Inter-regional movement of slaughter cattle. The movement of slaughter cattle was much varied and larger than that estimated by the model. The model indicated that it was more economical to slaughter the finished cattle at the location they are fed than to ship them to other regions for slaughter. Consequently, whenever the slaughter capacity allows, the cattle are slaughtered wherever they are finished. However, the Livestock Market Review showed that there were sizable movements of slaughter

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10. Canada Department of Agriculture, Livestock Market Review, 1977 (Ottawa: Canada Department of Agriculture, 1978), tables 17, 18, pp. 52-55. For a discussion of the inadequacy of the data published in the Livestock Market Review, see H. Bruce Huff, Market Information for Beef: Status and Requirement, Research Report No. 8 of the Commission of Inquiry into the Marketing of Beef and Veal, (Ottawa: Department of Agriculture, 1976), pp. 17-18.

cattle from Alberta to Ontario, Saskatchewan to Alberta, Manitoba to Ontario, B. C. to Alberta, and Quebec to Ontario[11] which did not appear in the model.

<u>Spatial pattern of cattle slaughter</u>. The estimated spatial pattern of cattle slaughter was relatively close to what actually happened. The estimated cattle slaughter was within five percent of the actual number in 1976 (complete 1977 figures were not available at the time of writing).[12] Alberta and Ontario were estimated to be leading in cattle slaughter and this is what actually happened. However, their estimated shares were less than their actual shares. Alberta had 37 percent of all cattle slaughtered in Canada in 1976 while Ontario had 31 percent (see Appendix Table 1.2). However, Appendix Table 3.15 shows that average percentage estimated for Alberta was only 31 percent in situations under the old F.F.A.P. and 33 percent under the new F.F.A.P.. The figures for Ontario were about 28 percent in both circumstances. On the other hand, Manitoba was estimated to have 20 percent and Saskatchewan nine percent of the nation's share of cattle slaughter in Model 1a and Model 2a. However, their actual shares of the nation's cattle slaughter were only 13 and six percent respectively.

<u>Pig production</u>. With respect to the production of pigs

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11. Canada Department of Agriculture, <u>Livestock Market Review 1977</u>, table 10, pp. 26-27.

12. Compare Table 5.15 with Table 1.2, p.   of the thesis. The estimated figure was lower.

and pork, the estimation was much closer to the actual spatial pattern than in cattle and beef. Again, as the model estimated the total number of pigs in the whole year while Statistics Canada data[13] estimated the number at a point in time, the figures are not directly comparable. However, the estimated percentage share of market pigs in each region was within a ten percent range except in Ontario and Manitoba. The estimation for Ontario was higher than the actual while the estimation for Manitoba was lower in situations under the old F.F.A.P.. Yet they were still within twenty percent of the actual shares.

Movement of weaner pigs. The estimated movement of weaner pigs from Ontario to Quebec was much smaller than the actual. However, it should be noted that institutional factors such as vertical integration of hog industry in Quebec have a strong influence on the movement of weaner pigs.[14]

Movement of slaughter pigs. The model estimated no movement of slaughter pigs except the movement from Ontario to Quebec. However, the Livestock Market Review recorded that there

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13. Statistics Canada, Report on Livestock Surveys, Pigs January 1 1977 and July 1, 1977, Cat. 23-005 (Ottawa: The Minister of Industry, Trade and Commerce, 1977).

14. To the author's knowledge, there are no precise published data on inter-regional movement of weaner pigs. Even a Canada Department of Agriculture publication merely noted in passing that Quebec bought some 250,000 weaner pigs from Ontario annually. See Canada Department of Agriculture, Orientation of Canadian Agriculture, A Task Force Report: A Review of the Canadian Agriculture and Food Complex - the Conditions, Vol. I, Part B (Ottawa: Canada Department of Agriculture, 1977), p.352.

were movements of slaughter pigs in various directions.[15] Nonetheless, the inter-regional movement of slaughter pigs involved only two percent of the slaughter pigs marketed in 1976 and 1977 and the largest movement was from Ontario to Quebec.[16] The small deviation should not have too much effect on the spatial pattern of pork production.

Pig slaughter. The estimated pig slaughter for Canada was less than five percent more than the actual slaughter in 1976 (compare Appendix Table 3.28 with Table 1.3). Ontario and Quebec were correctly estimated to be the leaders in pig slaughter. However, the share attributed to Quebec in the model under the old F.F.A.P. was about a fifth lower than what actually occurred. Saskatchewan's share was estimated to be about a fifth higher while that of Manitoba was also slightly more than a fifth lower than what actually occurred. The estimates for the other regions were rather close to the actual pattern.

Limitations in Model Specification

Besides the reasons already mentioned for the deviations between the estimated and the actual movement of grains and the lack of a stocker-feeder cattle program there are also limitations in the specification of the model.

First of all, economic factors, as is well known, are

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15. Canada Department of Agriculture, Livestock Market Review, 1977, table 35, pp. 119-20.

16. Ibid., tables 35 and 38, pp. 119-20, 122.

not the sole determinant of farm production patterns. An example related to meat production is the vast quantity of dairy cattle in Quebec which is out of proportion relative to the demand for dairy products in the province; and the location of dairy products is in general highly market-oriented. The number of dairy cows in the province, however, provides a large excess of dairy calves for veal or for feeding. The phenomenon cannot, therefore, be explained by the economics of cow-calf production alone.

A limitation in the model is due to the linear programming techniques used in the study. Linear programing techniques do not allow the resource constraints to interact with the variables in the objective function. A great weakness of the model is that it takes the demand for meat in the recource constraints as given and assumes that changes in prices of meat will not affect the demand for meat by region. Obviously the assumption is only true if the demand for meat is perfectly inelastic. But the demand for meat is more likely to be elastic (or at least it is not totally inelastic). Therefore, the quantity of meat demanded in a region will increase with a decrease in the price and vise versa. Consequently, the changes in the transport cost of grains will likely affect the quantity of meat demanded in a region. Furthermore, there is also the problem of "cross elasticities". Price changes in one type of meat will affect the demand for another.[17] The models based on the least-cost theory lack the flexibility of allowing changes in demand.

Another limitation concerning the analysis is that the assumption of perfect competition at the farm level may not be realistic. It is generally known that perfect competition is hardly witnessed in any sector of the economy these days. It certainly did not exist in the feed grains market in Canada, at least prior to the implementation of the new Feed Grains Policy in 1976. The feed grains prices in the Prairies and the transportation rates are certainly not determined by perfectly competitive forces of demand and supply because of the prices set by the Canadian Wheat Board and other government regulations.[18] Consequently, the costs of grains calculated and used in the models are most likely affected by the Wheat Board decisions.

The model also could not take into account all of the economic factors. The markets in the base year for grains, live animals, meat and transportation agents were not necessarily in equilibrium and hence the actual pattern which prevailed was not

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17. There are several published estimates on the elasticities of demand for beef and pork in response to price changes. Hassen and Johnson estimated in 1976 that price elasticity for beef was -0.85, while that of pork was -0.95. As to cross elasticities, they also estimated that a one percent increase in the price of pork would increase the consumption of beef by 0.11 percent. On the other hand, a one percent increase in the price of beef would increase pork consumption by 0.06 percent. See: Canada Department of Agriculture, Orientation of Canadian Agriculture, . . ., p. 342.

18. Food Prices Review Board, Feed Grains Policy in Canada (Food Prices Review Board, Ottawa: 1975), p. 40.

necessarily optimal in nature. Nor could the model take into account such factors as market profitability, international trade, structure of the industry, the effects of vertical integration, the exercise of market power by the various transport modes, the packers and the marketing boards. All these factors can affect the problem of capacity. Low utilization of capacity increases the cost of production as average overhead cost rises. A full capacity operation of the plant, however, can also lead to bottlenecks, excessive wear and tear, frequent breakdowns, and, therefore, increase the cost of production. Thus full utilization of capacity as shown by the model is unlikely. The model has not looked into the availability of alternative enterprise to the farmers. If farmers in a region have little economic opportunity except, for example, to grow pigs, even though pig production is not optimal for the region, they may have little choice but to produce at sub-optimal level. The model also assumes no international trade in meat. In fact this is not true. International trade in meat may affect the spatial pattern of production and movement of meat. Deficits can be met by foreign import and hence alleviate the dependence on Canadian sources. On the other hand, international export enables livestock and meat to be produced without regard to the domestic market.

The use of single figures for cost data and technical coefficients for the nation as a whole could also create problems. It is conceivable that there are variations among the regions with respect to cost and usage of an input.

The model is also static in nature and does not indicate the adjustment period needed for the new spatial pattern to reach optimum. Adjustment may be more obvious and take shorter time in hog production. Hogs are more dependent on grains than cattle as the latter feed on forages as well. Consequently, changes in grain prices will have a more immediate effect on hog production. Moreover changes in basic herds of pigs will affect hog production much faster than in the case of cattle because of the relatively short time involved (about six months) in producing breeding pigs and market pigs and the large number of weaner pigs produced by a sow. As a result, the new spatial pattern in hog production resulted from a change in grain freight subsidy can be reached in one to two years' time. Cattle production, however, is more complicated. It takes two years to produce a cow and the percentage of calf crop is usually about 85 percent. Consequently, effects of changes in basic herds will take much longer time. Adjustment period for cattle production to response to changes in grain costs may take four or more years.

Admittedly, the model has its limitations and deficiencies. Conceptually one may be able to construct a more complex and realistic model taking into account the economic, social and institutional factors not considered in the model used in this study. In fact, Graham and Winter have developed a conceptual model taking into account many factors not considered in this model. Those factors include international trade in livestock and animal products, adjustment in a certain class of nutrient fed in a province because of inter-provincial trade in livestock, and adjustment in yield of animal products due to inter-provincial and international trade.[19] However, a great disadvantage of taking into account all the conceivable economic, social and institutional factors in a model would be the over-complexity of the model. A model taking into account all the conceptual factors can become so complicated that it would become almost a comprehensive model of the whole agricultural economy. Such a complex model would be too detailed for the purpose of this research project. In establishing all the variables and equations required for a complicated model which might take into account all the factors mentioned in the previous paragraphs, more assumptions have to be made and more sub-sectors of the agricultural economy, agricultural policies and practices have to be considered. Changes in other agricultural policies or other social-economic conditions would invalidate the assumptions made accordingly. The original objectives in establishing the model can easily be lost in too many details. If the model does not make provisions for changes in these assumptions, the model would be too rigid, as all these agricultural policies and socio-economic conditions are always changing. If the model makes provisions for such changes, different patterns of empirical results would occur with changes in the assumptions. This would make

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19. J. D. Graham and G. R. Winter, "A Spatial Model for Analysis of the Canadian Livestock and Livestock Product Sectors", Chapter 10 in G. R. Winter, <u>Protein Efficiency in Canada</u> (Montreal: Canadian Livestock Feed Board, 1975), pp. 309-23.

comparison of the effects of different levels of grain freight subsidy[20] on location of livestock and meat production very difficult.

Furthermore, even if such a complex model is developed conceptually, much of the data required may not be available. As discussed in Chapter four of the thesis while describing the cost and technical coefficients, much of the data used in this model here are from unpublished sources already and data for a more complicated model would likely be even more difficult to obtain. This is particularly true for cost data relating to activities carried out by private corporations such as the meat packing industry. Even if such data could be obtained, collection and estimation of data on many items in the economic, social and institutional factors described in the previous paragraphs would be major projects by themselves. Limitations of time and financial resources make it infeasible to incorporate them into this study.

Consequently, the model used in this study had to be modified according to the availability of data. An example is in the delineation of regions. The model has to delineate regions according to provincial boundaries despite that provincial boundaries do not necessarily reflect the boundaries of economic regions. The regions delineated on the basis of provincial boundaries are also likely to be too large for the study. Even the

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20. As in Chapter five, the term "grain freight subsidy" used in this chapter refers to the subsidization of feed grains movement under the F.F.A.P. and the Statutory Grains Rates.

representation of a region by a point in space is far from ideal. Areas in a region delineated in the study may be markedly different from the rest in production practice and costs involved in livestock and meat production. A good example is the Peace River District in B. C. and Alberta. However, since usually only provincial, or in the case of the Maritimes, only regional data are available, one has to use provincial boundaries as the basis for delineation even though they are not ideal.

Aspects of Results in Accordance with Actual Occurrence

Notwithstanding the foregoing limitations and deviations from the actual pattern discussed in the previous section, the basic validity of the model in this study is substantiated by the fact that the results estimated by the model do indeed show a noticeable correspondence with the actual occurrence in many aspects.

For the model as a whole, while the estimated spatial pattern of the intermediate products is somewhat different from the actual pattern, the regional production of final products in the initial situation is in most cases within ten percent of the occurrence. Even at the inter-mediate stage, there is a reasonably close parallel between the estimated pattern and the actual occurrence.

The empirical results support the commonly held belief that meat production has shifted to the sites of livestock production, it indicates, in support of studies made by other researchers such as the Canadian Transport Commission and the Canadian Federation of Agriculture, that shipping live animals for slaughter is more expensive than transporting finished meat.[21] As a result, the location of livestock slaughter has shifted closer to the location of livestock production, except where interfered by institutional factors. Hence, Alberta's position as the dominant producing province of beef [22] was supported by the model. The same was true for Ontario, which, with its corn supply, dominates pork production.

Similiar locational relationship between input and output occurs between feed grains and livestock production. The empirical results support the growth in Canada's share of cattle production by the Prairies and a decline in Ontario and Quebec throughout the seventies (as shown in Table 1.3 in chapter one). The empirical results indicate that even with grain freight subsidy, Alberta overtook Ontario as the most important producing province of fed cattle.

While the pattern of grain movement indicated by the model differs from the actual, it indicates that Quebec is the greatest importing region in feed grains and much of Quebec's grain import is for pig and dairy production. The model also clearly indicates, as in the actual situation, the growing importance of Ontario corn in livestock feeding. It is shown that Ontario corn can provide its own province with self-sufficiency

21. See Chapter two, pp. 32-34.

22. See Chapter one, pp. 14-15.

in feed grains. It also indicates that Manitoba's feed grain production is a limiting factor for its livestock production.

As to the inter-regional movement of livestock and meat, the results shows that Manitoba's cattle feeding and slaughter is largely dependent on the import of feeder and slaughter calves from Saskatchewan. The model also shows Saskatchewan to be the major exporter of feeder calves to Ontario, which is also the case in reality. It also supports the fact that Quebec is usually a net exporter of calves and yearlings to Ontario and that B. C., despite its small volume of calf output and a deficiency in beef production, exports most of its calves to Alberta.[23] With respect to weaner pig movement, the model supports the existence of weaner pig movement from Ontario to Quebec despite the latter's deficiency in feed grains. This can be explained by Ontario's overloaded slaughter capacity.

With respect to slaughter capacity, the results support the contention that pig slaughter capacity in the Prairies, especially in Manitoba and to some extent, in Alberta, in much under-utilized.[24] The results provided little optimism for packers in Manitoba. On the other hand, the results are consistent with the actual phenomenon of the expansion of pig slaughter in Ontario.

As to the movement of meat, the results support that Quebec is the largest market of Alberta's beef and the movement

23. See Chapter one, p. 14.

24. See Chapter one, pp. 8-10.

of beef from Alberta to Quebec is the largest inter-regional beef movement in Canada. The results also show support that B. C. depends almost entirely on Alberta for beef supply.[25] With respect to pork movement, the model also supports that B. C. and the Maritimes are most dependent on pork import.[26]

Consequently, the empirical results do correspond to the actual spatial pattern in the real world.

CONCLUSIONS

General Conclusions

While acknowledging the limitations of the model, the empirical results do provide sufficient evidence to support the hypothesis put forward in Chapter four. Comparison of the results from the alternative situations in the model, indicates that reducing or eliminating the subsidy will encourage the growth of livestock and meat production in the Prairies at the expense of non-Prairie regions. The effects will be even more evident in the long run with changes in the production capacities in livestock and meat. While the limitations of the model may have caused some deviations in the magnitude of movement and production from what would happen in the real world, it is unlikely that there

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25. See Chapter one, p. 14.

26. See Chapter one, p. 15.

will be much difference from reality with respect to the general pattern of production and inter-regional trade of livestock and meat. Consequently, the second hypothesis that "elimination of the subsidies on feed grain movement from the Prairies would, certeris paribus, lead to increases in livestock and meat production in the Prairies and decreases in livestock and meat production in the non-Prairie regions" is verified. The results also indicate that the elimination of grain fréight subsidy will reduce the total cost involved in livestock and meat production besides reducing the cost to the taxpayers for the sum of money in subsidizing the grain movement and administering the subsidies. Consequently, the third hypothesis that "subsidization of grain movement has increased the total cost of livestock and meat production to the nation as a whole" is also verified. Turning back to the first hypothesis, while it is impossible to estimate what the spatial pattern of livestock and meat production would have been had there been no freight subsidy on feed grains, the results show that with reduction of grain freight subsidy, livestock and meat production in the Prairies at the expence of the non-Prairie regions. The Prairies, will also reduce their feed grain export to the non-Prairie regions and will increase their export of meat instead. One can therefore deduce that the opposite has occurred with the introduction of the subsidies. Consequently, the first hypothesis that "subsidization of feed grain movement has encouraged livestock and meat production in the non-Prairie regions at the expense of the Prairies and has resulted in encouraging the non-Prairies regions to import feed grains, rather than meat from the Prairies" is supported.

IMPLICATIONS FOR PUBLIC POLICY

The results of the model indicate that the grain freight subsidy has shifted livestock and meat production to the non-Prairie regions and elimination of the subsidy would not only re-locate livestock and meat production back to where feed grains are produced but would also reduce the overall cost of livestock and meat to the consumers and the nation as a whole.

Elimination of Subsidies

While the implementation of the new F.F.A.P. is a step closer toward bringing a more efficient spatial pattern of livestock and meat production, the study indicates that the Statutory Grain Rates have an even greater impact on the spatial pattern and total cost of livestock and meat production. Elimination of the Statutory Grain Rates and shipping feed grains to non-Prairie regions on a cost-of service rates basis from the Prairies will not only bring increased livestock and meat production in the Prairies but also eliminate the cost to the country in paying the subsidies. Not only that the country as a whole would also be relieved of its burden to make subsidy payments to the railways, but it would also have its total cost of livestock and meat production reduced. While the livestock and meat producers in the

East would be adversely affected by the elimination of Statutory Grain Rates, the consumers in the east would gain by being able to buy cheaper meat from the Prairies. Canadian tax-payers would certainly gain relief from their burden of having to subsidize grain movement by rail on the Prairies. Consequently, all evidence in this study supported the removal of the subsidies on domestic feed grain movement.

Alleviating the Hardships of Eastern Feeders

As shown by the model, changes in grain freight rates would cause changes in the spatial patterns of cattle and pig production and distribution. Cattle and pig producers in Quebec and the Maritimes would lose as their markets would be taken over by imported meat from the West. In Ontario and Manitoba, pig production would increase but cattle production would decrease. Appropriate measures would have to taken to alleviate the hardships on Eastern livestock producers. It certainly helps to increase stocks of feed grains in the East so that the Eastern livestock feeders can at least be sure of grain supply. In Ontario and Manitoba, cattle producers should be encouraged to shift to pig production. This could be accomplished by tax credits on acquiring facilities needed in the shifting to pig production.

Encouragement of Prairie Livestock Production

As noted earlier, the study shows that the reduction in grain freight subsidy would encourage more Prairie grains to be used within the Prairies and returns from selling feed grains will be reduced. It is desirable, from the standpoint of public policy, to have a well thoughtout program of incentives for the grain farmers in the Prairies in order to encourage them to shift to mixed farming, using their grains for livestock production. The program may include tax incentives, better livestock marketing systems and stabilization of returns from livestock production. In Saskatchewan, as shown in the model, encouragement to increase the capacity of cattle slaughter will help increase cattle production. This should be encouraged especially in view of the fact that increased cattle and beef production in Saskatchewan will not have to be shipped to Manitoba to slaughter, thus saving the cost in transportation.

Adjustments of Meat Packing Capacities

On the other hand, the study shows that Quebec's pork production will decrease with the reduction of grain freight subsidy. Quebec's beef production will also decline. Consequently, there will be lay-offs of workers. It may be necessary for the governement to help the workers in obtaining jobs outside the meat packing industry. In Manitoba there is a different problem. Even with increased pig production resulting from the reduction of grain freight subsidy, the province will still face excess capacity in pig slaughter. There, it is inevitable that a considerable portion of the pork processing capacity in Manitoba will be closed down. Manitoba's cattle slaughtering depends heavily on imported slaughter cattle from Saskatchewan. Yet as the study shows, reduction of grain freight subsidy together with the increase in cattle slaughter capacity in Saskatchewan would cause a reduction in beef production in Manitoba. Consequently, even more efforts may have to be put in to readjust the resources used in meat packing in Manitoba for other purposes.

Conversely, as in the case of cattle slaughter in Saskatchewan, enlargement of pig slaughter capacity should be encouraged by the government through a system of government incentives. As indicated by the study, enlarging the pig slaughter capacity in Ontario will only further increase pig production in Ontario.

Implication for the Transportation Industry

The transportation industry should be prepared for the changes in the grain-livestock-meat system. The reduction of grain freight subsidy will lead to reduction of inter-regional trade in feed grains and increases in inter-regional trade in livestock and meat. These changes will require improved transportation facilities. More refrigerated cars will be needed to transport meat. However, as to the mode of transport, one would expect trucks to gain at the expense of the railways. The reason is that meat has been shipped by trucks increasingly for reasons of economy, speed and flexibility. On the other hand, grains are almost exclusively transported by rail and ship. The increase in the movement of meat and a decrease in the shipment of grains would likely increase the demand for trucks and decrease the demand for rail and ship.

Implications for Manitoba

As to Manitoba, the reduction in grain freight subsidy may not be completely good news for her livestock producers because Manitoba's own supply of feed grains is rather limited. While pig production in the province will increase in response to a reduction in the grain freight subsidy, cattle production would be reduced because the feed grains available have to be used for pig production.

Furthermore, as discussed previously in this chapter, Manitoba's cattle and beef production depends heavily on Saskatchewan for imported calves and finished cattle. Reduction in the grain freight subsidy, changes in the transportation rate structure for livestock and increased cattle slaughter capacity in Saskatchewan would all lead to reduction in Manitoba's cattle and beef production. Consequently, it would be more appropriate for Manitoba to develop a strong pig industry instead of cattle industry and to encourage livestock producers to produce pigs. This may include tax incentives and stablizing the income of pig producers.

SUGGESTIONS FOR FURTHER RESEARCH

As it has been indicated, the data input, the given assumptions and constraints have limited the adaptability of the model.

In terms of the data input, the study would be much improved by including regional differences in livestock production costs and meat processing costs. A study of such differences would be a major research project by itself, but it would certainly be more accurate in assessing the economic factors in livestock and meat production. Similiarly, it would be much more helpful if international trade in live animals and meat by region were taken into account. Admittedly, the lack of published data makes this a major study by itself.

Of even greater interest and importance will be the study of effects in cost-saving techniques in shipping meat in the form of boxed beef or pork on livestock and meat production. Though it may create other problems in marketing of meat and its by-products if one would expect this innovation could reduce the cost of transporting meat, it would certainly be beneficial to the Prairies in terms of livestock and meat production.

The model has been constructed with the assumption of perfect competition at all levels. It is, doubtful, however, that perfect competition exists in the marketing of grains, livestock or meat. Studies have been made on the regional variation in the price-spreads and profit margin of meat.[26] It would be more realistic to include these factors in the model. Furthermore, examination of the vertical integration of the meat processing industry would also shed more light on the effects of factors other than economic ones on the spatial pattern of the livestock-meat system.

As to the demand side, there should also be studies on the regional demand for beef and pork. Any significant differences in regional demand wojld make a great difference in the spatial pattern of meat production. However, the survey by Statistics Canada[27] has become too outdated for use.

As to the impact of the reduction in grain freight subsidy on Manitoba, a detailed benefit-cost study is needed to determine the actual benefit and cost that would arist because of changes in grain freight subsidy, as provided under the Feed Freight Assistance Program and the Statutory Grain Rates.

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26. An example is the study by Daniel Richard, Farm to Retail Price Spreads for Beef in Canada, Research Report No. 2 (Ottawa: Commission of Inquiry into the Marketing of Beef and Veal).

27. Statistics Canada, Family Food Expenditure in Canada, 1969, Vol. II, Cat. 62-352 (Ottawa: Information Canada, 1971).

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APPENDIX ONE

FEED GRAINS POLICY IN CANADA, A BRIEF SUMMARY

The new Feed Freight Assistance Program was actually part of the new Feed Grains Policy which commenced on August 1976. Other major features of the new Feed Grains Policy included relocation of reserve stocks to a position closer to feed grains deficit areas and monitoring the feed grain market which permits the Canadian Livestock Feed Board to intervene if necessary. The most important feature, however, is the availability of feed grains at corn-competitive prices. In the past, Canadian livestock production has been much hampered by the Feed Grain Policy. Prior to August 1976, the sales of Western feed grains outside the Prairies as well as interprovincially within the Prairies had been under the control of the Canadian Wheat Board which based its pricing on imported U.S. corn. However, the Prairies feed grain producers could sell their grains either to the Canadian Wheat Board or to the feedlots, feedmills or neighbouring farmers (the "off-Board" market) within the province or use the grains to feed their own livestock. Frequently Prairie farmers were willing to sell outside the Canadian Wheat Board at a discount price in order to generate cash flow. This caused resentment among the Eastern Livestock producers because they felt that their counter-parts in Western Canada began to grow at their expense. Their resentment was more aggravated in the early seventies when the export prices of Canadian grains, determined by the Canadian grains, determined by the Canadian Wheat Board, were lower than the prices they had to pay.[1] In response to that resentment, the Federal Government began to change the Feed Grains Policy.

In August 1973, the "Interim Domestic Feed Grains Policy" was introduced and the Canadian Wheat Board had to sell domestic feed grains outside the Prairies based on the average monitored Prairie "off-Board" price plus the agreed upon marketing costs. But while the policy ensured equitable prices between Eastern and Western Canada, the "off-Board" prices themselves were much influenced by the Canadian Wheat Board prices. Consequently, the Wheat Board's pricing of feed grains based on the "off-Board" prices were a cirular exercise without paying much attention to the supply and demand condition elsewhere in the world. The result was high prices of Canadian feed grains in relation to imported U.S. corn.[2]

In May 1974, a new policy was introduced to provide fair and equitable pricing for feed grains in Canada. Starting from August 1974, grain elevators in Western Canada were allowed to buy and sell feed grains throughout Canada. It was anticipated that by having an open market, equitable prices between Eastern and Western Canada could be achieved. Furthermore, the Eastern livestock feeders could buy U.S. corn when Western feed grains became uncompetitive and Western feed grain producers could sell

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1. Food Prices Review Board, <u>Feed Grains Policy in Canada</u> (Ottawa: Food Prices Review Board, 1975), pp. 5-10.

2. <u>Ibid</u>..

to the Wheat Board if domestic feed grain prices became depressed. This, it was thought, would provide fair prices for all.

Despite the noble intentions, the 1974 Feed Grains Policy had many problems. A fundamental weakness was that with the Wheat Board still in the feed grain market, an open market system could not work effectively. Furthermore, the policy was still not designed with a North American feed grains market in mind. Hence Canadian grains were still over-priced vis-a-vis imported U.S. corn landed at Montreal. This led to lost domestic sales of Canadian grains and increased imports of U.S. corn, wider regional price spreads and further erosion of the competitive position of Canadian livestock producers. The objectives of equity were far from being achieved.

It was against this background that the new Feed Grain Policy of 1976 was introduced. Western feed grains from then onwards have been available to the domestic livestock producers at process competitive with U.S. corn landed at Montreal. The price of feed grains in Thunder Bay was then determined by subtracting transportation and handling costs to Montreal. Prices in both Eastern and Western Canada were determined accordingly.[3] It was expected that with pricing of grains with differences based on transportation and handling costs only, livestock production would be developed according to its natural potential.

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3. H. Garth Coffins, "The Case for Formula Pricing of Canada's Feed Grains", Paper presented at the Canadian Agricultural Economics Society Workshop in Banff, March 14-15, 1977, pp. 3-4, 18-19.

Furthermore, with the price of grains being corn-competitive, the livestock producers could compete in a North American market. However, as pointed out by many authors, the corn-competitive price being used now is based on the corn price at Montreal, which includes eight cents per bushel tariff. This is a hindrance for Canadian livestock products attempting to be competitive with the U.S. produce in an open market and increases the cost of livestock products to the Canadian consumers.[4]

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4. Food Prices Review Board, Feed Grains Policy in Canada, pp. 44-45.

APPENDIX TWO

INPUT DATA

Explanation of the symbols in Appendices Two and Three.

1a = The cost situation under the BUY condition when the feed grains were shipped under the old F.F.A.P. and Statutory Grain Rates with no change in production capacities.

1b = The cost situation under the OWN condition when the feed grains were shipped under the old F.F.A.P. and Statutory Grain Rates with no change in production capacities.

2a = The cost situation under the BUY condition when the feed grains were shipped under the new F.F.A.P. and Statutory Grain Rates with no change in production capacities.

2b = The cost situation under the OWN condition when the feed grains were shipped under the new F.F.A.P. and Statutory Grain Rates with no change in production capacities.

2c = The cost situation as in 2a but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

2d = The cost situation as in 2a and 2c but with the number of basic herds in a region allowed to increase up to ten percent or to decrease, and the slaughter capacities allowed to expand.

2e = The cost situation as in 2b but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

2f = The cost situation as in 2b and 2e but with the number of basic herds in a region allowed to increase up to ten percent or to decrease, and the slaughter capacities allowed to expand.

3a = The cost situation under the BUY condition when the feed grains were shipped under the new F.F.A.P. and substitution of the Statutory Grain Rates by cost-of-service rates with no change in production capacities.

3b = The cost situation under the OWN condition when the feed grains were shipped under the new F.F.A.P. and substitution of the Statutory Grain Rates by cost-of-service rates with no change in production capacities.

3c = The cost situation as in 3a but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

3d = The cost situation as in 3a and 3c but with the number of basic herds in a region allowed to increase up to ten percent or to decrease, and the slaughter capacities allowed to expand.

3e = The cost situation as in 3b but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

3f = The cost situation as in 3b and 3e but with the number of basic herds in a region allowed to increase by ten percent or to decrease, and the slaughter capacities allowed to expand.

4a = The cost situation under the BUY condition when the F.F.A.P. was removed completely and the Statutory Grain Rates were replaced by cost-of-service rates and there was no change in production capacities.

4b = The cost situation under the OWN condition when the F.F.A.P. was removed completely and the Statutory Grain Rates were replaced by cost-of-service rates and there was no change in production capacities.

4c = The cost situation as in 4a but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

4d = The cost situation as in 4a and 4c but with the number of basic herds in a region allowed to increase up to ten percent or to decrease, and the slaughter capacities allowed to expand.

4e = The cost situation as in 4b but with the number of basic herds in a region allowed to increase up to ten percent or to decrease.

4f = The cost situation as in 4b and 4e but with the number of basic herds in a region allowed to increase up to ten percent or to decrease, and the slaughter capacities allowed to expand.

Input Data

Appendix Table 2.1

Regional Prices of Feed Grains Under Different Situations in Dollars Per Ton of Barley Equivalent

Model	1a	2a 2c, 2d	3a 3c, 3d	4a 4c, 4d
Maritimes	98.330	92.330	92.330	99.730
Quebec	93.870	93.370	93.370	93.370
Ontario	73.760	73.760	73.760	73.760
Manitoba	86.540	80.540	74.940	72.940
Saskatchewan	85.340	79.340	71.340	69.340
Alberta	84.140	78.140	67.740	65.740
B. C.	90.846	84.846	74.446	82.566

Model	1b	2b 2e, 2f	3b 3e, 3f	4b 4e, 4f
Maritimes	98.330	92.330	92.330	99.730
Quebec	93.870	93.370	93.370	93.370
Ontario	73.760	73.760	73.760	73.760
Manitoba	81.850	75.850	66.650	64.650
Saskatchewan	80.650	74.650	70.250	68.250
Alberta	79.450	73.450	63.050	61.050
B. C.	90.846	84.846	74.446	82.566

Input Data

Appendix Table 2.2

Costs of Inter-regional Movement of Feed Grains in Dollars Per Barley Ton Equivalent

Model	1a	2a 2c, 2d	3a 3c, 3d	4a 4c, 4d
Ont. to Mar.	14.310	14.310	14.310	20.920
Ont. to Que.	15.390	17.240	17.240	18.640
Man. to Mar.	13.250	13.250	18.850	28.250
Man. to Que.	8.790	14.290	19.890	21.890
Man. to Ont.	13.240	17.240	22.840	22.840
Sask. to Mar.	14.450	14.450	22.450	31.850
Sask. to Que.	9.990	15.490	23.490	25.490
Sask. to Ont.	14.440	18.440	26.440	26.440
Sask. to Man.	11.550	11.550	11.550	11.550
Sask. to B.C.	16.996	16.996	16.996	28.086
Alta. to Mar.	15.650	15.650	26.050	35.450
Alta. to Que.	11.190	16.690	27.090	29.090
Alta. to Ont.	15.640	19.640	30.040	30.040
Alta. to Man.	15.160	15.160	15.160	15.160
Alta. to B.C.	8.166	8.166	8.166	18.566

Input Data

Appendix Table 2.2 (cont.)

Costs of Inter-regional Movement of Feed Grains in Dollars Per Barley Ton Equivalent

Model	1b	2b 2e, 2f	3b 3e, 3f	4b 4e, 4f
Ont. to Mar.	14.310	14.310	14.310	20.920
Ont. to Que.	15.390	17.240	17.240	18.640
Man. to Mar.	17.940	17.940	23.540	32.940
Man. to Que.	13.480	18.980	24.580	26.580
Man. to Ont.	17.930	21.930	27.530	27.530
Sask. to Mar.	19.140	19.140	27.140	36.540
Sask. to Que.	14.680	20.180	28.180	30.180
Sask. to Ont.	19.130	23.130	31.130	31.130
Sask. to Man.	16.240	16.240	16.240	16.240
Sask. to B.C.	21.686	21.686	21.686	32.776
Alta. to Mar.	20.340	20.340	30.740	40.140
Alta. to Que.	15.880	21.380	31.780	33.780
Alta. to Ont.	20.330	24.330	34.730	34.730
Alta. to Man.	19.850	19.850	19.850	19.850
Alta. to B.C.	12.856	12.856	12.856	23.256

Input Data

Appendix Table 2.3

Cost of Forages in all Situations

By Region

Forages (Dollars per Ton of Tame Hay Equivalent):	
Maritimes	58.650
Quebec	54.000
Ontario	51.000
Manitoba	40.000
Saskatchewan	46.000
Alberta	47.500
B. C.	60.000

Appendix Table 2.4

Cost Involved in Livestock Production Other Than Costs of Feed Grains and Forages

(in All Situations and Regions)
in dollars

Calf (including costs for Breeding Herds and Replacement Herds):		
	All Regions	222.820
Feeder Calf		
	All Regions	98.330
Stocker Calf		
	All Regions	71.720
Feeder Yearling		
	All Region	60.870
Breeding Herds of Pigs (per unit, Weanling Pigs born included):		
	All Regions	369.000
Market Pig:		
	All Regions	72.710

Input Data

Appendix Table 2.5

Costs in Transporting Live Animals Between Regions
(in dollars)

All Situations

Inter-regional Movement of Calves (per calf):	
Maritimes to Quebec	8.600
Maritimes to Ontario	10.530
Quebec to Maritimes	8.600
Quebec to Ontario	6.390
Ontario to Maritimes	12.150
Ontario to Quebec	6.390
Ontario to Manitoba	10.940
Manitoba to Quebec	11.480
Manitoba to Ontario	10.940
Manitoba to Saskatchewan	4.730
Manitoba to Alberta	8.020
Saskatchewan to Quebec	14.630
Saskatchewan to Ontario	14.090
Saskatchewan to Manitoba	4.730
Saskatchewan to Alberta	6.280
Alberta to Quebec	18.910
Alberta to Ontario	18.150
Alberta to Saskatchewan	6.280
Alberta to B. C.	10.130
B. C. to Alberta	10.130

Appendix Table 2.5 (cont.)

Costs in Transporting Live Animals Between Regions (in Dollars)

Inter-regional Movement of Yearling Cattle (per cattle):

Maritimes to Quebec	13.370
Quebec to Maritimes	13.370
Quebec to Ontario	9.940
Ontario to Maritimes	16.380
Ontario to Quebec	9.940
Ontario to Manitoba	17.010
Manitoba to Quebec	17.850
Manitoba to Ontario	17.010
Manitoba to Saskatchewan	7.350
Manitoba to Alberta	12.540
Saskatchewan to Quebec	22.750
Saskatchewan to Ontario	21.910
Saskatchewan to Manitoba	7.350
Saskatchewan to Alberta	9.820
Alberta to Quebec	29.470
Alberta to Ontario	28.700
Alberta to Manitoba	19.810
Alberta to Saskatchewan	9.820
Alberta to B. C.	15.750
B. C. to Alberta	15.750

Appendix Table 2.5 (cont.)

Costs in Transporting Live Animals
Between Regions

(in Dollars)

Inter-regional Movement of Finished Cattle (per cattle):	
Maritimes to Quebec	20.060
Quebec to Maritimes	20.060
Quebec to Ontario	14.910
Ontario to Maritimes	24.570
Ontario to Quebec	14.910
Ontario to Manitoba	25.520
Manitoba to Quebec	26.780
Manitoba to Ontario	25.520
Manitoba to Saskatchewan	11.030
Manitoba to Alberta	18.710
Saskatchewan to Quebec	34.130
Saskatchewan to Ontario	32.870
Saskatchewan to Manitoba	11.030
Saskatchewan to Alberta	14.650
Alberta to Quebec	44.210
Alberta to Ontario	42.050
Alberta to Manitoba	29.720
Alberta to Saskatchewan	14.650
Alberta to B. C.	23.630
B. C. to Alberta	23.630

Appendix Table 2.5 (cont.)
Costs in Transporting Live Animals
Between Regions
(in Dollars)

Inter-regional Movement of Weanling Pigs (per pig):	
Ontario to Quebec	0.720
Inter-regional Movement of Finished Pigs for Slaughter (per pig):	
Maritimes to Quebec	4.410
Quebec to Maritimes	4.410
Quebec to Ontario	3.280
Ontario to Quebec	3.280
Ontario to Manitoba	5.610
Manitoba to Quebec	5.890
Manitoba to Ontario	5.610
Manitoba to Saskatchewan	2.430
Saskatchewan to Quebec	7.510
Saskatchewan to Ontario	7.230
Saskatchewan to Manitoba	2.430
Saskatchewan to Alberta	2.430
Alberta to Quebec	9.730
Alberta to Ontario	9.350
Alberta to Saskatchewan	3.220
Alberta to B. C.	5.200
B. C. to Alberta	5.200

Appendix Table 2.5 (cont.)

Costs in Transporting Live Animals
Between Regions

(in Dollars)

Inter-regional Movement of Cows and Bulls for Slaughter:

	Per Cow	Per Bull
Maritimes to Quebec	20.060	28.650
Maritimes to Ontario	24.570	35.100
Quebec to Maritimes	20.060	35.100
Quebec to Ontario	14.910	28.650
Ontario to Quebec	14.910	28.650
Ontario to Manitoba	25.520	36.450
Manitoba to Quebec	26.780	38.250
Manitona to Ontario	25.520	36.450
Manitoba to Alberta	18.710	26.940
Saskatchewan to Quebec	34.130	48.750
Saskatchewan to Ontario	32.870	46.950
Saskatchewan to Alberta	14.650	21.900
Alberta to Quebec	44.210	63.150
Alberta to Ontario	42.050	61.500
Alberta to Saskatchewan	14.650	21.900
Alberta to B. C.	23.630	33.750

Appendix Table 2.6

Costs of Transporting Meat Between Regions (in Dollars)

Inter-regional Movement of Beef (per thousand pounds):	
Maritimes to Quebec	32.500
Maritimes to Ontario	36.000
Quebec to Maritimes	32.500
Quebec to Ontario	25.900
Ontario to Maritimes	36.000
Ontario to Quebec	25.900
Ontario to Manitoba	33.000
Manitoba to Maritimes	50.300
Manitoba to Quebec	32.900
Manitoba to Ontario	33.000
Manitoba to Saskatchewan	14.900
Saskatchewan to Maritimes	58.100
Saskatchewan to Quebec	41.000
Saskatchewan to Ontario	41.100
Saskatchewan to Alberta	15.500
Saskatchewan to B. C.	22.200
Alberta to Maritimes	69.200
Alberta to Quebec	51.200
Alberta to Ontario	51.400
Alberta to Manitoba	25.470
Alberta to Saskatchewan	15.500
Alberta to B. C.	14.300
B. C. to Alberta	14.300

Appendix Table 2.6 (cont.)

Costs of Transporting Meat Between Regions (in Dollars)

Inter-regional Movement of Pork (per thousand pounds):	
Maritimes to Quebec	32.500
Quebec to to Ontario	35.300
Quebec to Maritimes	32.500
Quebec to Ontario	22.100
Ontario to Maritimes	35.300
Ontario to Quebec	22.100
Ontario to Manitoba	24.000
Manitoba to Maritimes	49.500
Manitoba to Quebec	29.500
Manitoba to Ontario	24.000
Manitoba to Saskatchewan	14.900
Manitoba to B. C.	27.000
Saskatchewan to Maritimes	57.600
Saskatchewan to Quebec	35.400
Saskatchewan to Ontario	33.900
Saskatchewan to Manitoba	14.900
Saskatchewan to Alberta	15.500
Saskatchewan to B. C.	22.200
Alberta to Maritimes	68.200
Alberta to Quebec	41.600
Alberta to Ontario	40.000
Alberta to Manitoba	25.470
Alberta to Saskatchewan	15.500
Alberta to B. C.	14.300
B. C. to Alberta	14.300

Appendix Table 2.7

Feed Grains Available for Cattle and Pig Production By Region

(in tons of Barley Equivalent)

in all situations

Maritimes	120,879
Quebec	376,623
Ontario	3,533,776
Manitoba	1.806,716
Saskatchewan	3,898,587
Alberta	4,287,469
B. C.	0

Appendix Table 2.8

Number of Basic Herds for Cattle and

Pigs By Region

Number of Dairy Cows and Dairy Heifers By Region

	Dairy Cows	Dairy Heifers
Maritimes	95,300	24,850
Quebec	861,000	191,000
Ontario	634,000	193,500
Manitoba	91,750	22,000
Saskatchewan	74,500	14,500
Alberta	152,000	34,000
B. C.	84,250	24,000

Number of Bulls By Region:

Maritimes	6,250	Quebec	40,500
Ontario	36,000	Manitoba	22,000
Saskatchewan	52,500	Alberta	73,000
B. C.	13,500		

Input Data

Appendix Table 2.8 (cont.)

Number of Basic Herds for Cattle and Pigs By Region

Number of Beef Cows By Region:

	Under Situations when the number of bas-herds are restricted	Maximum number allowed with relaxation of restrictions on basic herds
Maritimes	61,400	67,540
Quebec	227,500	250,250
Ontario	498,500	548,350
Manitoba	447,500	492,250
Saskatchewan	1,115,000	1,222,650
Alberta	1,505,000	1,655,500
B. C.	215,000	236,500

Size of Breeding Herds of Pigs By Region:

	Under Situations when the number of basic herds are restricted	Maximum number allowed with relaxation of restrictions on basic herds
Maritimes	23,250	25,575
Quebec	162,850	179.135
Ontario	263,050	289,355
Manitoba	68,250	75,075
Saskatchewan	57,250	62,975
Alberta	96,500	106,150
B. C.	7,750	8,525

Appendix Table 2.9

Slaughter Capacities for Cattle and Pigs Per Annum, By Region

Cattle Slaughter Capacity By Region

Maritimes	106,823
Quebec	349.963
Ontario	1,409,607
Manitoba	860,850
Saskatchewan	385,286
Alberta	1,761,560
B. C.	176,269

Pig Slaughter Capacity By Region

Maritimes	657,173
Quebec	3,654,008
Ontario	3,382,737
Manitoba	3,512,860
Saskatchewan	1,766,136
Alberta	3,670,310
B. C.	487,191

Appendix Table 2.10

Consumption of Meat Per Annum,

By Region

Beef Consumption By Region (in thousand pounds)

	Fed Beef	Fed and Non-Fed Beef
Maritimes	123,526	170,381
Quebec	473,410	652,979
Ontario	623,114	859,468
Manitoba	81.297	112,134
Saskatchewan	73,574	101,482
Alberta	148,025	204,172
B. C.	187,743	258,956

Consumption of Pork By Region (in thousand pounds):

Maritimes	78,170
Quebec	299,584
Ontario	430,795
Manitoba	55,734
Saskatchewan	50,439
Alberta	101,479
B. C.	129,798

Appendix Table 2.11

Number of Calves Slaughtered and Net Exported By Region

Maritimes	16,702
Quebec	502,836
Ontario	203.368
Manitoba	65,439
Saskatchewan	66,316
Alberta	66,609
B. C.	27,591

APPENDIX THREE: SOLUTION DATA

Solution Data

Appendix Table 3.1

Total Cost Involved in Each Situation

BUY Condition		OWN Condition	
Model 1a	$4,790,472,364	Model 1b	$4,764,042,370
Model 2a	$4,752,190,656	Model 2b	$4,725,249,428
Model 3a	$4,700,201,761	Model 3b	$4,672,055,297
Model 4a	$4,692,485,471	Model 4b	$4,664,035,598
Model 2c	$4,693,463,517	Model 2e	$4,665,223,441
Model 3c	$4,639,042,247	Model 3e	$4,608,892,014
Model 4c	$4,629,988,675	Model 4e	$4,599,647,543
Model 2d	$4,692,723,125	Model 2f	$4,663,651,201
Model 3d	$4,636,025,513	Model 3f	$4,605,684,381
Model 4d	$4,626,773,465	Model 4f	$4,596,432,332

Solution Data

Appendix Table 3.2 (cont.)

Cost Difference Between Alternative Situations
(in Dollars)

7. Between		1b	2b	3b
And	2b	38,792,942	--	53,194,131
	3b	91,987,073	53,194,131	--
	4b	100,006,772	61,213,830	8,019,699

8. Between		2b	2e
And	2e	60,025,987	--
	2f	61,598,227	1,572,240

9. Between		3b	3e
And	3e	63,163,283	--
	3f	66,370,916	3,207,633

10. Between		4b	4e
And	4e	64,388,055	--
	4f	67,603,266	3,215,211

11. Between		2e	3e
And	3e	56,331,427	--
	4e	65,575,898	9,244,471

12. Between		2f	3f
And	3f	57,966,820	--
	4f	67,218,869	9,252,049

Solution Data

Appendix Table 3.2

Cost Difference Between Alternative Situations

(in Dollars)

1. Between		1a	2a	3a
And	2a	38,281,708	--	51,988,890
	3a	90,270,503	51,988,890	--
	4a	97,986,893	59,705,288	7,716,390

2. Between		2a	2c
And	2c	58,727,139	--
	2d	59,467,531	740,392

3. Between		3a	3c
And	3c	61,159,514	--
	3d	64,176,248	3,016,734

4. Between		4a	4c
And	4c	62,496,496	--
	4d	65,712,006	3,215,510

5. Between		2c	3c
And	3c	54,421,270	--
	4c	63,474,842	9,053,572

6. Between		2d	3d
And	3d	56,697,612	--
	4d	65,949,660	9,252,048

Solution Data

Appendix Table 3.3
Supply and Consumption of Feed Grains By Region
in tons of Barley Equivalent

Model	1a	2a	3a
Importing Regions			
Maritimes			
Consumption	359,604	271,198	271,198
Local Supply	120,879	120,879	120,879
Import from Ontario	0	0	74,616
Import from Prairies	238,725	150,319	75,703
Quebec			
Consumption	2,123,694	2,075,293	1,979,997
Local Supply	376,623	376.623	376,623
Import from Prairies	1,747,071	1,698,670	1,603,374
B. C.			
Consumption	290,510	290,510	290,510
Local Supply	0	0	0
Import from Prairies	290,510	290,510	290,510
Exporting Regions			
Ontario			
Consumption	3,533,776	3,533,776	3,459,160
Export to Maritimes	0	0	74,616
Total Supply	3,633,776	3,533,776	3,533,776
Prairies			
Consumption-			
Manitoba	1,775,166	1,806,716	1,806,716
Saskatchewan	957,588	957,588	1,107,228
Alberta	2,788,415	2,923,986	2,972,098
Eastbound Export	1,985,796	1,848,989	1,679,077
Export to B. C.	290,510	290,510	290,510
Total Supply	7,797,475	7,827,789	7,855,629
TOTAL CONSUMPTION	11,828,753	11,858,667	11,886,507

Solution Data

Appendix Table 3.3 (cont.)

Supply and Consumption of Feed Grains By Region
in tons of Barley Equivalent

Model	4a	1b	2b
Importing Regions			
Maritimes			
Consumption	271,198	271,198	271,198
Local Supply	96,778	120,879	120,879
Import from Ontario	174,420	0	0
Import from Prairies	0	150,319	150,319
Quebec			
Consumption	1,979,997	2,075,293	1,979.997
Local Supply	376,623	376,623	376,623
Import from Prairies	1,063,374	1,698,670	1,603,374
B. C.			
Consumption	279,276	285,799	290,510
Local Supply	0	0	0
Import from Prairies	279,276	285,799	290,510
Exporting Region			
Ontario			
Consumption	3,358,956	3,533,376	3,533,376
Export to Maritimes	174,420	0	0
Total Supply	3,533,376	3,533,376	3,533,376
Prairies			
Consumption-			
Manitoba	1,806,716	1,806,716	1,806,716
Saskatchewan	1,107,227	962,298	1,011,122
Alberta	3,111,880	2,923,986	2,992,098
Eastbound Export	1,603,374	1,848,989	1,753,693
Export to B. C.	279,276	285,799	290,510
Total Supply	7,908,473	7,827,728	7,854,139
TOTAL CONSUMPTION	11,915,250	11,814,340	11,865,417

Solution Data

Appendix Table 3,3 (cont.)

Supply and Consumption of Feed Grains By Region in tons of Barley Equivalent

Model	3b	4b	2c
Importing Regions			
Maritimes			
Consumption	271,198	271,198	317,938
Local Supply	96,778	0	120,879
Import from Ontario	174,420	271,198	0
Import from Prairies	0	0	197,059
Quebec			
Consumption	1,979,997	1,979,997	1,769,821
Local Supply	376,623	376,623	376,623
Import from Prairies	1,603,374	1,603,374	1,393,198
B. C.			
Consumption	290,510	279,276	232,750
Local Supply	0	0	0
Import from Prairies	290,510	279,276	232,750
Exporting Regions			
Ontario			
Consumption	3,359,356	3,262,578	3,533,776
Export to Maritimes	174,420	271,198	0
Total Supply	3,533,776	3,533,776	3,533,776
Prairies			
Consumption			
Manitoba	1,806,716	1,806,716	1,806,716
Saskatchewan	1,107,227	1,107,227	981,032
Alberta	3,100,646	3,117,554	3,156,004
Eastbound Export	1,603,374	1,603,374	1,393,198
Export to B. C.	290,510	279,276	232,750
Total Supply	7,908,473	7,914,147	7,569,700
TOTAL CONSUMPTION	11,893,599	11,943,522	11,758,037

lution Data

Appendix Table 3.3 (cont.)

Supply and Consumption of Feed Grains By Region in tons of Barley Equivalent

del	3c	2e	3e
porting Regions			
aritimes			
Consumption	265,847	265,847	265,847
Local Supply	120,879	120,879	35,357
Import from Ontario	0	0	230,490
Import from Prairies	144,968	144,968	0
uebec			
Consumption	1,644,349	1,644,349	1,644,349
Local Supply	376,623	376,623	376,623
Import from Prairies	1,267,726	1,267.726	1,267,726
. C.			
Consumption	232,750	232,750	232,750
Local Supply	0	0	0
Import from Prairies	232,750	232,750	232,750
Exporting Regions			
Ontario			
Consumption	3,533,776	3,533,776	3,303,286
Export to Maritimes	0	0	230,490
Total Supply	3,533,776	3,533,776	3,533,776
Prairies			
Consumption			
Manitoba	1,806,716	1,806,716	1,806,716
Saskatchewan	1,113,760	1,209,734	1,117,313
Alberta	3,251,978	3,533,722	3,545,296
Eastbound Export	1,412,694	1,412,694	1,267,726
Export to B. C.	232,750	232,750	232,750
Total Supply	7,817,898	7,787,890	7,969,801
TOTAL CONSUMPTION	11,849,176	11,890,503	11,915,556

Solution Data

Appendix Table 3.3.(cont.)

Supply and Consumption of Feed Grains By Region in tons of Barley Equivalent

Model	4c, 4e	2d	2f
Importing Regions			
Maritimes			
Consumption	265,847	265,847	265,847
Local Supply	35,357	120,879	120,879
Import from Ontario	230,490	0	144,968
Import from Prairies	0	144,968	0
Quebec			
Consumption	1,644,349	1,644,349	1,644,349
Local Supply	326,623	326,623	326,623
Import from Prairies	1,267,726	1,267,726	1,267,726
B. C.			
Consumption	232,750	232,750	232,750
Local Supply	0	0	0
Import from Prairies	232,750	232,750	232,750
Exporting Regions			
Ontario			
Consumption	3,303,286	3,533,776	3,388,808
Export to Maritimes	230,490	0	144,968
Total Supply	3,533,776	3,533,776	3,533,776
Prairies			
Consumption			
Manitoba	1,806,716	1,806,716	1,806,716
Saskatchewan	1,117,313	1,506,604	1,506,610
Alberta	3,545,740	3,091,883	3,045,852
Eastbound Export	1,267,726	1,412,694	1,267,726
Export to B. C.	232,750	232,750	232,750
Total Supply	7,970,245	7,817,897	7,859,648
TOTAL CONSUMPTION	11,916,000	11,849,175	11,915,556

Solution Data

Appendix Table 3.3 (cont.)
Supply and Consumption of Feed Grains By Region
in tons of Barley Equivalent

Model	3d, 3f	4d, 4f
Importing Regions		
Maritimes		
Consumption	265,847	230,490
Local Supply	35,357	0
Import from Ontario	230,490	230,490
Import from Prairies	0	0
Quebec		
Consumption	1,644,349	1,679,706
Local Supply	376,623	376,623
Import from Prairies	1,267,726	1,303,083
B. C.		
Consumption	232,750	232,750
Local Supply	0	0
Import from Prairies	232,750	232,750
Exporting Regions		
Ontario		
Consumption	3,303,286	3,303,286
Export to Maritimes	230,490	230,490
Total Supply	3,533,776	3,533,776
Prairies		
Consumption		
Manitoba	1,217,938	1,217,938
Saskatchewan	2,095,383	2,130,740
Alberta	3,156,004	3,156,004
Eastbound Export	1,267,726	1,303,083
Export to B. C.	232,750	232,750
Total Supply	7,969,801	8,005,158
TOTAL CONSUMPTION	11,915,557	11,915,557

Solution Data

Appendix Table 3.4

Consumption of Forages By Region
in tons of tame hay equivalent

Model	1a	2a	3a	4a
Maritimes	835,250	746,844	746,844	746,844
Quebec	5,421,750	5,412,565	5,412,565	5,412,565
Ontario	6,573,565	6,565,899	6,469,233	6,369,428
Manitoba	2,472,043	2,472,043	2,472,043	2,472,043
Saskatchewan	4,255,015	4,255,015	4,255,015	4,255,015
Alberta	6,550,518	6,608,620	6,629,240	6,689,106
B. C.	1,138,214	1,138,214	1,138,214	1,133,440

Model	1b	2b	3b	4b
Maritimes	746,844	746,844	746,844	746,844
Quebec	5,412,565	5,412,565	5,412,565	5,412,565
Ontario	6,565,899	6,565,899	6,565,899	6,565,899
Manitoba	2,472,043	2,442,671	2,442,671	2,442,671
Saskatchewan	4,255,015	4,275,940	4,317,128	4,317,128
Alberta	6,608,620	6,629,240	6,684,332	6,742,527
B. C.	1,138,214	1,138,214	1,138,214	1,133,440

Solution Data

Appendix Table 3.4 (cont.)

Consumption of Forages By Region
in tons of tame hay equivalent

Model	2c	3c	2e	3e
Maritimes	595,292	544,201	544,201	544,201
Quebec	4,687,889	4,687,889	4,687,889	4,687,889
Ontario	6,689,918	6,564,446	6,564,446	6,333,956
Manitoba	2,569,574	2,569,574	2,569,574	2,569,574
Saskatchewan	4,602,066	4,658,949	4,700,081	4,660,472
Alberta	7,163,074	7,204,205	7,163,074	7,329,913
B. C.	432,540	432,540	432,540	432,540

Model	4c, 4e	2d	2f	3d, 4d 3f, 4f
Maritimes	544,201	544,201	544,201	544,201
Quebec	4,687,889	4,687,889	4,687,889	4,687,889
Ontario	6,333,956	6,564,446	6,419,478	6,333,956
Manitoba	2,569,574	2,569,574	2,569,574	2,317,240
Saskatchewan	4,660,472	4,827,311	4,827,311	5,079,645
Alberta	7,329,913	7,035,843	7,115,866	7,163,074
B. C.	432,540	432,540	432,540	432,540

Solution Data

Appendix Table 3.5

Number of Beef Cows By Region

Models	1a, 2a, 3a, 4a 1b, 2b, 3b, 4b		All other Situations	
	Number	Percentage	Number	Percentage
Maritimes	61,400	1.5	0	0.0
Quebec	227,500	5.6	5,207	0.1
Ontario	498,500	12.3	548,350	14.0
Manitoba	447,500	11.0	492,250	12.5
Sask.	1,111,500	27.3	1,222,650	31.2
Alberta	1,505,000	37.0	1,655,500	42.2
B. C.	215,000	5.3	0	0.0
Total	4,066,400	100.0	3,923,957	100.0

Appendix Table 3.6

Number of Calves Produced By Region

odels	1a, 2a, 3a, 4a 1b, 2b, 3b		4b		All Other Situations	
	Number	%	Number	%	Number	%
laritimes	141,030	2.6	62,826	1.2	85,770	1.6
Quebec	979,650	18.3	979,650	18.3	779,586	14.6
Ontario	1,019,250	19.0	1,019,250	19.0	1,064,115	20.0
Manitoba	485,325	9.1	485,325	9.1	525,600	9.9
Saskatchewan	1,067,400	19.9	1,067,400	19.9	1,167,435	21.9
Alberta	1,491,300	27.9	1,491,300	27.9	1,626,750	30.5
B. C.	168,394	3.1	246,598	4.6	75,825	1.4
TOTAL	5,352,349	100.0	5,352,349	100.0	5,325,081	100.0

Solution Data

Appendix Table 3,7

Inter-regional Movement of Feeder Calves

Model	1a	2a	3a	4a
Mar. to Ont.	11,073	81,798	81,798	81,798
Que. to Ont.	211,051	211,051	211,051	211,051
Sask. to Ont.	127,293	127,293	79,844	0
Sask. to Man.	466,464	466,464	423,896	423,896
Sask. to Alta.	0	0	0	79,844
Alta. to Ont.	114,089	29,883	0	0
B. C. to Alta.	60,412	60,412	60,412	60,412
Total Sask. Export	593,757	540,423	503,740	503,740
Total Alta. Export	114,089	29,883	0	0
Total Ont. Import	463,506	450,025	405,064	325,220
Total Alta. Import	60,412	60,412	60,412	140,256
Total Movement	990,382	976,801	857,001	857,001

olution Data

Appendix Table 3.7 (cont.)

Inter-regional Movement of Feeder Calves

Model	1b	2b	3b	4b
Mar. to Ont.	81,798	81,798	81,798	4,376
Que. to Ont.	211,051	211,051	211,051	211,051
Sask. to Ont.	127,293	139,536	0	0
Sask. to Man.	466,464	423,896	423,896	423,896
Sask. to Alta.	0	0	79,844	79,844
Alta. to Ont.	29,883	0	0	0
B. C. to Alta.	60,412	60,412	60,412	137,834
Total Sask. Export	593,757	563,432	503,740	503,740
Total Alta. Export	29,883	0	0	0
Total Ont. Import	420,142	432,385	292,849	215,437
Total Alta. Import	60,412	60,412	140,256	140,256
Total Movement	976,901	916,693	857,001	857,001

Solution Data

Appendix Table 3.7 (cont.)

Inter-regional Movement of Feeder Calves

Model	2c	3c	4c
Mar. to Ont.	0	41,673	41,673
Que. to Ont.	65,783	65,783	65,783
Sask. to Ont.	326,442	184,392	0
Sask. to Man.	365,701	365,701	365,701
Sask. to Alta.	0	59,611	241,796
B. C. to Alta.	19,831	19,831	19,831
Total Sask. Export	692,143	607,497	607,497
Total Ont. Import	433,898	291,848	107,456
Total Alta. Import	19,831	79,442	261,627
Total Movement	819,430	736,991	734,784

Model	2d	3d	4d
Mar. to Ont.	41,673	41,673	41,673
Que. to Ont.	65,783	65,783	65,783
Sask. to Man.	365,701	0	0
Alta. to Ont.	184,392	0	0
B. C. to Alta.	19,831	19,831	19,831
Total Ont. Import	291,848	107,456	107,456
Total Movement	561,481	127,287	127,287

olution Data

Appendix Table 3.7 (cont.)

Inter-regional Movement of Feeder Calves

odel	2e	3e	4e
ar. to Ont.	41,673	41,673	41,673
ue. to Ont.	65,783	65,783	65,783
ask. to Ont.	184,392	0	0
ask. to Man.	365,701	365,701	365,701
ask. to Alta.	0	241,796	241,796
B. C. to Alta.	19,831	19,831	19,831
Total Sask. Export	550,093	607,497	607,497
Total Ont. Import	291,848	107,456	107,456
Total Alta. Import	19,831	261,627	261,627
Total Movement	677,380	734,784	734,784

Model	2f	3f	4f
Mar. to Ont.	41,673	41,673	41,673
Que. to Ont.	65,783	65,783	65,783
Sask. to Man.	365,701	0	0
Alta. to Ont.	68,418	0	0
B. C. to Alta.	19,831	19,831	19,831
Total Ont. Import	107,456	107,456	107,456
Total Movement	512,988	127,287	127,287

Solution Data

Appendix Table 3.8

Inter-regional Movement of Excess Replacement Heifers

Model	1a	2a, 3a 1b, 2b, 3b	4a, 4b	Other Situations
Que. to Ont.	0	10,806	10,806	247
B. C. to Alta.	0	0	10,213	0
Total Movement	0	10,816	21,019	247

Solution Data

Appendix Table 3.9

Number of Feeder Calves By Region

Model	1a		2a, 1b		3a	
	Number	%	Number	%	Number	%
Mar.	70,725	2.5	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	947,582	33.7	934,101	33.2	856,768	30.4
Man.	747,276	26.6	747,276	26.6	704,708	25.0
Sask.	103,996	3.7	103,996	3.7	194,014	5.6
Alta.	944,953	33.6	1,029,159	36.6	1,059,042	37.6
B. C.	0	0.0	0	0.0	0	0.0
Total	2,814,532	100.0	2,814,532	100.0	2,814,532	100.0

Model	2b		3b, 4a		4b	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	916,461	33.2	776,925	27.6	699,503	24.9
Man.	704,708	25.0	704,708	25.0	704,708	25.0
Sask.	134,321	4.8	194,014	6.9	194,014	6.9
Alta.	1,059,042	37.6	1,138,886	40.5	1,216,308	43.2
B. C.	0	0.0	0	0.0	0	0.0
Total	2,814,532	100.0	2,814,532	100.0	2,814,532	100.0

Solution Data

Appendix Table 3.9 (cont.)

Number of Feeder Calves By Region

Model	2c		3c		4c	
	Number	%	Number	%	Number	%
Mar.	41,673	1.5	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	908,878	32.2	808,500	28.7	624,108	22.1
Man.	675,757	24.0	675,757	24.0	675,757	24.0
Sask.	78,247	2.8	160,686	5.7	162,893	5.8
Alta.	1,116,813	39.6	1,176,424	41.7	1,358,609	48.2
B. C.	0	0.0	0	0.0	0	0.0
Total	2,821,368	100.0	2,821,368	100.0	2,821,368	100.0

Model	2d		3d		4d	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	808,500	28.7	624,108	22.1	624,108	22.1
Man.	675,757	24.0	310,056	11.0	310,056	11.0
Sask.	404,689	14.3	770,390	27.3	770,390	27.3
Alta.	932,421	33.0	1,116,813	39.6	1,116,813	39.6
B. C.	0	0.0	0	0.0	0	0.0
Total	2,821,368	100.0	2,821,368	100,0	2,821,368	100.0

Solution Data

Appendix Table 3.9 (cont.)

Number of Feeder Calves By Region

Model	2e		3e		4e	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	808,500	28.7	624,108	22.1	624,108	22.1
Man.	675,757	24.0	675,757	24.0	675,757	24.0
Sask.	220,297	7.8	162,893	5.8	162,893	5.8
Alta.	1,116,813	39.6	1,358,609	48.2	1,358,609	48.2
B. C.	0	0.0	0	0.0	0	0.0
Total	2,821,368	100.0	2,821,368	100.0	2,821,368	100.0

Model	2f		3f		4f	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	692,526	24.5	624,108	22.1	624,108	22.1
Man.	675,757	24.0	310,056	11.0	310,056	11.0
Sask.	404,689	14.3	770.390	27.3	770,390	27.3
Alta.	1,048,395	37.2	1,116,813	39.6	1,116,813	39.6
B. C.	0	0.0	0	0.0	0	0.0
Total	2,821,368	100.0	2,821,368	100.0	2,821,368	100.0

Solution Data

Appendix Table 3.10

Number of Excess Replacement Heifers on Feed By Region

Model	1a		2a, 3a 1b, 2b, 3b	
	Number	%	Number	%
Maritimes	2,917	1.5	2,917	1.5
Quebec	10,807	5.6	0	0.0
Ontario	23,679	12.3	34,485	17.9
Manitoba	21,256	11.0	21,256	11.0
Saskatchewan	52,796	27.1	52,796	27.1
Alberta	71,488	37.0	71,488	37.0
B. C.	10,213	5.3	10,213	5.3
TOTAL	193,155	100.0	193,155	100.0

Model	4a, 4b		All Other Situations	
Maritimes	Number	%	Number	%
Maritimes	2,917	1.5	0	0.0
Quebec	0	0.0	0	0.0
Ontario	34,485	17.9	26,294	17.9
Manitoba	21,256	11.0	23,382	12.5
Saskatchewan	52,796	27.1	58,076	31.2
Alberta	81,701	42.3	78,636	42.2
B. C.	0	0.0	0	0.0
TOTAL	193,155	100.0	186,387	100.0

Solution Data

Appendix Table 3.11

Total Number of Cattle on Feed By Region

Model	1a		2a, 1b		3a	
	Number	%	Number	%	Number	%
Mar.	73,642	2.4	2,917	0.1	2,917	0.1
Que.	10,806	0.4	0	0.0	0	0.0
Ont.	971,261	32.3	968,586	32.2	891,253	29.6
Man.	768,532	25.6	768,532	25.6	725,964	24.1
Sask.	156,792	5.2	156,792	5.2	246,810	8.2
Alta.	1,016,441	33.8	1,100,647	36.6	1,130,530	37.6
B. C.	10,213	0.3	10,213	0.3	10,213	0.3
TOTAL	3,007,687	100.0	3,007,687	100.0	3,007,687	100.0

Model	4a		2b		3b	
	Number	%	Number	%	Number	%
Mar.	2,917	0.1	2,917	0.1	2,917	0.1
Que.	0	0.0	0	0.0	0	0.0
Ont.	811,410	27.0	968,586	32.2	950,946	31.6
Man.	725,964	24.1	725,964	24.1	725,964	24.1
Sask.	246,810	8.2	187,117	6.2	246,810	8.2
Alta.	1,220,586	40.5	1,130,530	37.6	1,210,374	40.2
B. C.	0	0.0	10,213	0.3	10,213	0.3
TOTAL	3,007,687	100.0	3,007,687	100.0	3,007,687	100.0

lution Data

Appendix Table 3.11 (cont.)

Total Number of Cattle on Feed By Region

›del	4b		2c		3c	
	Number	%	Number	%	Number	%
ar.	2,917	0.1	41,673	1.4	0	0.0
ue.	0	0.0	0	0.0	0	0.0
nt.	733,988	24.4	935,172	31.1	834,734	27.8
an.	725,794	24.1	699,139	23.2	699,139	23.2
ask.	246,810	8.2	136,323	4.5	218,762	7.3
lta.	1,298,008	43.2	1,195,449	39.7	1,255,060	41.7
3. C.	0	0.0	0	0.0	0	0.0
TOTAL	3,007,687	100.0	3,007,756	100.0	3,007,756	100.0

Model	4c		2e		3e, 4e	
Mar.	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	652,646	21.7	834,794	27.8	650,402	21.6
Man.	699,139	23.2	699,139	23.2	699,139	23.2
Sask.	220,969	7.3	278,373	9.3	221,569	7.4
Alta.	1,437,245	47.8	1,195,449	39.7	1,437,245	47.8
TOTAL	3,007,756	100.0	3,007,756	100.0	3,007,756	100.0

Solution Data

Appendix Table 3.11 (cont.)
Total Number of Cattle on Feed By Region

Model	2d		2f		3d, 4d 3f, 4f	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	834,794	27.8	718,820	23.9	650,402	21.6
Man.	699,139	23.2	699,139	23.2	333,438	11.1
Sask.	462,785	15.4	462,785	15.4	828,466	27.5
Alta.	1,011,057	39.7	1,127,031	37.4	1,195,449	39.7
B. C.	0	0.0	0	0.0	0	0.0
TOTAL	3,007,756	100.0	3,007,756	100.0	3,007,756	100.0

Solution Data

Appendix Table 3.12

Inter-regional Movement of Slaughter Cattle

Model	3a, 4a 3b, 4b	3c
Sask. to Ont.	0	0
Sask. to Man.	41,717	41,717
Total Movement	41,717	41,717

Model	2e	4c 3e, 4e
Sask. to Ont.	58,419	2,163
Sask. to Man.	59,930	59,930
Total Movement	118,349	62,093

Note: There was no movement for slaughter cattle in all other situations.

Solution Data

Appendix Table 3.13
Fed Cattle Slaughtered By Region

Model	1a		2a, 1b		3a	
	Number	%	Number	%	Number	%
Mar.	72,198	2.4	2,887	0.1	2,887	0.1
Que.	10,698	0.4	0	0.0	0	0.0
Ont.	952,073	32.3	949,559	32.2	873,773	29.6
Man.	753,374	25.5	753,374	25.5	753,374	25.5
Sask.	154,184	5.2	154,184	5.2	154,184	5.2
Alta.	996,827	33.8	1,079,348	36.6	1,108,634	37.6
B. C.	10,110	0.3	10,110	0.3	10,110	0.3
Total	2,949,463	100.0	2,949,463	100.0	2,949,463	100.0

Model	4a		2b		3b	
	Number	%	Number	%	Number	%
Mar.	2,887	0.1	2,887	0.1	2,887	0.1
Que.	0	0.0	0	0.0	0	0.0
Ont.	795,526	27.0	932,272	31.6	795,526	27.0
Man.	753,374	25.5	711,657	24.1	753,374	25.5
Sask.	200,685	6.8	183,903	6.2	200,685	6.8
Alta.	1,079,348	36.6	1,108,634	37.6	1,186,881	40.2
B. C.	10,011	0.3	10,011	0.3	10,011	0.3
Total	2,949,463	100.0	2,949,463	100.0	2,949,463	100.0

Solution Data

Appendix Table 3.13 (cont.)

Fed Cattle Slaughtered By Region

Model	4b		2c		3c	
	Number	%	Number	%	Number	%
Mar.	2,887	0.1	40,839	1.4	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	719,650	24.4	916,731	31.1	818,361	27.7
Man.	753,374	25.5	685,389	23.2	745,319	25.3
Sask.	200,685	6.8	134,177	4.6	155,038	5.3
Alta.	1,272,865	43.2	1,172,327	39.7	1,230,745	41.7
B. C.	0	0.0	0	0.0	0	0.0
Total	2,949,463	100.0	2,949,463	100.0	2,949,463	100.0

Model	4c		2e		3e, 4e	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	704,326	23.9	876,780	29.7	639,820	21.7
Man.	745,319	25.3	745,319	25.3	745,319	25.3
Sask.	155,038	5.3	155,038	5.3	155,038	5.3
Alta.	1,409,287	47.8	1,172,327	39.7	1,409,287	47.8
B. C.	0	0.0	0	0.0	0	0.0
Total	2,949,463	100.0	2,949,463	100.0	2,949,463	100.0

Solution Data

Appendix Table 3.13 (cont.)

Fed Cattle Slaughtered By Region

Model	2d		2f		3d, 4d 3f, 4f	
	Number	%	Number	%	Number	%
Mar.	0	0.0	0	0.0	0	0.0
Que.	0	0.0	0	0.0	0	0.0
Ont.	818,361	21.6	704,706	23.9	637,657	21.6
Man.	685,389	23.2	685,389	23.2	327,003	11.1
Sask.	454,091	15.4	454,091	15.4	812,478	27.5
Alta.	1,091,623	33.6	1,105,277	37.5	1,172,327	39.7
B. C.	0	0.0	0	0.0	0	0.0
Total	2,949,463	100.0	2,949,463	100.0	2,949,463	100.0

Solution Data

Appendix Table 3.14

Number of Non-Fed Cattle Slaughtered By Region

A. Number of Cows Slaughtered

Model	1a, 2a, 1b	2b	3a, 3b 4a, 4b
Maritimes	32,971	32,971	32,971
Quebec	238,980	238,980	238,980
Ontario	235,550	235,550	235,550
Manitoba	101,653	101,653	101,653
Saskatchewan	217,205	187,486	170,704
Alberta	305,860	305,860	305,860
B. C.	58,078	58,078	58,078
TOTAL	1,190,297	1,160,578	1,143,796

Model	2c	3c, 4c 2e, 3e, 4e	2d, 3d, 4d 2f, 3f, 4f
Maritimes	21,919	21,919	21,919
Quebec	198,967	198,967	198,967
Ontario	244,523	244,523	244,523
Manitoba	109,708	109,708	109,708
Saskatchewan	237,212	216,351	237,212
Alberta	312,089	332,950	332,950
B. C.	19,378	19,378	19,378
TOTAL	1,143,796	1,143,796	1,143,796

Solution Data

Appendix Table 3.14

Number of Non-Fed Cattle Slaughtered
By Region

B. Number of Bulls Slaughtered::

Models	2d, 3d, 4d 2f, 3f, 4f	All Other Situations
Maritimes	1,654	1,654
Quebec	10,720	10,720
Ontario	9,529	9,529
Manitoba	5,823	5,823
Saskatchewan	13,897	13,897
Alberta	4,720	19,323
B. C.	3,573	3,573
TOTAL	499,16	64,519

Solution Data

Appendix Table 3.15 (cont.)

Total Number of Cattle Slaughtered By Region

Model	3b		4b		2c	
	Number	%	Number	%	Number	%
Mar.	37,513	0.9	37,513	0.9	64,413	1.5
Que.	249.700	6.0	249,700	6.0	209,688	5.0
Ont.	1,040,606	25.0	964,732	23.2	1,170,783	28.0
Man.	860,850	20.7	860,850	20.7	800,920	19.2
Sask.	385,286	9.3	385,286	9.3	385,286	9.3
Alta.	1,512,064	36.4	1,598,048	38.4	1,524,606	36.5
B. C.	71,761	1.7	61,651	1.5	22,951	0.5
TOTAL	4,157,780	100.0	4,162,814	100.0	4,157,780	100.0

Model	3c		4c 3e, 4e		2e	
	Number	%	Number	%	Number	%
Mar.	23,573	0.6	23,573	0.6	23,573	0.6
Que.	209,688	5.0	209,688	5.0	209,688	5.0
Ont.	1,072,413	25.8	893,872	21.5	1,130,832	27.2
Man.	860,850	20.7	860,850	20.7	860,850	20.7
Sask.	385,286	9.3	385,286	9.3	385,286	9.3
Alta.	1,583,019	38.1	1,761,560	42.4	1,524,600	36.7
B. C.	22,951	0.6	22,951	0.6	22,951	0.6
TOTAL	4,157,780	100.0	4,157,780	100.0	4,157,780	100.0

Solution Data

Appendix Table 3.15

Total Number of Cattle Slaughtered By Region

Model	1a		2a		3a	
	Number	%	Number	%	Number	%
Mar.	106,823	2.5	37,513	0.9	37,513	0.9
Que.	260,399	6.2	249,700	5.9	249,700	6.0
Ont.	1,197,152	28.5	1,194,639	28.4	1,118,852	26.6
Man.	860,850	20.5	860,850	20.5	860,850	20.5
Sask.	385,286	9.2	385,286	9.2	385,286	9.2
Alta.	1,322,010	31.4	1,404,531	33.4	1,433,817	34.1
B. C.	71,761	1.7	71,761	1.7	71,761	1.7
TOTAL	4,204,280	100.0	4,204,280	100.0	4,157,780	100.0

Model	4a		1b		2b	
	Number	%	Number	%	Number	%
Mar.	37,513	0.9	37,513	0.9	37,513	0.9
Que.	249,700	6.0	249,700	6.0	249,700	6.0
Ont.	1,040,606	24.8	1,194,639	28.5	1,177,351	28.1
Man.	860,850	20.5	860.850	20.5	860,850	20.5
Sask.	385,286	9.2	385,286	9.2	385,286	9.2
Alta.	1,522,174	36.2	1,385,208	33.1	1,422,070	34.0
B. C.	61,651	1.7	71,761	1.7	71,761	1.7
TOTAL	4,157,780	100.0	4,184,957	100.0	4,162,814	100.0

Solution Data

Appendix Table 3.15 (cont.)

Total Number of Cattle Slaughtered By Region

Model	2d		2f		3d, 4d 3f, 4f	
	Number	%	Number	%	Number	%
Mar.	23,573	0.6	23,573	0.6	23,573	0.6
Que.	209,688	5.0	209,688	5.0	209,688	5.0
Ont.	1,072,413	25.8	958,758	23.0	891,709	21.4
Man.	800,920	19.2	800,920	19.2	442,533	10.6
Sask.	705,199	16.9	705,199	16.9	1,063,586	25.5
Alta.	1,329,293	38.1	1,442,948	34.7	1,509,997	36.3
B. C.	22,951	0.6	22,951	0.6	22,951	0.6
TOTAL	4,164,037	100.0	4,164,037	100.0	4,164,037	100.0

Solution Data

Appendix Table 3.16

Beef Production By Region

Model	1a		2a		3a	
	'000 lbs.	%	'000 lbs.	%	'000 lbs.	%
Mar.	60,425	2.5	20,226	0.8	20,226	0.8
Que.	139,709	5.9	133,505	5.6	133,505	5.6
Ont.	683,013	28.7	681,555	28.6	637,609	27.0
Man.	494,692	20.8	494,692	20.8	494,692	20.8
Sask.	213,882	9.0	213,882	9.0	213,882	9.1
Alta.	753,188	31.6	801,090	33.6	818,076	34.7
B. C.	39,035	1.6	39,035	1.6	39,035	1.6
TOTAL	2,383,944	100.0	2,383,944	100.0	2,359,572	100.0

Model	4a		1b		2b	
	'000 lbs.	%	'000 lbs.	%	'000 lbs.	%
Mar.	20,226	0.9	20,226	0.9	20,226	0.9
Que.	133,505	5.7	133,505	5.7	133,505	5.7
Ont.	592,216	25.1	681,555	28.8	671,529	28.5
Man.	494,692	21.0	494,692	21.0	470,496	19.9
Sask.	213,882	9.1	213,882	9.1	215,516	9.1
Alta.	869,459	36.8	786,598	33.2	809,266	34.3
B. C.	33,035	1.5	39,035	1.6	39,035	1.7
TOTAL	2,359,572	100.0	2,369,493	100.0	2,359,572	100.0

lution Data

Appendix Table 3.16 (cont.)

Beef Production By Region

del	2d		2f		3d, 4d 3f, 4f	
	'000 lbs.	%	'000 lbs.	%	'000 lbs.	%
r.	12,748	0.5	12,748	0.5	12,748	0.5
e.	112,498	4.8	112,498	4.8	112,498	4.8
t.	610,170	25.9	544,251	23.1	505,363	21.5
n.	455,144	19.3	459,490	19.5	251,625	10.7
sk.	389,242	16.5	398,333	16.9	606,491	26.7
ta.	753,480	31.9	819,400	34.7	838,288	36.4
C.	12,853	0.5	12,853	0.5	12,853	0.5
TAL	2,359,572	100.0	2,359,572	100.0	2,359,572	100.0

Solution Data

Appendix Table 3.17

Regional Utilization of Cattle Slaughter Capacity

(By Percentage)

Model	1a	2a	3a	4a
Maritimes	100.0	35.1	35.1	35.1
Quebec	74.4	71.4	71.4	71.4
Ontario	84.9	84.7	79.4	73.8
Manitoba	100.0	100.0	100.0	100.0
Saskatchewan	100.0	100.0	100.0	100.0
Alberta	75.0	79.7	100.0	100.0
B. C.	40.7	40.7	40.7	40.7

Model	1b	2b	3b	4b
Maritimes	35.1	35.1	35.1	35.1
Quebec	71.4	71.4	71.4	71.4
Ontario	84.7	83.5	73.8	68.4
Manitoba	100.0	100.0	100.0	100.0
Saskatchewan	100.0	100.0	100.0	100.0
Alberta	79.7	80.7	85.8	90.7
B. C.	40.7	40.7	40.7	40.7

Solution Data

Appendix Table 3.17 (cont.)

Regional Utilization of Cattle Slaughter Capacity

(By Percentage)

Model	2c	3c	2e	4c 3e, 4e
Maritimes	60.3	22.1	22.1	22.1
Quebec	59.9	59.9	59.9	59.9
Ontario	83.1	76.1	80.2	63.4
Manitoba	93.0	100.0	100.0	100.0
Saskatchewan	100.0	100.0	100.0	100.0
Alberta	86.5	89.9	100.0	100.0
B. C.	13.0	13.0	13.0	13.0

Model	2d	2f	3d, 4d 3f, 4f
Maritimes	22.1	22.1	22.1
Quebec	59.9	59.9	59.9
Ontario	76.1	68.0	63.3
Manitoba	93.0	93.0	51.4
Saskatchewan	183.0	183.0	276.1
Alberta	75.5	84.4	85.7
B. C.	13.0	13.0	13.0

Solution Data

Appendix Table 3.18

Inter-regional Movement of Fed Beef

(in thousand pounds)

Model	1a	2a	3a	4a
Man. to Mar.	65,799	105,998	79,028	79,028
Man. to Que.	218,950	177,292	160,306	114,923
Man. to Ont.	70.912	72,370	116,326	161,709
Sask. to Mar.	15,853	15,853	42,823	42,823
Alta. to Que.	248,256	296,118	313,104	358,487
Alta. to B. C.	181,879	181,879	181,879	18 ,743
Total Movement	801,648	849,510	893,467	944,714
Export from Man.	355,660	355,660	355,660	355,660
Export from Sask.	15,853	15,853	42,823	42,823
Export from Alta.	430,135	477,997	494,983	546,230
Import into Mar.	81,652	121,851	121,851	121,851
Import into Que.	467,206	473,410	473,410	473,410
Import into Ont.	70,912	72,370	116,326	161,709
Import into B. C.	181,879	181,879	181,879	181,743

Solution Data

Appendix Table 3.18 (cont.)

Inter-regional Movement of Fed Beef

(in thousand pounds)

Model	1b	2b	3b	4b
Man. to Mar.	105,998	88,762	79,028	79,028
Man. to Que.	177,292	160,306	114,923	70,917
Man. to Ont.	72,370	82,396	161,719	205,715
Sask. to Mar.	15,853	33,090	42,823	42,823
Alta. to Que.	296,118	313,104	358,487	402,493
Alta. to B. C.	181,879	181,879	181,879	187,743
Total Movement	849,510	859,537	938,849	988,719
Export from Man.	355,660	331,464	355,660	355,660
Export from Sask.	15,853	33,090	42,823	42,823
Export from Alta.	477,997	494,983	540,366	590,236
Import into Mar.	121,857	121,851	121,851	121,851
Import into Que.	473,410	473,410	473,410	473,410
Import into Ont.	72,370	82,396	161,719	205,715
Import into B. C.	181,879	181,879	181,879	181,743

Solution Data

Appendix Table 3.18 (cont.)

Inter-regional Movement of Fed Beef

(in thousand pounds)

Model	2c	3c	2e	4c 3e, 4e
Man. to Mar.	95,590	107,178	107,178	107,178
Man. to Que.	129,229	95,346	129,229	0
Man. to Ont.	91,410	148,465	114,582	243,810
Sask. to Mar.	4,249	16,348	16,348	16,348
Alta. to Que.	344,181	378,064	344,181	473,410
Alta. to Ont.	0	8,208	0	8,208
Alta. to B. C.	187,743	187,743	187,743	187,743
Total Movement	852,402	911,351	899,264	1,036,698
Export from Man.	316,229	350,989	350,989	350,989
Export from Sask.	4,249	16,348	16,348	16,348
Export from Alta.	531,924	544,015	531,924	669,361
Import into Mar.	99,839	123,526	123,526	123,526
Import into Que.	473,410	473,410	473,410	473,410
Import into Ont.	91,410	156,673	114,582	252,018
Import into B. C.	187,743	181,743	181,743	181,743

Solution Data

Appendix Table 3.18 (cont.)

Inter-regional Movement of Fed Beef

(in thousand pounds)

Model	2d	2f	3d, 4d 3f, 4f
Man. to Mar.	0	0	0
Man. to Que.	167,764	101,845	0
Man. to Ont.	148,465	214,384	108,364
Sask. to Mar.	123,526	123,526	123,526
Sask. to Que.	66,273	66,273	20,864
Sask. to Ont.	0	0	253,273
Alta. to Que.	239,373	305,293	344,181
Alta. to Ont.	8,208	0	0
Alta. to B. C.	187,743	187,743	187,743
Total Movement	933,144	999,064	1,037,952
Export from Man.	316,229	316,229	108,364
Export from Sask.	189,799	189,799	397,663
Export from Alta.	427,116	493,036	531,924
Import into Mar.	123,526	123,526	123,526
Import into Que.	473,410	473,410	473,410
Import into Ont.	148,465	214,384	361,637
Import into B. C.	187,743	187,743	187,743

Solution Data

Appendix Table 3.19
Inter-regional Movement of Non-Fed Beef

(in thousand pounds)

Model	1a, 2a 1b	2b	3a, 4a 3b, 4b
Man. to Ont.	26,898	26,898	26,898
Sask. to Mar.	28,304	28,304	28,304
Sask. to Ont.	68,243	52,640	43,830
Alta. to Que.	46,064	46,064	46,064
Alta. to Ont.	10,402	26,005	34,815
Alta. to B. C.	38,042	38,042	38,042
Total Movement	217,953	217,953	217,953
Export from Man.	26,898	26,898	26,898
Export from Sask.	96,547	80,944	72,134
Export from Alta.	94,058	110,111	118,921
Import into Mar.	28,304	28,304	28,304
Import into Que.	46,064	46,064	46,064
Import into Ont.	78,645	78,645	78,645
Import into B. C.	38,042	38,042	38,042

Solution Data

Appendix Table 3.19 (cont.)

Inter-regional Movement of Non-Fed Beef

(in thousand pounds)

Model	2c	3c, 4c 2e, 3e, 4e	2d, 3d, 4d 2f, 3f, 4f
Man. to Que.	3,239	0	0
Man. to Ont.	27,888	31,127	31,127
Sask. to Mar.	34,107	34,107	34,107
Sask. to Que.	0	0	3,239
Sask. to Ont.	72,944	61,992	69,706
Alta. to Que.	63,832	67,071	63,832
Alta. to Ont.	0	7,713	0
Alta. to B. C.	58,360	58,360	58,360
Total Movement	260,370	260,370	260,370
Export from Man.	31,127	31,127	31,127
Export from Sask.	107,051	96,099	107,051
Export from Alta.	122,192	133,144	122,192
Import into Mar.	34,107	34,107	34,107
Import into Que.	67,071	67,071	67,071
Import into Ont.	100,832	100,832	100,832

Solution Data

Appendix Table 3.20

Inter-regional Movement of Fed and Non-Fed Beef

(in thousand pounds)

Model	1a	2a	3a	4a
Man. to Mar.	65,799	105,998	79,028	79,028
Man. to Que.	218,950	177,292	160,306	114,923
Man. to Ont.	97,810	99,268	143,224	188,607
Sask. to Mar.	44,157	44,157	71,127	71,127
Sask. to Ont.	68,243	68,243	43,820	43,820
Alta. to Que.	294,320	342,182	359,168	404,551
Alta. to Ont.	10,402	10,402	34,815	34,815
Alta. to B. C.	219,921	219,921	219,921	225,921
Total Movement	1,019,602	1,067,463	1,111,420	1,162,802
Export from Man.	382,558	382,558	382,558	382,558
Export from Sask.	112,400	112,400	114,957	114,957
Export from Alta.	524,643	572,505	613,904	665,287
Import into Mar.	109,956	150,155	150,155	150,155
Import into Que.	513,270	519,474	519,474	519,474
Import into Ont.	176,455	177,913	221,859	267,252
Import into B. C.	219,921	219,921	219,921	225,921

Solution Data

Appendix Table 3.20 (cont.)

Inter-regional Movement of Fed and Non-Fed Beef

(in thousand pounds)

Model	2c	3c	2e	4c 3e, 4e
Man. to Mar.	95,590	107,178	107,178	107,178
Man. to Que.	132,468	95,346	129,229	0
Man. to Ont.	119,298	179,592	145,709	274,937
Sask. to Mar.	38,356	50,455	50,455	50,455
Sask. to Ont.	72,944	61,992	61,992	61,992
Alta. to Que.	408,013	445,135	411,252	540,481
Alta. to Ont.	0	15,921	7,713	15,921
Alta. to B. C.	246,103	246,103	246,103	246,103
Total Movement	1,112,772	1,201,722	1,159,631	1,297,067
Export from Man.	347,356	382,116	382,116	382,116
Export from Sask.	111,300	112,447	112,447	112,447
Export from Alta.	654,116	707.159	665,068	802,505
Import into Mar.	133,946	157,633	157,633	157,633
Import into Que.	540,481	540,481	540,481	540,481
Import into Ont.	192,242	257,505	215,414	257,505
Import into B. C.	246,103	246,103	246,103	246,103

Solution Data

Appendix Table 3.20 (cont.)

Inter-regional Movement of Fed and Non-Fed Beef

(in thousand pounds)

Model	2d	2f	3d, 4d 3f, 4f
Man. to Que.	234,037	101,845	0
Man. to Ont.	113,319	245,511	139,491
Sask. to Mar.	157,633	157,633	157,633
Sask. to Que.	3,239	69,512	132.468
Sask. to Ont.	135,979	69,706	214,614
Alta. to Que.	303,205	369,125	408,013
Alta. to B. C.	246,103	246,103	246,103
Total Movement	1,193,515	1,259,434	1,298,322
Export from Man.	347,356	347,356	139,491
Export from Sask.	296,851	296,851	504,715
Export from Alta.	549,308	615,228	654,116
Import into Mar.	157,633	157,633	157,633
Import into Que.	540,481	540,481	540,481
Import into Ont.	249,298	315,217	354,105
Import into B. C.	246,103	246,103	246,103

Solution Data

Appendix Table 3.21

BEEF: Regional Production as a Percentage of Regional Consumption

Model	1a	2a	3a	1b	2b	3b	4a, 4b
Mar.	35.5	11.9	11.9	11.9	11.9	11.9	11.9
Que.	21.4	20.4	20.4	20.4	20.4	20.4	20.4
Ont.	79.5	79.3	74.2	78.1	78.1	68.9	68.9
Man.	441.2	441.2	441.2	441.2	419.6	441.2	441.2
Sask.	210.8	210.8	210.8	210.8	210.8	210.8	210.8
Alta.	368.9	350.5	400.7	385.3	396.4	422.9	425.8
B. C.	15.1	15.1	15.1	15.1	15.1	15.1	12.8

Model	2c	3c	2e	4c 3e, 4e	2d	2f	3d, 4d 3f, 4f
Mar.	21.4	7.5	7.5	7.5	7.5	7.5	7.5
Que.	17.2	17.2	17.2	17.2	17.2	17.2	17.2
Ont.	77.6	70.0	74.9	58.9	71.0	63.3	58.8
Man.	409.8	440.8	440.8	440.8	405.9	409.8	224.4
Sask.	209.7	210.8	210.8	210.8	369.0	392.5	597.6
Alta.	420.4	446.4	425.7	493.1	405.8	401.3	420.4
B. C.	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Solution Data

Appendix Table 3.22

Number of Breeding Pigs By Region

Model	1a, 2a, 3a, 4a 1b, 2b, 3b, 4b		2c	
	Number	%	Number	%
Maritimes	23,250	3.4	25,575	3.9
Quebec	162,850	24.0	109,750	16.8
Ontario	263,050	38.7	264,012	40.4
Manitoba	68,250	10.1	75,075	11.5
Saskatchewan	57,250	8.4	62,975	9.7
Alberta	96,500	14.2	106,150	16.3
B. C.	7,750	1.1	8,525	1.3
TOTAL	678,900	100.0	652,062	100.0

Model	3c, 4c, 2d, 3d 2e, 3e, 4e, 2f, 3f		4d, 4f	
	Number	%	Number	%
Maritimes	25,575	3.9	18,434	2.8
Quebec	84,407	12.9	91,548	14.0
Ontario	289,355	44.4	289,355	44.4
Manitoba	75,075	11.5	75,075	11.5
Saskatchewan	62,975	9.7	62,975	9.7
Alberta	106,150	16.3	106,150	16.3
B. C.	8,525	1.3	8,525	1.3
TOTAL	652,062	100.0	652,062	100.0

Solution Data

Appendix Table 3.23

Number of Market Pigs By Region

Model	1a		2a	
	Number	%	Number	%
Maritimes	325,500	3.6	325,500	3.6
Quebec	2,389,352	26.2	2,244,910	24.6
Ontario	3,573,247	39.2	3,601,483	39.5
Manitoba	586,863	6.4	703,070	7.7
Saskatchewan	784,149	8.6	784,149	8.6
Alberta	1,351,000	14.8	1,351,000	14.8
B. C.	108,500	1.2	108,500	1.2
TOTAL	9,118,612	100.0	9,118,612	100.0

Model	1b		3a, 4a 2b, 3b, 4b	
	Number	%	Number	%
Maritimes	325,500	3.6	325,500	3.6
Quebec	2,244,910	24.6	1,893,912	20.8
Ontario	3,601,483	39.5	3,682,700	40.4
Manitoba	703,070	7.7	955,500	10.5
Saskatchewan	801,500	8.8	801,500	8.8
Alberta	1,351,000	14.8	1,351,000	14.8
B. C.	91,149	1.0	108,500	1.2
TOTAL	9,118,612	100.0	9,118,612	100.0

Solution Data

Appendix Table 3.23 (cont.)
Number of Market Pigs By Region

Model	2c		3c, 4c, 2d, 3d 2e, 3e, 4e, 2f, 3f	
	Number	%	Number	%
Maritimes	358,050	3.9	358,050	3.9
Quebec	1,536,497	16.7	1,181,698	12.9
Ontario	3,696,171	40.5	4,050,970	44.4
Manitoba	1,051,050	11.5	1,051,050	11.5
Saskatchewan	881,650	9.7	881,650	9.7
Alberta	1,486,100	16.3	1,486,100	14.3
B. C.	119,350	1.3	119,350	1.3
TOTAL	9,128,868	100.0	9,128,868	100.0

Model	4d, 4f	
	Number	%
Maritimes	258,076	2.8
Quebec	1,281,672	14.0
Ontario	4,050,970	44.4
Manitoba	1,050,050	11.5
Saskatchewan	881,650	9.7
Alberta	1,486,100	14.3
B. C.	119,350	1.3
TOTAL	9,128,868	100.0

Solution Data

Appendix Table 3.24

Inter-regional Movement of Weaner Pigs

Model	1a	All Other Situations
Ont. to Que.	109,453	Nil
Total Movement	109,453	Nil

Appendix Table 3.25

Inter-regional Movement of Finished Pigs for Slaughter

Model	3a, 4a 2b, 3b, 4b	2c
Ont. to Que.	76,344	88,988
Total Movement	76,344	88,988
Model	**3c, 4c 2e, 3e, 4e**	**All Other Situations**
Ont. to Que.	422,252	Nil
Total Movement	422,252	Nil

Solution Data

Appendix Table 3.26

Slaughter of Finished Market Pigs By Region

Model	1a		2a	
	Number	%	Number	%
Maritimes	294,345	3.5	294,345	3.5
Quebec	2,164,567	26.3	2,028,790	24.6
Ontario	3,227,327	39.2	3,253,869	39.5
Manitoba	517,526	6.3	626,761	7.6
Saskatchewan	708,475	8.6	708,475	8.6
Alberta	1,221,690	14.8	1,221,690	14,8
B. C.	98,115	1.2	98,115	1.2
TOTAL	8,232,045	100.0	8,232,045	100.0

Model	1b		3a, 4a 2b, 3b, 4b	
	Number	%	Number	%
Maritimes	294,345	3.5	294,345	3.5
Quebec	2,028,790	24.6	1,775,196	21.6
Ontario	3,253,869	39.5	3,253,869	39.5
Manitoba	626,761	7.6	864,945	10.5
Saskatchewan	724,785	8.8	724,785	8.8
Alberta	1,221,690	14.8	1,221,690	14.8
B. C.	81,805	1.0	98,115	1.2
TOTAL	8,232,045	100.0	8,232,045	100.0

Solution Data

Appendix Table 3.26 (cont.)

Slaughter of Finished Market Pigs By Region

Model	2c		3c, 4c 2e, 3e, 4e	
	Number	%	Number	%
Maritimes	323,780	3.9	323,780	3.9
Quebec	1,478,430	17.9	1,490,845	18.1
Ontario	3,253,397	39.4	3,240,982	39.3
Manitoba	950,450	11.5	950,450	11.5
Saskatchewan	797,264	9.7	797,264	9.7
Alberta	1,343,859	16.3	1,343,859	16.3
B. C.	107,927	1.3	107,927	1.3
TOTAL	8,255,107	100.0	8,255,107	100.0

Model	2d, 3d 2f, 3f		4d, 4f	
	Number	%	Number	%
Maritimes	323,780	7.9	323,780	7.9
Quebec	1,068,593	12.9	1,159,003	14.0
Ontario	3,663,243	44.4	3,663,243	44.4
Manitoba	950,450	11.5	950,450	11,5
Saskatchewan	797,264	9.7	797,264	9.7
Alberta	1,343,859	16.3	1,343,859	14.3
B. C.	107,927	1.3	107,927	1.3
TOTAL	8,255,107	100.0	8,255,107	100.0

Solution Data

Appendix Table 3.27

Pigs: Slaughter of Basic Herd By Region

Model	1a, 2a, 3a, 4a 1b, 2b, 3b, 4b		2c	
	Number	%	Number	%
Maritimes	11,390	3.4	12,529	3.9
Quebec	79,780	24.0	53,766	14.2
Ontario	128,868	38.7	129,340	44.4
Manitoba	33,435	10.1	36,779	10.3
Saskatchewan	28,047	8.4	30,851	9.7
Alberta	47,275	14.2	52,003	16.3
B. C.	3,797	1.1	4,176	1.3
TOTAL	332,592	100.0	319,444	100.0

Model	3c, 4c, 2d, 3d 2e, 3e, 4e, 2f, 3f		4d, 4f	
	Number	%	Number	%
Maritimes	12,529	3.9	9,030	2.8
Quebec	41,351	12.9	44,849	14.0
Ontario	141,755	44.4	141,755	44.4
Manitoba	36,779	11.5	36,779	11.5
Saskatchewan	30,851	9.7	30,851	9.7
Alberta	52,003	14.2	52,003	14.2
B. C.	4,176	1.3	4,176	1.3
TOTAL	319,444	100.0	319,444	100.0

Solution Data

Appendix Table 3.28

Total Number of Pigs Slaughtered By Region

Model	1a		2a	
	Number	%	Number	%
Maritimes	305,735	3.6	305,735	3.6
Quebec	2,244,347	26.2	2,108,570	24.6
Ontario	3,356,196	39.2	3,382,737	39.5
Manitoba	550,961	6.4	660,196	7.7
Saskatchewan	736,522	8.6	736,522	8.6
Alberta	1,268,965	14.8	1,268,965	14.8
B. C.	101,912	1.2	101.912	1.2
TOTAL	8,564,638	100.0	8,564,638	100.0

Model	1b		3a, 4a 2b, 3b, 4b	
	Number	%	Number	%
Maritimes	305,755	3.6	305,755	3.6
Quebec	2,108,570	24.6	1,854,977	21.7
Ontario	3,382,737	39.5	3,382,737	39.5
Manitoba	660,166	7.7	897,481	10.5
Saskatchewan	752,832	8.8	752,832	8.8
Alberta	1,268,965	14.8	1,268,965	14.8
B. C.	85,602	1.0	101,912	1.2
TOTAL	8,564,638	100.0	8,564,638	100.0

Solution Data

Appendix Table 3.28 (cont.)

Total Number of Pigs Slaughtered By Region

Model	2c, 3c, 4c 2e, 3e, 4e		2d, 3d 2f, 3f	
	Number	%	Number	%
Maritimes	336,309	3.9	336,309	3.9
Quebec	1,532,196	17.9	1,109,944	12.9
Ontario	3,382,737	39.5	3,804,989	44.4
Manitoba	987,229	11.5	987,229	11.5
Saskatchewan	828,115	9.7	828,115	9.7
Alberta	1,395,862	16.3	1,395,862	16.3
B. C.	112,103	1.3	112,103	1.3
TOTAL	8,574,500	100.0	8,574,500	100.0

Model	4d, 4f	
	Number	%
Maritimes	242,400	2.8
Quebec	1,203,852	14.0
Ontario	3,804,989	44.4
Manitoba	987,229	11.5
Saskatchewan	828,115	9.7
Alberta	1,395,862	16.3
B. C.	112,103	1.3
TOTAL	8,574,500	100.0

Solution Data

Appendix Table 3.29
Percentage Utilization of Pig Slaughter Capacity

Model	1a	2a	1b	3a, 4a 2b, 3b, 4b
Maritimes	48.0	48.0	48.0	48.0
Quebec	61.4	57.7	57.7	50.8
Ontario	99.2	100.0	100.0	100.0
Manitoba	15.7	18.8	18.8	25.5
Saskatchewan	41.7	41.7	42.6	42.6
Alberta	34.6	34.6	34.6	34.6
B. C.	21.8	21.8	18.3	21.8

Model	2c, 3c, 4c 2e, 3e, 4e	2d, 3d 2f, 3f	4d, 4f
Maritimes	48.0	48.0	36.9
Quebec	41.9	30.4	32.9
Ontario	100.0	112.5	112.5
Manitoba	27.3	27.3	27.3
Saskatchewan	46.9	46.9	46.9
Alberta	38.0	38.0	38.0
B. C.	21.8	21.8	21.8

Solution Data

Appendix Table 3.30
Pork Production By Region

Model	1a		2a	
	'000 pounds	%	'000 pounds	%
Maritimes	40,861	3.6	40,861	3.6
Quebec	299,584	26.1	281,933	24.6
Ontario	448,935	39.2	452.386	39.5
Manitoba	74,902	6.5	89,103	7.8
Saskatchewan	98,497	8.6	98,497	8.6
Alberta	169,599	14.8	169,599	14.8
B. C.	13,620	1.2	13,620	1.2
TOTAL	1,145,999	100.0	1,145,999	100.0

Model	1b		3a, 4a 2b, 3b, 4b	
	'000 pounds	%	'000 pounds	%
Maritimes	40,861	3.6	40,861	3.6
Quebec	281,933	24.6	248,966	21.7
Ontario	452,386	39.5	452,386	39.5
Manitoba	89,103	7.8	119,950	10.5
Saskatchewan	100,617	8.8	100,617	8.8
Alberta	169,599	14.8	169.599	14.8
B. C.	11,500	1.0	14,982	1.3
TOTAL	1,145,999	100.0	1,145,999	100.0

Solution Data

Appendix Table 3.30 (cont.)

Pork Production By Region

Model	2c		3c, 4c 2e, 3e, 4e	
	'000 pounds	%	'000 pounds	%
Maritimes	44,948	3.9	44,948	3.9
Quebec	204,455	17.8	203,238	17.7
Ontario	452,432	39.5	453,649	39.6
Manitoba	131,944	11.5	131,944	11.5
Saskatchewan	110,679	9.7	110,679	9.7
Alberta	186,559	16.3	186,559	16.3
B. C.	14,982	1.3	14,982	1.3
TOTAL	1,145,999	100.0	1,145,999	100.0

Model	2d, 3d 2f, 3f		4d, 4f	
	'000 pounds	%	'000 pounds	%
Maritimes	44,948	3.9	32,397	2.8
Quebec	178,850	15.6	191,400	16.7
Ontario	508,541	44.4	508,541	44.4
Manitoba	131,944	11.5	131,944	11.5
Saskatchewan	110,679	9.7	110,679	9.7
Alberta	186,559	16.3	186,559	16.3
B. C.	14,982	1.3	14,982	1.3
TOTAL	1,145,999	100.0	1,145,999	100.0

Solution Data

Appendix Table 3.31

Inter-regional Movement of Pork

(in thousand pounds)

Model	1a	2a	1b
Ont. to Mar.	18,140	21,591	21,591
Man. to Mar.	19,168	15,718	15,718
Man. to Que.	0	17,651	17,651
Sask. to B. C.	48,058	48,058	50,178
Alta. to B. C.	68,120	68,120	68,120
Total Movement	153,487	171,138	173,258
Export from Ont.	18,140	21,591	21,591
Export from Man.	19,168	33,369	33,369
Export from Sask.	48,058	48,058	48,058
Export from Alta.	68,120	68,120	68,120
Import into Mar.	37,309	37,309	37,309
Import into Que.	0	17,651	17,651
Import into B. C.	116,178	116,178	118,298

Solution Data

Appendix Table 3.31 (cont.)

Inter-regional Movement of Pork

(in thousand pounds)

Model	3a, 4a 2b, 3b, 4b	2c	3c, 4c 2e, 3e, 4e
Ont. to Mar.	21,591	21,637	22,854
Man. to Mar.	15,178	11,585	10,368
Man. to Que.	48,498	64,625	65,842
Sask. to Que.	2,120	30,504	30,504
Sask. to B. C.	48,058	29,736	29,736
Alta. to B. C.	68,120	85,080	85,080
TOTAL	204,866	243,167	244,834
Export from Ont.	21,591	21,637	22,854
Export from Man.	63,676	76,120	76,120
Export from Sask.	50,178	60,240	60,240
Export from Alta.	68,120	85,080	85,080
Import into Mar.	37,309	33,222	33,222
Import into Que.	50,618	95,129	96,346
Import into B. C.	116,178	114,816	114,816

Solution Data

Appendix Table 3.31 (cont.)

Inter-regional Movement of Pork

(in thousand pounds)

Model	2d, 3d 2f, 3f	4d, 4f
Ont. to Mar.	33,222	45,773
Ont. to Que.	44,524	31,974
Man. to Que.	76,210	76,210
Sask. to Que.	30,504	30,504
Sask. to B. C.	29,736	29,736
Alta. to B. C.	85,080	85,080
TOTAL	299,276	299,276
Export from Ont.	77,746	77,746
Export from Man.	76,210	76,210
Export from Sask.	60,240	60,240
Export from Alta.	85,080	85,080
Import into Mar.	33,222	45,773
Import into Que.	120,734	108,184
Import into B. C.	114,816	114,816

Solution Data

Appendix Table 3.32

PORK: Regional Production as a Percentage of Regional Consumption

Model	1a	2a	1b	3a, 4a 2b, 3b, 4b
Mar.	52.3	52.3	52.3	52.3
Que.	100.0	94.1	94.1	83.1
Ont.	104.5	105.0	105.0	105.0
Man.	140.6	159.9	159.9	215.2
Sask.	195.3	195.3	199.5	199.5
Alta.	167.1	167.1	167.1	167.1
B. C.	10.5	10.5	8.9	10.5

Model	2c	3c, 4c 2e, 3e, 4e	2d, 3d 2f, 3f	4d, 4f
Mar.	57.5	57.5	57.5	41.4
Que.	68.2	67.8	59.7	63.9
Ont.	105.3	105.3	118.0	118.0
Man.	236.7	236.7	236.7	236.7
Sask.	219.4	219.4	219.4	219.4
Alta.	183.8	183.8	183.8	183.8
B. C.	11.5	11.5	11.5	11.5