THE INTERRELATIONS BETWEEN THE UNITED STATES AND THE CANADIAN CATTLE INDUSTRIES

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by

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ABSTRACT

INTERRELATIONS BETWEEN THE U.S. AND CANADIAN

BEEF CATTLE INDUSTRIES

by

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There has been a long association between the cattle industries in the U.S. and in Canada. Historically the U.S. market has proved to be Canada's largest and the most lucrative export outlet for beef cattle. Cattle move easily across the border subject only to a minor tariff. A 'continental' market has, so to speak, been created comprising the major cattle markets in the U.S. and Canada. Despite the fact that cattle production in the U.S. is increasing, the U.S. is still a deficit producing area. It is an area of very strong demand, the prices there being the highest in the world. Because of the geographical proximity of the U.S. and Canada and also because the two countries have certain economic ties in common, fluctuations in cattle production and cattle prices in the U.S. have far reaching consequences for Canada. This study was initiated to measure the degree of interrelationships between the beef cattle industries of the two countries.

The first four chapters of the study are introductory and descriptive. They cover the objectives and the scope of the study; the theory underlying the concepts used and the basic economic postulates

regarding perfect competition which are involved. The U.S.-Canada trade in beef cattle and certain characteristics of the beef cattle industry in North America are described.

In chapters V to VIII, annual and monthly data obtained from the Dominion Bureau of Statistics and the U.S. Department of Agriculture sources are used in the empirical analysis. In chapter V, a modified Fourier analysis is the main operational model used in isolating the long, medium and short-period cycles in cattle production in Canada and in the U.S. The composite cyclical values were added to the trend values to obtain the predicted production for each year. Cattle production (Y_t) is regarded as dependent on resource inputs (A_t), technology (T_c) and the composite inventory cycles (I_c). The basic model is as follows:

$$Y_t = A_t + B_t + I_c + E_t. \qquad \text{(i)}$$

where A_t represents resource inputs and B_t represents technology coefficient. Using simple harmonic functions, the composite inventory cycle is formulated as:

$$I_c = \sum_{k=1}^{n} \frac{1}{N} C_k \left[\text{sine} \left[\beta_k + \left(\frac{\pi}{N} k\right) (T - T_0) \right] \right] \qquad \text{(ii)}$$

where $\frac{I_{C_k}}{N}$ = the amplitude of the cycle;

β_k = the phase angle of the cycle;

$\frac{\pi}{N} K$ = the frequency of the cycle, and

k = the index of the individual cycle.

Spectrum analysis was performed on the residuals in order to estimate the approximate time lag between the U.S. and the Canadian cattle

production cycles.

In chapter VI, elasticities of export response are calculated using pooled regression analysis based on monthly data. In chapter VII, a Cobb-Douglas multiplicative formulation is used in order to incorporate in the analysis several variables which have some influence on cattle prices in Canada and in the U.S. Factors which impinge on cattle prices, such as income, population, imports and beef cattle production are examined. In particular, the influence of the U.S. cattle prices on prices in Canada are investigated.

In the VIIIth chapter, an analysis of variance technique and Newman-Keuls sequential range test are employed to isolate and evaluate the geographical variations of beef cattle prices which prevailed on the 'continental' market for the period 1959-60.

It has been determined in the analysis that the cattle production cycles in the U.S. and in Canada are similar in timing, the Canadian cycle lagging that of the U.S. by approximately one year. The annual rates of change of cattle numbers and structural adjustment by class of cattle on farms in the two countries are also similar in timing. The empirical results show that cattle prices in Canada and the exports of cattle to the U.S. from Canada are very sensitive to price movements in the United States.

With a view to confirming or refuting the validity of the results presented in this study, further research is recommended. This should be directed toward improving the application of the modified Fourier analysis to cattle production cycles. Specifically, a growth model or a curvilinear formulation should be used in the first part of equation (i) above.

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CHAPTER I

INTRODUCTION

Just about all possible relationships have historically existed between the U.S. and the Canadian cattle markets. These relationships have been both symbiotic and influential. In a seemingly alarming article in the Winnipeg Free Press, an announcement was made to the effect that:

> In the past two months--December and January--in the livestock industry a most unusual thing happened. Canada imported 6,500 head of cattle from the U.S. By comparison, the shipment of coal to Newcastle would be regarded as a routine operation.[1]

Mr. Dexter further mentioned the fact that even the officials of the Canada Department of Agriculture refused to believe that cattle could ever be imported into the prairies.

However unusual the situation was, it represented a new departure in U.S.-Canada relations with respect to the livestock trade. The 1947-48 Canada-U.S. Reciprocal Trade Agreement had created one vast continental livestock market. A single price structure had begun to prevail in Toronto, Winnipeg, Chicago, St. Paul and Omaha cattle markets. The U.S. prices are the highest in the world and this constitutes an added advantage to Canadian cattle producers. The U.S. consumes most of her high quality meat produced domestically. Only relatively small amounts are exported. Several factors account for this low volume of exports of U.S. beef and beef cattle. The most important one appears to be the

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[1] Winnipeg Free Press, February 24, 1956.

high disparity in income between the U.S. and the other countries. Incomes in Canada are higher by comparison with these "other" countries but lag slightly behind those of the U.S. But in Canada, domestic consumption is often high enough to hold prices at levels that practically prevent imports from the U.S. At times shortages in Canada do occur, resulting in higher prices relative to those in the U.S., and thus flows from the U.S. into Canada are occasionally initiated.

The chief suppliers of cattle imports into the U.S. are Australia, New Zealand, Ireland, Mexico and Argentina. By comparison, Canada is not reckoned as a major supplier, but the U.S. represents the largest and the only profitable export market for Canadian cattle. All indications point to the fact that this mutual relationship is a desirable thing, at least from the point of view of the Canadian producers. The following quotations reflect the views commonly expressed by Canadians on the beef cattle trade with the U.S.:

> Canadian producers of both slaughter and feeder cattle are fortunate in their proximity to the large and affluent U.S.A. market. So long as the present reciprocal trade agreement for livestock remains on the statutes of both countries, the United States' market provides a very effective floor price and a good outlet for surplus livestock and livestock products. In the overall picture our daily prices on Canadian markets are largesly determined by the price obtainable in adjacent U.S.A. markets... No change in tariff regulations between Canada and the U.S.A. should be consumated that will in any way disturb our present livestock trading arrangement under the reciprocal trade agreement.[2]
>
> The amount exported to the United States, though usually a small proportion of the total Canadian supply, is important to the Canadian industry in the stability it helps to provide.... As demand in the United States has been expanding, export

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[2]Manitoba Pool Elevators--Presentation to the Special Committee on Marketing of Livestock, 1961. Mimeo.

prospects to that market will be at least as favourable as in the past.[3]

The U.S. market, of course, is the obvious choice since Canadian prices and costs of production are too high to allow entry into the European Market. Apart from absorbing almost all Canadian surplus beef since the 1948 agreement, the general opinion seems to be that the U.S. market has provided strength and stability to Canadian cattle prices.[4]

The interdependence of the U.S. and Canadian beef cattle prices produced a spirited debate in the House of Commons in 1954.[5] At that time, there were ardent suggestions on the part of some interested groups to create a marketing board for beef cattle. The expressed motive was to create a government body which would guarantee a floor price for cattle producers. The Canadian Government had some reasons to object to such a move as succintly expressed by the then Minister of Agriculture:

> I would like to say that there have been representations made to the effect that we should set a floor price for cattle in Canada. We have replied to that by saying that we do not believe it is necessary. Our surplus beef all goes to the United States and the U.S. price is the highest in the world. Our price is secondary only to theirs and we obtain prices for our cattle in the U.S. based upon the market price which is established there, less the duty we have to pay in order to get our cattle there... We believe that the market as it at present operates, provides very good support for the cattle industry in this country.

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[3] A.W. Wood, Livestock Marketing System in Manitoba, 1961, pp. 4-5. Mimeo.

[4] H.K. Leckie, "Canadian Marketing Puzzle" Farm Policy Forum, Iowa State College Press. September 1956, pp. 27ff.

[5] House of Commons Debates, Dominion of Canada, Vol. IV, 1953-54, pp. 4275-4322.

Mr. Gardiner's optimism, despite misgivings expressed by some members[6] was made clear when he pointed out further that:

> The regulator of cattle prices is the prices in the U.S.... operating on the American price they have a floor which is as high and as strong as any floor could be--whether this government were to put it on or whether it was put on in any other way. The American market is the natural market for our surplus. Our cattle go there, and if the market here will not stay close to that price, then they will go there in greater numbers....But we are still convinced that the best floor price we can have at the moment and probably for some time to come, is the American market, with the American price.

But this was a bitter pill which some members of the House found difficult to swallow. Mr. A.M. Nicholson (McKenzie), for instance, pointed out that Canadians were consuming about 95% of beef produced domestically. For this reason it could not by any stretch of imagination seem reasonable that the 5% exported to the U.S. should be responsible for the fluctuations of the price of beef cattle being exported.

This observation is an interesting one indeed as it strikes at the core of the problem being investigated in this thesis. Canada consumes such a large proportion of the domestic production that, in theory, it would seem that the meager volumes exported exert no significant influence on domestic prices. Should this be the case, internal forces alone could conceivably establish stable or near stable equilibrium

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[6] A member, Hon. Mr. Charlton was suspicious of the long term effect of the U.S. market. While advocating a switch of interest toward the U.K. market, he lamented that the U.S. market, despite the better price offered, was "so unstable that the average position is poorer than it would have been if we had taken less money and sold in the market we were sure of...". Ibid., pp. 4286ff.

prices.[7] But because of the geographical proximity of the two countries, and because of the elimination of certain institutional impediments to trade, backwash and spread effects have had such an impact on the Canadian market as to modify the effects of whatever internal independent forces might have existed. The question then is asked: Why should this be so? Are there advantages, and if so, are these benefits illusory or what?

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[7]This may happen if the supply level remains reasonably stable.

CHAPTER II

IMPORTANCE OF THE STUDY

The purpose of this study is to shed some light on the question often raised about the precise beef cattle price differentials between the major markets in Canada and in the U.S. So far there has been awareness that the U.S. market sets the outside limits to beef cattle prices in Canada. Yet very little work has been done to evaluate this relationship. There is no doubt that such a knowledge is necessary to facilitate projections for trade potentials and help improve the basis upon which Canadian beef production and export programs could be formulated.

Profound changes have taken place in the economics of beef cattle marketing in both the U.S. and in Canada. Canada now consumes domestically roughly 95% of annual production. The U.S. absorbs practically all the surplus. Before World War II, cattle shipments from Canada to the U.S. were limited to only 50,000 head in each three month period. Since 1948, beef cattle have crossed the border easily, subject to a minor tariff.[1] Other developments have been improvements in transportation--especially trucking and refrigeration, better market news facilities, standardization of beef cattle grades and the increasing demand for beef. It is necessary to know the degree to which these factors are interrelated and specifically to try to find out whether

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[1] Leckie, op. cit., p. 27.

these revolutionary changes have had the tendency to diminish or accentuate beef cattle price differences between the two countries. An evaluation of these price differentials should help in explaining the conditions under which a flow of beef cattle across the border is triggered. In particular, the tracing of price relationships between the two countries as the market situation changes will help to indicate the long-run pattern of cattle exports in the absence of any increase in trade barriers.

Even though cattle numbers and volume of cattle slaughter have trended upward in recent years, the U.S. is still not self-sufficient and is likely to remain a net importer in the forseeable future. One aspect of this change is the possible effect it might have on exports from Canada. In an FAO study it has been pointed out that the volumes imported into the U.S. will be significantly influenced by the cattle cycle and the resultant volume of cow slaughter.[2] Hence it is deemed expedient to trace out all the relevant relationships between the cattle cycles in the U.S. and in Canada. A well defined and identified cycle will provide Canadian producers an opportunity of knowing precisely where they are in the current cycle in relation to that of the U.S. so as to plan and execute production programs accordingly. A workable knowledge in this respect would be provided if it were clearly established that the two cycles are similar in timing or, if there is a time lag,

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[2] Trade in Agricultural Commodities in the United Nations Development Decade, Vol. 1, Parts I, II and III, FAO, Rome 1964, pp. 11-19.

how long this lag is.

Cattle marketings are influenced at a point in time not only by the size of the total inventory but also by the composition of this inventory. There are differences in the numbers of the various types of livestock marketed. These differences are suggestive of the fact that some important structural changes occur during the course of the cyclical changes in the total inventory.[3] For Canada, Marshall has discovered that the proportion of different classes of cattle held in inventories as well as the proportion marketed vary during the course of cyclical variations. The same pattern holds true for the U.S. cattle inventory. It is an important objective of this study to examine the annual rates of change in the different classes of cattle on farms in the U.S. and in Canada.

In addition to the above mentioned objectives, this study will attempt to provide an analysis which could help all those connected with the industry in making better management and policy decisions which affect directly or indirectly the beef cattle industry than might otherwise occur. As an illustration, fluctuating production and prices throw packers into an uncomfortable position for overhead costs continue for them whether production is great or small. The average cattle producer, on the other hand, delivers cattle to market rather infrequently.[4] The implication is

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[3] R.G. Marshall, Variations in Cattle Inventories and Marketing, Department of Agricultural Economics, Ontario Agricultural College, June 1964, pp. 31.

[4] This does not imply that he does the negotiations himself. It

that should he market at the time prices are at a very low ebb, profits of an entire year may vanish. What the individual producers, packers, dealers, exporting agents, etc., need is a reasonnable expectation with which they could count on expanding markets (domestic and foreign) in order to encourage a corresponding expansion of their enterprise.

The specific objectives of this study therefore are to investigate and collate the basic relationships between cattle production and prices in the individual countries in a way that will help:

1. to show the spatial variations in prices paid to producers of fed cattle and feeders.
2. to show whether the Canadian cattle cycle is generated internally and whether it follows closely the movement of the U.S. cattle cycle.
3. to estimate supply and demand elasticities for fed cattle and feeder cattle.
4. to analyse several meaningful questions that either have a bearing on current policy and appropriate actions or may have some bearing in the near future.
5. to estimate the possible impact of selected foreign production on the United States cattle prices.

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should be interpreted to mean that he mainly sells particular lots of his produce twice a year.

THE PROBLEMATIC SITUATION

It is a common belief held among all those who are connected with the beef cattle industry and the officials of the Department of Agriculture that Canadian cattle prices are historically dependent on prices in the U.S. An outstanding limitation is the lack of adequate parameters to estimate precisely what this dependence is. There is a long stretch of border with price differentials sometimes favouring movement across the border in one area but not in the other. To what extent, then, do economic or other factors justify the resultant price-induced flows? What are the conditions under which trade in beef cattle between the two countries takes place?

Again, the geographical situation of both countries, natural resources of soil and climate, and variations in different sections seem to point to the expectation that price induced contraction and expansion in cattle numbers will approximate each other in timing. Data on total cattle inventories in both countries have shown a sharp upward trend since 1950. This has brought about a deviation from the cyclical pattern exhibited in previous years. To what extent, then, do external factors, such as conditions in the U.S., explain part or all of the apparent departure from the usually alternating phases of the cattle cycle.

HYPOTHESES

The process of scientific method is based on the use of hypotheses.

In an enquiry certain facts become puzzling to the investigator and because this is so, a problem is introduced. Hypotheses are then instituted which, if tested and validated, would explain the facts and the puzzlement and the problem would disappear. The problematic situation dictates the hypothesis and provides the circumstances from which do evolve a suggested explanation or solution of the difficulty. By explaining the facts, it is meant that the facts could be deduced from a conjunction of the hypothesis and some generalizations. To establish an interpersonal validity of the solution, some criteria of acceptability must be established.

The hypotheses:

1. The Canadian cattle cycle is not internally generated but is strongly influenced by the U.S. cattle cycle.
2. The Canadian cattle prices are very sensitive to the level and variations in cattle prices in the United States.
3. Beef cattle prices in the U.S. set the outside limits to beef cattle prices in Canada, i.e. the level of the U.S. prices sets the boundaries of price changes in Canada.

SCOPE OF THE STUDY

The analysis will cover beef cattle production and marketing, including exports, in the U.S. and Canada. For the evaluation of the historical variations in beef cattle production, total cattle inventories from 1906 to 1963 will be used. Because earlier data are not readily available, an interpretative analysis of the different classes

of cattle on farms and their annual rates of change will be restricted to the period 1940-1964.

Historically, trends in total cattle inventory may not be adequate to describe trends in cattle output. Of importance, in this connection are changing slaughter weights, the changing proportion of calves to cattle marketed and slaughtered, the changing relative importance of the dairy and beef components as well as technological factors.[5] These together with strategic inputs such as feed do influence output from a given inventory. Whenever possible, an attempt will be made to investigate whether the historical developments in these items are traceable, directly or remotely, to developments in the United States. A model will be used to isolate the influence of each of these factors on total output. The treatment here is a straight forward matter and presents little complications. The scope is comprehensive enough to deal with all the aspects of the problem being handled.

In the case of the analysis of price differentials, between markets, however, it would be a herculean task to consider all classes and grades of beef cattle. It is probably appropriate to select a sample representative of each class or grade of cattle in the markets under consideration. For the present purpose, price series are chosen to represent the bulk of the product being marketed. For example, the choice steer price is used to represent movement in the markets for finished cattle and the price of good feeder and stocker steers to

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[5]Marshall, op. cit., pp. 25ff.

reflect movement in the feeder or intermediate market. These two grades provide a good basis for evaluating the price relationship between markets for finished and feeder cattle. In similar studies conducted in Canada good steers were taken as the representative grade. Choice steer prices are being used here so as to facilitate comparison with the U.S. prices. In both countries steer beef is the largest class consumed as fresh beef. Harold F. Briemyer, commenting on the prominence of meat in the modern diet had this to say:

> Not every meat and meat animal has shared equally in this progress. Easily outdistancing others has been beef. Beef now holds place of honor in the family budget and at the dinner table. And if the lion is the king of wild beasts, the steer reigns over domestic ones in the farmstead.[6]

In the U.S., choice grade is the grade of the largest volume of cattle ultimately consumed. Canada's largest consumption varies between choice steer and good steer. For the sake of convenience, choice grade is used as the common grade representative of the beef consumed in the two countries.[7]

Fed cattle and feeder cattle are considered as distinct markets; but they are related in that the demand for feeders is derived from the demand for beef. In particular, the choice of these two grades could be justified by the fact that the bulk of the beef cattle shipments to the U.S. from Canada consists of feeders and it seems reasonable to suppose that the quality of animals shipped should be high enough for

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[6]H.F. Breimyer, Demand and Prices for Meat, Economic Research Services Technical Bulletin No. 1253, United States Department of Agriculture, December 1961. p.1.

[7]Note that U.S. choice steer and the Canadian choice steer are not the same. Actually, the U.S. choice steer is higher in grade and in yield than the choice steer in Canada.

them to compete with other supplies available to the U.S.

Price data for choice steers are taken mainly from Chicago and Toronto markets. These two are the largest public markets in the U.S. and Canada respectively. They also serve the largest deficit beef producing areas and thus tend to set the seasonal price pattern for all other markets in the two countries. Feeder prices in Winnipeg and St. Paul and Kansas City are introduced, where necessary, to reflect prices which should prevail nearer to the supply area. In sum, these markets in the U.S.--Chicago, Omaha, St.Paul and Kansas City--are selected for their juxtaposition to the large Canadian markets. It is probable that these U.S. markets influence prices in the Canadian markets.

CHAPTER III

THEORETICAL BACKGROUND

A conceivable international trade model is one involving two countries. It is more meaningful to treat the U.S. as one country and Canada, together with the other suppliers of beef and beef cattle to the U.S., as another. One limitation of this model is that it does not provide a method of estimating the influence of Canadian exports on the U.S. equilibrium price. Canada supplies about one percent of the total U.S. annual intake from abroad. This meagre contribution obvoiusly is insignificant as compared withthe total U.S. global absorption and thus this model would not permit an estimation of the coefficients whould the analysis be restricted to the U.S. and Canada alone. In the general model, Canada is included with the "rest of the world" except when export response from the Canadian point of view is under consideration.

Pure competition postulates underly all the analyses. Under the assumption of perfect competition, once the demand and supply functions for the product in each of the two 'countries' are estimated, the volume of trade, and both the consumption and price of the product in each country could be derived. It is assumed for the sake of simplicity that one country (i.e. the U.S.) is a deficit producing area and that the product flows in one direction. Under these abstract conditions the equilibrium price of the product in the importing country i.e. U.S., exceeds the price in the exporting country by an amount equal to the

cost of transferring the product between the two countries. The nature (level and elasticity) of the supply and demand functions in the two countries with due allowance made for the cost of transportation and tariff charges will determine the volume of international trade, i.e. the amount of the product imported by the deficit country and exported by the surplus country.

There is need to question the validity of the competitive model assumptions posited here. Perfect competition as such is an economist's utopia for, in the real world situation, most of these assumptions are not met. For an analysis calculated to explain interregional flows, some of these assumptions may be met approximately. The assumptions developed to facilitate analysis of international competitive model are yet more complicated. However, the difficulty involved would be an inadequate excuse for not using them at all. Yet, since these assumptions are germane to the full understanding of the model being used, their brief analysis will be in order.

1. Assumption of large number of buyers.

Speaking generally, in respect of agricultural products the value of this particular assumption is somewhat vitiated. The number of ultimate buyers may be relatively large. Numbers at this level are limited only by lack of pecuniary ability to acquire the products--in fact, effective demand in economics is that backed by ability in terms of purchasing power. Beef is characterized by its ubiquitousness on the family table. But when the discussion is translated from the retail level into an intermediate stage such as the processing level, it

becomes obvious that the number of buyers may be restricted to a few functionally powerful meat packing companies. Charges of coercion, collusive oligopoly and price leadership are often heard.

2. Large number of sellers.

At the farm level this assumption is fully met. There is a progression of departures from the norm as one moves toward the retail level. The departure is further accentuated at the export level, at which stage the product is handled by a few exporting dealers. Some of these are powerful enough to collude and they could conceivably act as price leaders. The development of communication and efficient news media may have acted as a catalyst to this role. A.W. Wood[1] mentions three major departures from competitive conditions. A relevant one here concerns restrictions on resource inputs or on amounts sold in a particular market. The impact of these restrictions on the operation of competitive models is best seen in domestic markets. The imposition of acreage and delivery quotas are restrictive in the sense that they do cause major diversion of acreage to the production of unrestricted crops which have relatively less value. With respect to the beef cattle trade between the U.S. and her suppliers, including Canada, there have been some prohibitions and the imposition of quotas.[2] These restrictions

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[1]A.W. Wood, "The Implications of Interregional Competition in Canadian Agriculture for Government Programs Arrived at Direct Support of Farm Incomes", Canadian Journal of Agricultural Economics, Vol. XIII, No. 1, 1964. pp. 1-19.

[2]Tariffs are not considered as they will be treated as an element of handling costs in our analysis.

do not prevent sales in excess of the quotas; rather extra levies are imposed on amounts exceeding the quotas. Canada has exceeded this global quota once[3] and it is hard to determine how restrictive this quota device has been.

Recently, the U.S. concluded separate Meat Agreements with Australia, New Zealand and Ireland. The motive behind this was to limit meat exports to U.S. to manageable levels.[4] The agreement covers the period 1964-1966 (Table 3.1). Prior to the consumption of the

TABLE 3.1

ANNUAL IMPORT QUOTAS FOR BEEF, 1964-1966

	Australia		New Zealand		Ireland	
	'000 head:	Million lbs.	'000 head:	Million lbs.	'000 head:	Million lbs.
1964	242	542	103	231	34	76
1965	251	562	107	239	35	79
1966	260	582	111	248	36	82

SOURCE: Compiled from scattered references in Livestock and Meat Situation, Economic Research Service, USDA.

agreement the annual percentage absorption of meat from abroad was 3.7. The agreement was therefore contrived with the obvious intention of

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[3] In 1948 when some 650,000 head were exported to the U.S.

[4] February 17, 1964 with Australia and New Zealand and March 25th with Ireland.

placing a ceiling on the quantity of beef imports into the U.S.

These quotas and prohibitions are enough to justify the contention that there are certain upper boundaries beyond which the market as between countries ceases to be competitive in any meaningful sense.

3. Perfect knowledge.

The real world situation is much more complicated. Knowledge may be less than perfect. The radio, the T.V., the telephone and other information media are helping to make this assumption valid but the real net effect of these media on producers and often buyers is still uncertain. Live grading of beef cattle affects the validity of this assumption. More complications are introduced on the export-import markets. The grading standards operative in U.S. and in Canada only approximate each other. Both depend on eye estimation with its attendant human errors.

Cattle prices vary from year to year, month to month, even day to day and from place to place. Of greater consequence for the flow of the product is the dearth of knowledge at the time decisions are made as to where a particular lot of cattle should be marketed. This defect may result in substantial inter-market pricing errors.

4. Rationality.

This notion has some philosophical overtones. Like the assumption of ceteris paribus this one may be invoked for obscurantist purposes. At times profit motive is implied; but cattle producers, processors and sellers may act in a way that is at considerable variance with the materialistic maximising position attributed to them.

For instance, using this assumption, it is hard to explain the reason why some powerful processors expand their operations in areas claimed to produce low returns or for a dealer to continue shipping to a market where prices are known to be relatively low. Such actions serve to support the contention that other motives are inextricably involved.[5]

5. Absence of friction or hindrances to resource and product movements.

Certain institutional and technological considerations invalidate this assumption. A case in point is that of transportation rates.[6] The existence of refrigeration and other allied facilities has made it possible to ship beef to great distances. Yet there are still some economic advantages to be gained from processing near a producing centre. For one thing, a plant located near a source of supply has an edge in bidding for lots of cattle, and for another, there are probably external economies to be gained from the use of cheaper labour. The establishment of transportation rates may restrict the operation of an interregional or international competitive model. The following rates for live and carcass beef serve as an illustration.

Weight Shipped	Real Cost/cwt.	Total Cost	Rate Charged	Total Charge
10 cwt. live	$1.00	$10.00	$1.70	$12.00
6 cwt. carcass	.80	4.80	2.50	15.00

[5]Perhaps the basic objective is that of survival and growth. Sales maximization subject to a minimum profit constraint implied in Baumol's "Static Oligopoly Model" may be the real goal, especially for such functionally powerful groups as the large meat packing companies.

[6]Wood, op. cit., p. 4.

This diversity of rates is a result of charging according to the value of the product. The evidence points to the possibility that the transportation system charges what the traffic will bear. Higher charges are imposed on the shipment of higher valued goods even if fewer resources are required to provide the needed service. Further variations are introduced through the use of agreed rates when class rates do not permit the systems to meet competition from other carriers.

6. Product homogeneity.

Generally, agricultural products are substantially homogenous. The cross elasticity of demand for different lots of such products is large and positive. Because live grading is adhered to in beef cattle, there may be some varietal or biological differences which may be hidden. In the U.S. and in Canada, in particular, differences in feeding methods could generate variations in the quality of beef. These biological differences may, however, be imperceptible, and generally there is very little to choose between U.S. and Canadian choice grade beef.

Add to these the fact that production and consumption take place, not under static and certain conditions but under dynamic and uncertain conditions. Besides, several institutional and political barriers exist and all these impinge upon trade.

In this study these assumptions have been adopted, not for their realism, but for their utility and reliability.[7] Science ought to have

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[7]Milton Friedman, Essays in Positive Economics, University of Chicago Press, 1953, pp. 3-43.

an anchorage[8] for without it, it is hard to ferret out what it is that is to be known. So long as these assumptions are useful, they can be employed within the constraints imposed by such limitations.

Shepherd makes reference to such a perfect competitive market and argues that the price surface is far from being flat. "The price surface shows ridges and valleys, due mainly to the differential in freight charges. It is, therefore, flat plus or minus transportation charges."[9] In such a market the price will gravitate to uniformity, with the necessary adjustment made for transportation costs. In the international scene other costs, e.g. tariffs and exchange rates, are incurred; hence it is more appropriate to speak of the composite of all these elements of costs as total transfer costs.

The spatial equilibrium price needs a long period to work itself out. A complication is introduced when a shorter period is considered, i.e. from month to month or day to day. Shepherd succintly explains it thus:

> The water in the ocean averages flat over a period of time, but for short periods of time, tidal movements raise some areas above and depress other areas below the average level, storms sweep the tidal movements, and ripples ride the surface of the waves .... the price surface heaves and sinks, bellows and ripples, it is never still.[10]

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[8]R.G. Siu, The Tao of Science, M.I.T. Press, 1957, pp. 17ff.

[9]G.S. Shepherd, Agriculture Price Analysis, Iowa State Press, 1941, p. 127.

[10]G.S. Shepherd, Marketing Farm Produce, The Iowa State University Press, 1947, p. 137.

7. Importance of transportation.

The Ricardian version of international trade assumed away the role of transport costs. These costs were considered as zero or infinite and therefore negligible. Ricardo's conclusion was that factors of production were immobile and hence dwelt on specialization of products among nations which had comparative advantage in their production. However, it is hard to dismiss Ricardo's conclusions in view of certain two assumptions implicit in his analysis. Because he concentrated on industries which were historically volatile and also had locational advantage, his assumption of zero cost of transportation is not invalidated.

The question of costs of transportation has been discussed in detail by Kindleberger[11] in a way that repudiates the Ricardian position.[12] In a simplified model, assume that in the absence of transport costs, wheat and cloth would have to exchange on a pro-rata basis.[13] The need to circumvent the costs of transportation will make the imported goods more expensive in both countries and the exported goods less valuable. In the United States, for example, wheat might exchange for cloth at eight yards to twelve bushels. Kindleberger demonstrates the implication of this type of trading diagnamatically (Figure 3.1.)

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[11] C.P. Kindleberger, International Economics, 3rd Edition, p. 137.

[12] i.e., that international trade equalizes the prices of the traded goods in the trading countries.

[13] or a predetermined quantitative ratio of 1:1.

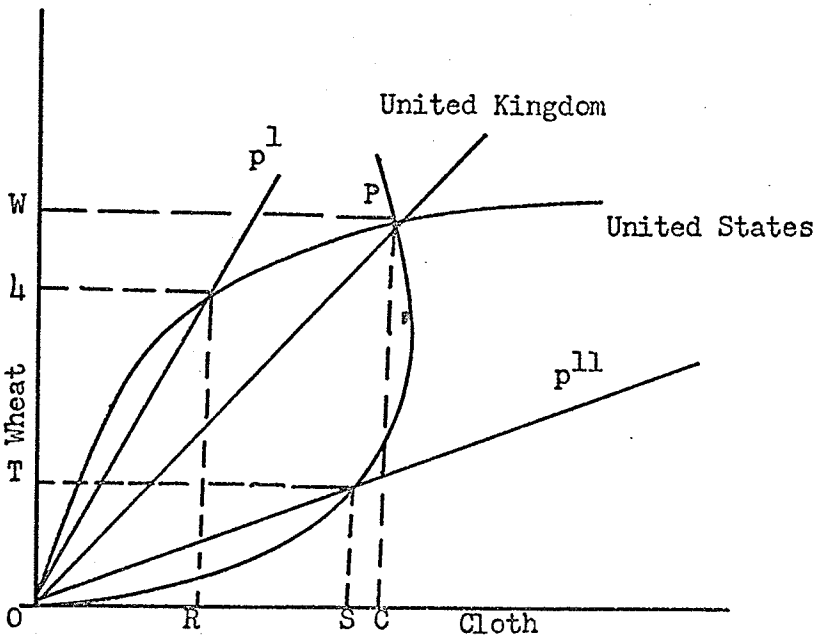

FIGURE 3.1

GENERAL EQUILIBRIUM WITH TRANSPORT COSTS

In the two commodity situation and using Marshall's offer curve principle,[14] P represents an intersection of the British offer of cloth curve and the U.S. offer curve of wheat. P is the free trade equilibrium point, the U.S. importing OC of cloth in exchange for OW of wheat which is what Britain imports in exchange for OC. The price line which cuts through at P_1, the equilibrium point, reflects the price in both countries. This price line abstracts from the consideration of transportation costs. The new price levels, p^1 and p^{11} respectively, are drawn to take into account the cost of transportation. At the price OP^1 the U.S. is willing to offer OU of wheat against OR of cloth. At price OP^{11} the U.K. is willing to offer OS of cloth for OT of wheat.

In Figure 3 suppose three commodities are considered instead of two. Transportation cost is introduced as an intangible or invisible commodity. In the new situation, Britain offers cloth for wheat and transport, and the U.S. offers wheat for cloth and transport. Transportation cost represents the difference between what the U.S. gets at the price OP^1 and what the U.K. is willing to offer in terms of cloth at the price prevailing in her home country. The economic significance of the offer curve analysis can be tenuous unless these costs can be expressed in terms of tangible traded goods themselves.

The Ricardian formulation was couched in terms of a frictionless and costless world where each region was thought of as a point and all

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[14] "Survey of Welfare Economics", reprinted in Welfare Economics, Random House Series, 1964, p. 32 footnotes. First published in "The Economic Journal", Vol. 70, No. 278 (1960), pp. 197-256.

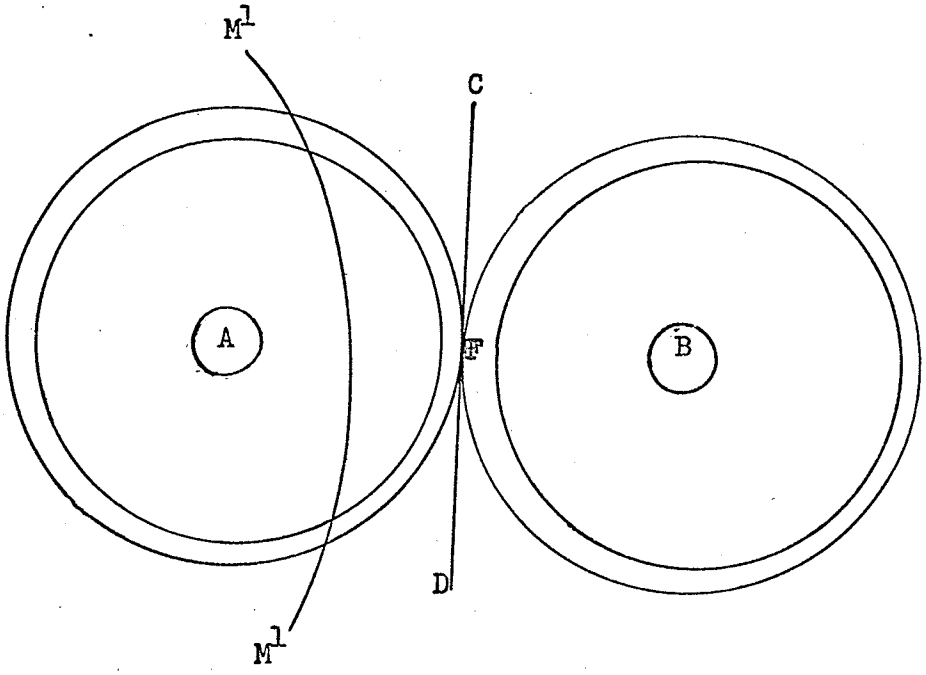

FIGURE 3.2*

TWO SPATIALLY SEPARATED MARKETS

*Sidney Weintraub, Price Theory, New York, Pitman Publishing Corp., 1949, p. 271.

other regions so contiguous to one another that distances between markets were considered immaterial. This is unrealistic as distance could be considered as a cost item to be met or as an input, practically equivalent to a factor of production along with land, capital and labour. Nearness to the market, like productive land, makes it possible to produce a commodity for sale more cheaply.

Distance is thus seen to represent a cost element for two separate markets. Between the two markets there develops a clearly well defined border equilibrium. Resources from the adjoining areas tend to gravitate towards the nearest market. Assuming (Fig. 3.2) that markets A and B cater for beef cattle producers scattered all over the areas. Equal prices are described by price contours with the markets at the centre. Prices at markets A and B are assumed to be equal. In this hypothetical situation there is a point F between, at which point the sellers are indifferent as to where to market their produce. The point of mutual tangency, F, represents the position of indifference.

Suppose the price at B rises relatively to the price at A, the line CD will not shift to the left in a manner parallel to the origional position, but the market area will be in the form of a hyperbola MM^1 about market A. This could be explained away by the assumption that freight rates are an increasing function of mileage or freight rates are proportional to distance covered.[15] The position of line

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[15]A model to reflect transport rates between market and supply points has been worked out by T.D. Wallace and G.G. Judge as $Cij = B_1Mij + B_2Mij + E$ where Cij represents the cost in cents of shipping a lb. of beef carcass from point i to point j. Mij is the

MM^1 is only transitory as the existence of perfect competition will sooner or later bring about a conjunction with line CD at the latter's unaltered position.

8. Economic considerations: The case of borderline equilibrium between nationally connected markets.

Several attempts have been made to introduce transport costs to account for price differentials in location and space economics. Enke[16] Samuelson[17] Beckman[18] Ohlin[19] and Baumol have attempted to develop spatial equilibrium analysis in terms of interconnected competitive markets. These developments have made it possible to explain the geographic location of production, spatial equilibrium prices and optimum geographical flows consistent with a given set of data. Samuelson considered the problem of equilibrium in spatially separated markets, in the case of a single homogenous commodity, with given demand and supply functions in each market and given transport costs from each source to the final destination. A spatial competitive model implicit in the

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mileage between i and j. The Corr. Coef. is high and significant at 1% level. See footnote 22, page 32 for reference.

[16]Enke, S. "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue", Econometrica, Vol. 19, pp. 40-48, 1951.

[17]P.A. Samuelson, "Spatial Price Equilibrium and Linear Programming", AER, Vol. 42, June 1952.

[18]M. Beckman, "A Continuous Model of Transportation", Econometrics, Vol. 20, pp. 643-660, 1952.

[19]B. Ohlin, Interregional and International Trade (Cambridge, Mass., 1933).

analysis is less appropriate for an analysis of international trade than for interregional trade.[20] The existence of exchange rates, quotas, tariffs and factor immobility all impinge on an efficient operation of this model. However, assuming a static situation and constancy of the existing psychological-institutional complex, Enke's 'electric' analogue of the solution of the problem could be adopted:

> There are three (or more) regions trading a homogenous good. Each region constitutes a single and distinct market. The regions of each possible pair of regions are separated--but not isolated--by a transportation cost per physical unit which is independent of volume. There are no legal restrictions to limit the actions of the profit-seeking traders in each region. For each region, the functions which relate local production and local price are known and, consequently, the magnitude of the difference which will be exported or imported at each local price is known. Given these trade functions and transportation costs, we wish to ascertain: (1) the net price in each region; (2) the quantity of exports or imports for each region; (3) which regions import, export, or do neither; (4) the aggregate trade in each commodity; (5) the volume and direction of trade between each possible pair of regions ....[21]

Given this setting, Figure 33is set up to illustrate the situation that should exist on the international scene. Demand and supply functions in the United States are shown by DD and SS, respectively; in other areas including Canada by D_1D_1 and S_1S_1, respectively. The demand and supply functions for the rest of the world are placed back to back with those of the United States. Quantities demanded and supplied in the "other areas" are read from right to the left, and in the United States from

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[20] Wood, op. cit., p.5. Also see A.D. Snider, Introduction to International Economics, The Irwin Series in Economics. Revised 1958, pp. 20-30.

[21] Enke, op. cit., p. 41.

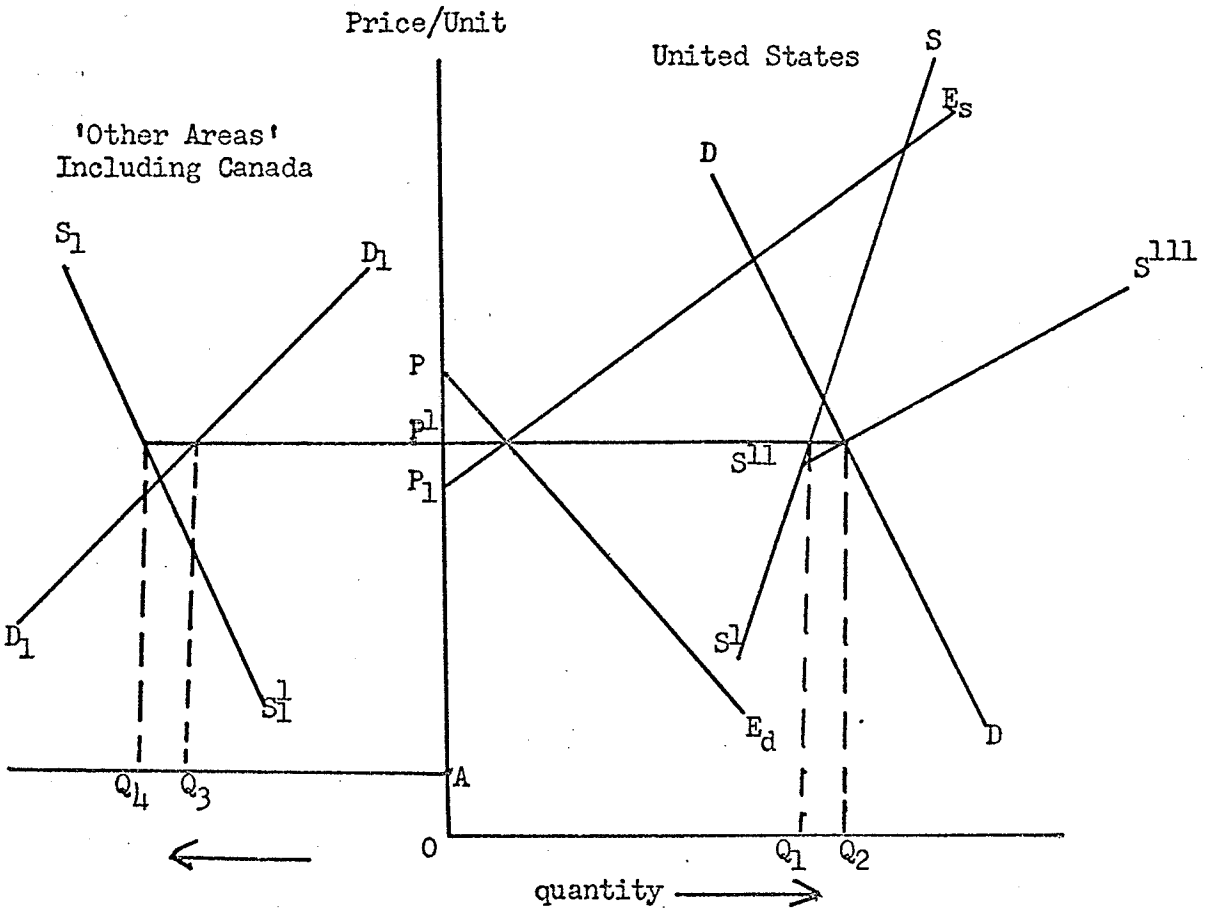

FIGURE 3.3

HYPOTHETICAL INTERNATIONAL BEEF TRADE MODEL

Source: Kenneth R. Farrel, World Trade and the Implications of Tariff Regulations for the United States Walnut Industry, California Agricultural Experimental Station. Giannini Foundaticon of Agricultural Economics. Research Report No. 274. April 1964.

left to right. OA represents per unit costs of transferring (tariffs, transportation, etc.) beef between the two areas. It is assumed, to start with, that there is no trade between the two areas. The price and quantity demanded in each area will be determined by the intersection of the internal supply and demand functions. At any price less than internal equilibrium price in the United States, demand exceeds supply as represented by the "excess demand" function PE_d. At any price above the "no trade", internal price AP_1 in the other area, supply will exceed demand in the amount represented by the excess supply function P_1E_s.

Now assuming that trade can occur at a unit transport cost of OA, a joint equilibrium can be established at P^1, i.e., the intersection of the excess demand and supply functions. The joint equilibrium price will be OP^1 in the United States and AP^1 in the "other areas". At this price the quantity Q_1Q_2 will be imported into the United States, OQ_2 consumed and producer price decreased from OP to OP^1. Q_4Q_3 will represent exports in "other areas" (equal to imports to United States), internal consumption being AQ_3, and price to domestic producer is increased from AP_1 to AP^1. The total supply function in the United States has been depicted by $S^1S^{11}S^{111}$ in Figure 3. (i.e. because of the additive nature of the functions) It is the sum of the domestic supply function, S^1S and the "excess supply function" P_1E_s, which

shows the quantities of beef that will be imported at various prices in the United States.[22]

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[22] G.G. Judge and T.D. Wallace: Spatial Price Equilibrium Analysis of the Livestock Economy, Dept. of Agric. Econ., Oklahoma State Univ., Tech. Bul. TB-78, June 1959. In their model, the supply functions in the United States and the "other areas" are fixed, thus making S^1S_1 and SS^1 vertical straight lines. Let the amount produced in the United States be B and the amount consumed B^1; the amount consumed in the "other areas" be A^1 and the amount produced be A. Total transportation costs =

$$OA(B - B^1) = OA(A - A^1)$$

Let D_1 $\quad A^1 = BP'o + K.$

D_2 $\quad B^1 = B(P'o + OA) + K$

$$A^1 + B^1 = A + B = 2BP'o . + B(OA) + 2K$$

Hence the solution for P'o, the equilibrium price

$$P'o = \frac{1}{2B}(A + B - B(OA) - 2K)$$

$$OA = \frac{1}{B}(A + B - 2BP'o - 2K) = \text{Transportation rate.}$$

CHAPTER IV

A REVIEW OF UNITED STATES TRADE IN BEEF AND BEEF CATTLE AS IT AFFECTS CANADA

Characteristics of beef consumption in North America.

Economic literature is replete with factors which affect the consumption and production of meat. Among these may be mentioned disposable income, prices of beef and prices of competing (other meats) products. Population groups and their characteristics determine the type of meat consumed; income and urbanization are co-operant factors which tend to influence the quantities consumed. Certain population characteristics which do influence meat consumption are occupation, family composition, national origin, and religion.[1] These factors under consideration are all value creators and the meat consumption habits of North Americans are largely influenced by these values. For example, the widespread use of refrigerators in the homes tend to determine the type and quantities of meat eaten. Again 'supermarket' beef is highly valued not so much because of its inherent qualities, but because it is a status symbol[2]. Technological and institutional factors such as ".... increased retailing of meat in supermarkets and the use of self-service in meat retailing, more advertising and promotion and larger use of Federal grading of beef[3]..." have all been continuously creating

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[1] Meat Consumption Trends and Patterns, USDA, Agr. Handbook 187.

[2] Cattle Market in Iowa, Iowa State Univ. Co-op. Ext. Service, M-929, May 1961, p. 13.

[3] Briemyer, op. cit., pp. 3-4.

new values and new uses. Developments in Canada in particular have also contributed to the expansion of demand for beef.[4] A great majority of the people appear to be close imitators of the American way of living. Their eating habits and in general, their response to the introduction of new products etc. tend to be quite similar to the American life. However, there is no clear proof of copying rather than being affected by the same forces.

Some features of the developments of the beef cattle industry in North America.

In the previous section it was posited that, historically, certain institutional and technological changes have influenced the development of a continental beef cattle market. The consequences of these changes as they affected the beef cattle industry will be traced in this section.

Writing generally about the industry in North America S.H. Thompson pointed out that:

> Within a century the hand of the white man has transformed the habitat of the Indian into an agricultural plant of extraordinary productiveness in which meat animals are the principal products. Within that same period have come the railroad, the telegraph, the telephone, improved highways, the motorcar, and the radio. These developments have generated striking changes in livestock marketing ....[5]

The cessation of hostilities in the American Civil War encouraged the

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[4]General economic prosperity as it affects meat consumption habits in Canada.

[5]Sam H. Thompson, Economic Trends in Livestock Marketing, John S. Swift Co. Inc., St. Louis, Chicago, 1940, p. 8. Planograph.

development of the beef cattle industry on the continent.[6] Stocks for breeding purposes migrated from the west coast of the United States to the Prairie and British Columbia. Coincident with this transplantation of the industry in Canada was the settlement of Lord Selkirk in 1820. By 1840, range cattle production in the west of Canada encouraged by a mass migration of cattle from the states of Oregon and Washington had made substantial headway. The active participation of the Hudson's Bay Company in the industry provided an added impetus. High cattle prices encouraged further expansion of the beef cattle industry. Buffalo hunting was also a lucrative venture and, in order to replenish the fast depleting herds of these animals, cattle raising was encouraged to provide meat for the Indians. The early success of the industry was contigent upon this factor. Had the buffalo existed in an inexhaustible or replenishable supply the development of the cattle industry might have taken a different course.

Some particular factors affecting the development of the beef cattle industry on the continent are:

1. Railways, highways (paved, bituminous surfacing, gravelled).
2. Truck transportation.
3. Improvements of roads.[7]

In Canada the completion of the Canadian Pacific Railway alleviated some

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[6]J.S. Carmichael and T.S. Rackham, Livestock Marketing in Western Canada, Economic Division, Mkt. Service Dept. of Agri., Ottawa, pp. 2-5.

[7]Thompson, op. cit., pp. 6-10.

of the problems connected with marketings. Parallel with this development was the opening up of coastal markets for Canadian cattle. Beef cattle originating from British Columbia serviced coastal markets in the United States. The building of the transcontinental railway in Canada opened up new vistas for the industry. It linked the surplus beef producing areas in the West with the deficit and large consuming areas in the East. Together with the traditional markets in the United States, a fresh encouragement was given to beef cattle production in Canada. Road improvement and the emergence of truck transportation for live cattle and carcass beef speeded up the delivery of the products, especially with respect to comparatively short distances. These new developments could hardly have been inconsequential in interrelating the markets in Canada and in the United States. These new transportation facilities brought Manitoba closer to the corn belt areas in the United States. Feeder cattle shipments were thus encouraged. Refrigeration facilities also made it possible to construct large processing plants near public markets and interior plants in the producing areas far removed from the centres of consumption. Thompson outlines four direct effects of refrigeration on the beef markets:

1. It became possible and often more convenient to locate packing plants in the heart of the producing areas.
2. It helped to lengthen the period of consumption.
3. It stimulated further expansion of the industry.
4. It provided continuous solvency for those connected with

the industry.[8]

All these developments had far reaching consequences for the beef cattle trade relations between Canada and the United States:

1. The major beef cattle markets in the two countries were brought into a closer relationship. Improved transportation considerably shortened the distances in terms of time and economy between these markets.
2. The Chicago Mercantile Exchange metamorphosed into an important distribution centre, absorbing most of the Canadian supplies. The development of new modes of transportation coupled with efficient communication media facilitated prompt deliveries and also made it possible for daily price quotations to be bandied about, thus reaching as many buyers and sellers as possible.

Grading and standardization.

Product homogeneity is a necessary precondition for the application of the concept of the competitive model. To grade is to reduce goods to a common denominator. Whether the general purpose is to make possible an accurate determination of value or to facilitate trading on description, or a combination of both, a properly functioning system of grading beef furnishes a foundation for effective market news.[9] An

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[8]Thompson, op. cit., pp. 26-31.

[9]Thompson, op. cit., p. 32ff.

effective grading system enables the consumer by the price he pays, to tell the producer what types and qualities of animals he prefers. On this score, a Canadian producer or exporter of beef is alerted to meet the requirements of the market with the greatest effectiveness. The system of beef grading itself operating on the two markets has its drawbacks; but it is very obvious that it has helped a great deal in promoting sales domestically and across the borders:

> Grading has not only served to create price differentials for quality products but has also brought about a substantial increase in comsumption.[10]

Trade in beef and beef cattle.

United States imports of beef and beef cattle constitute a small percentage of the total domestic procurement. During the period 1950-63, imports of beef ranged between 1.8 percent in 1953 and 10.7 percent in 1963. Imports of cattle, mostly feeders, were about 0.5 percent of the domestic supply.[11] The United States trade in beef has the following features:

1. Canada and Mexico are the chief supplies of feeders and slaughter cattle. Feeder cattle are imported into the United States and these represent additional supplies which compete with domestic production for the consumer's dollar. The bulk of these imports of live animals is the high grade type,

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[10]Robert Weir, Report of the Ministry of Agriculture, Dominion of Canada, year ended March 31, 1933, p. 39.

[11]Breimyer, op. cit., p. 5.

to supplement the U.S. supplies when they are low.

2. By comparison, substantial quantities of low grade beef are imported chiefly from the Oceana and Argentina. To some extent these imports do affect directly and indirectly the United States industry.[12] High grade supplies of slaughter cattle from Canada and frozen-boneless beef from these other countries compete with the U.S. domestic supplies. Of importance is fresh and frozen boneless beef which constitutes a sizeable percentage of total beef imports.[13] Most of these supplements to United States beef are used to produce hamburgers.

3. The demand for foreign supplies is cyclical in nature. Imports are high when the U.S. cow slaughter is low. Most of the beef imported is the low grade type and since cow beef production reflects the size of domestic production of this type of beef, it is reasonable to suppose that these imports will tend to follow the same cyclical pattern as cow beef production.

In Table 4.1, the United States domestic production of beef and foreign supplies are compared. In the period 1953-56 imports as a percentage of total domestic production were low. This could be explained partly

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[12]Venel W. Benson, "Impact of Beef Imports on the U.S. Beef Industry", J.F.E., Vol. 47, No. 5, Dec. 1965, pp. 1594-95.

[13]82% of U.S. imports in 1963 or 7.4% of U.S. total production.

by the high domestic production and partly by the prohibitions of imports from Canada and Mexico as result of the outbreak of foot-and-mouth disease in these countries.

TABLE 4.1

U.S. IMPORTS OF CATTLE, CALVES, BEEF, AND VEAL*

Year	Live Animals[a] Number '000	Live Animals[a] Meat Equiv. Mil. lbs.	Meat Mil. lbs.	Total[b] Mil. lbs.	Meat Prod.[c] Mil. lbs.	Imports as % of prod.
1950	438	157	348	505	10764	4.7
1951	220	91	485	575	9896	5.8
1952	138	47	429	476	10819	4.4
1953	177	62	271	333	13953	2.4
1954	71	35	232	267	14610	1.8
1955	296	93	229	322	15147	2.1
1956	141	43	211	254	16094	1.6
1957	703	221	395	616	15728	3.9
1958	1126	340	909	1249	14576	8.6
1959	688	191	1063	1254	14588	8.6
1960	645	163	775	938	15835	5.9
1961	1023	250	1037	1287	16341	7.9
1962	1232	280	1440	1720	16311	10.5
1963	834	180	1679	1859	17350	10.7

*Source: Livestock and Meat Situation, U.S.D.A., LMS-130, May 1963, p. 20.

[a]Estimated at 53% of all dutiable cattle.

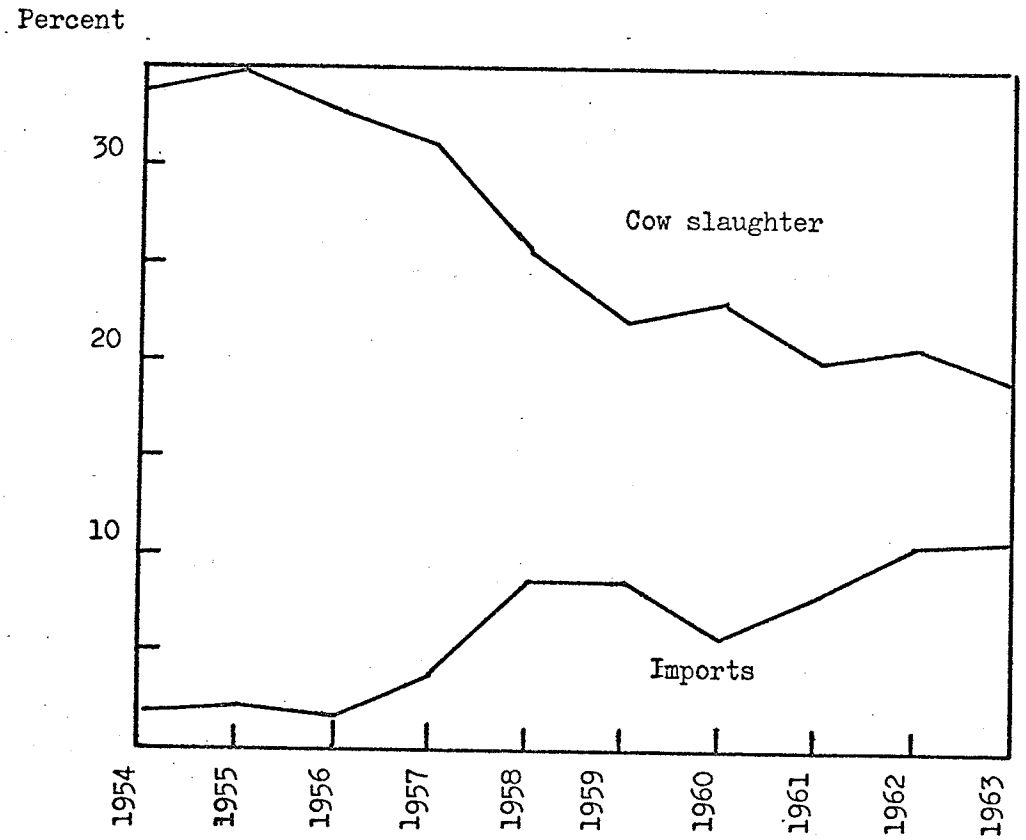
[b]Cured and processed converted to carcass weight equivalent.

[c]Total production of beef including an estimate for farm slaughter.

In figure 4.1 imports as percentage of domestic production are compared with the percentage of cow slaughter in the United States. There is a negative correlation of 0.8 between them. A 5 percent critical value for n=100 is .564, thus leading to a rejection of the hypothesis of independence of the variables.

FIGURE 4.1. A COMPARISON OF U.S. COW SLAUGHTER AS PERCENT OF TOTAL CATTLE SLAUGHTER AND BEEF IMPORTS AS PERCENT OF TOTAL DOMESTIC BEEF PRODUCTION.

1954-1963.



Imports of beef have trended up sharply since 1958 (Table 4.1). This development has been coincident with the up-swing of the total cattle cycle in the United States and in Canada, indication that there is a component in the cattle cycle in the United States whose buildup (and therefore low cow slaughter) has encouraged more imports.

Tariffs and other trade barriers.

The primary objective of this section is to demonstrate the economic impacts which the various United States tariff arrangements and exchange restrictions have had on the trade relationships between Canada and the United States. Since the First World War, there have been several changes in tariff regulations and it is pertinent to trace out their implications for the Canadian beef cattle trade.

TABLE 4.2

CANADIAN EXPORT OF CATTLE*

Year	United Kingdom	United States	All Countries
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1870	--	104,609	107,731
1875	455	34,651	38,968
1880	32,680	16,044	54,944
1885	69,446	67,758	143,003
1890	66,963	7,840	81,454
1895	85,863	882	93,802
1900	115,056	86,989	205,524
1905	159,078	3,696	177,102
1910	140,424	12,210	157,386

*Source: Interim Report of the Livestock Commission of the Province of Saskatchewan, (Regina, King's Printer, 1917) p. 76.

Although variations in production appear to have affected cattle exports historically,[14] the political and institutional arrangements have had considerable impact. On balance, political considerations had, until the consumation of the Reciprocal Trade Agreement in late 1947, been more influential than economic considerations. The struggle between the Loyalists who favoured imperial preference and the 'Jonas' who advocated reciprocity could be traced through Canada's external trade in beef cattle.

Economically, the United States market had proven a profitable one for Canadian beef cattle, but this has been disrupted often. In 1870 about 105,000 cattle were exported to the United States, representing about 97 percent of the total shipments originating from Canada. The Treaty of Washington of 1871 which ended a long and dangerous series of border disputes provided a very healthy atmosphere for the development of the industry in Canada and trade with the United States in general.[15]

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[14] A.L. Neal, "Export Trade in Agricultural Products", in Economic Organization of Canadian Agriculture, Edited by J.F. Broth, pp. 242-243, 1940.

[15] On January 13, 1965 a U.S. Congressman, Lloyd Meeds (Dem. Wash.) introduced a bill to establish a Pig War National Park on an island in the northwest corner of his state. Introducing the bill he recalled an incident involving the shooting of a pig belonging to the British Hudson Bay Company by an American farmer, named Lyman A. Cutler. The matter involving the pig's fondness for Cutler's potatoes [illegible] led to this incident erupting into a flame of disagreement that had been smoldering between the two nations. Matters came to an end in 1871 when the then German Emperor was invited to arbitrate. "In the 105 years since the death of that pig", Meeds recalled, "neither this nation nor Canada has felt the need to resort to arms in solving their differences. The Pig War National Park will stand in the Westernmost end of the longest unguarded border in the world, as a permanent reminder of that international restraint and co-operation."

...U.S. Congressional Record..., Jan. 13, 1965.

Until 1895, then, the United States market was the natural outlet available to the Canadian producers. From 1895 to the first World War, the United Kingdom superseded the United States as the principal recipient of Canadian cattle. A time came when Britain imposed an embargo on live cattle entering the United Kingdom as a disease preventing measure. This factor, together with the abrogation of the McKinley Tariff, caused a major shift of emphasis to the United States markets up to 1920. The United Kingdom only took token shipments from Canada. But the flow to the United States was soon to be disrupted by the Emergency Regulations undertaken by the United States. An exorbitant ad valorem duty of 30 percent was imposed on cattle imports into the United States.

More favourable duties on imported cattle came into effect in 1922. The Fordney-McCumber Tariff imposed a duty of 2¢ per pound on cattle weighing 1050 lbs. This was followed by the removal of the British embargo in 1923 and thus exports in general were enhanced. But this period coincided with the downturn of cattle production in Canada. The reduced exports of cattle in the period 1920-23 were probably ascribable to increased domestic consumption of beef and the downward trend in beef cattle production.

A major rift in the cattle trade with the United States came with the imposition of the Smoot-Hawley Tariff rates of 1931. The new rates were 3¢ per lb. for cattle weighing over 700 lbs. Throughout the period the new rates were in effect, the United Kingdom market absorbed almost all beef cattle shipments from Canada.

The Hawley tariff was widely condemned and the general comment of

the press was hot, tart and to the point.[16] It was regarded by the press as "the last raid of the buccaneers of protectionism on the pockets of the consumers".[17] The Canadian producers reacted to this tariff and thus elicited the following observation reported in the Philadelphia Public Ledger:

> The Public Ledger believes the Hawley bill should be revised in several particulars.... The duty on feed cattle from Canada has aroused what seems to be just protests from a neighbor toward whom we have a special relation.[18]

Although the Ottawa Agreement (1932) with the United Kingdom was designed to help promote exports in that direction, the general picture was a noticeable diminution of cattle shipments during the period the 'austere' tariff was in effect.

The United States-Canada rapprochement which culminated in an agreement of November 15, 1935 helped in a downward revision of the high Hawley tariff rates. In that very year that the Agreement was consumated some 102,934 cattle were exported to the U.S. as against a token figure of 6,704 to the U.K. It was a comprehensive trade agreement signed in Washington to secure for Canada reduced duties for commodities representative of several fields of Canadian production. Canada reciprocated the gesture by granting tariff concessions including the extension to the U.S. of the intermediate tariff in its entirety and some specific regu-

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[16] Extracts from the American Press as Reported to the "Christian Science Monitor", 1932. Quoted in R.J. Deachman, A Stupid Tariff--American Opinion on American Tariff Policy, no date.

[17] Ibid.

[18] Ibid.

lations.[19] The tariff duty was lowered from 3¢ per lb. to 2¢ per lb. To protect her farmers, the United States limited imports to 156,000 head. This number represented roughly 3/4 of 1% of the United States average annual slaughter for the period. Canada found the whole deal very attractive and conducive to expanded trade not only in beef cattle but in other agricultural products as well:

> Recently we have observed that Canada is contemplating further reduction in her rate of duty upon agricultural machinery produced almost entirely in the U.S. Perhaps the trade agreement originally concluded revealed to her that an even larger trade with the U.S. is so desirable that she is prepared to consider lowering her duties entirely on her own account, that is unilaterally.[20]

The U.S.-Canadian Trade Agreement of 1938 proved more beneficial to the cattle export trade than the previous one. With a few exceptions, the general provisions of the new agreement were similar to the 1935 agreement. The two countries continued to guarantee each other unconditional most-favoured nation treatment in respect of customs duties. A provision was made for an importation of some 22,500 cattle weighing 700 lb. and over at $1\frac{1}{2}$¢ per lb. and those weighing between 200 and 699 lbs., at the rate of $2\frac{1}{2}$¢ per lb. After the first quarter of 1939, the U.S. Government allocated to Canada a definite percentage (86.2) of the

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[19] The Canada Year Book, 1937, p. 491.

[20] Arthur R. Upgreen, Reciprocal Trade Agreement, The Day and Hour Series, Univ. of Minnesota, Sept. 1937. In the period mentioned here, there were other influences also: Canadian cattle and seed grain exports to the U.S. increased because of drought in the U.S.

necessary part of the total quota. This amount was 142,230 head for April to December inclusive of which Canada was to export to the U.S. not more than 57,720 head at the reduced rate in any of the remaining three months. The amounts the U.S. allowed for other countries for the balance of the year were 22,770 head of which no more than 8,280 head could be admitted at the $1\frac{1}{2}¢$ per lb. rate in any quarter. Immediately these quotas were filled, the regular rate of 3¢ per lb. would apply. This new agreement further increased exports to the United States at the expense of the U.S. Shipments to the United States were 702,922 head as compared with 4,274 head to the U.K. Thus, economic conditions rather than purely political considerations set the pattern of cattle trade throughout these years.

In 1942, under the stimulus of favourable export outlet in the U.S. and wartime conditions, cattle production reached a record height. Additional to Canada's domestic requirements, requests came from many quarter: meat supplies for armed forces in Canada, ship stores, the Red Cross for prisoners of war, essential Canadian industries, supplies for British dependancies whose normal source of meat was curtailed, and other wartime developments such as the Alaskan Highway. Backed by the pressing demand also for more meat for domestic and foreign consumption, it became imperative to regulate the marketing and disposition of livestock[21] and to develop equitable distribution and control of meat throughout Canada. As a primary step, it was deemed necessary to restrict the export of

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[21] Livestock Market Review, 1942, Dept. of Agr. Marketing Service, Dominion of Canada, pp. 1-8.

livestock from Canada. Consequently, exports of beef cattle were prohibited by the War Time Food Corporation, Canada Ltd. operating under the War Time Prices and Trade Board. From September 4, 1942, this body became the sole exporter of beef cattle in Canada. Stringent measures were instituted, designed to encourage an orderly supply of cattle and beef throughout the year and to maintain cattle prices in "proper relationship to maximum wholesale and beef prices at all times".[22] In October 1942, exports of calves came to an abrupt end under regulations similar to those applied to beef cattle. Between October 1942 and March 15, 1947, therefore, no cattle moved South except those for dairy purposes or purebreds for the improvement of stocks. The U.S.-Mexico Agreement signed in 1944, fixed a rate of 1½¢ lb. for all classes of cattle imported into the U.S. In 1947, surplus beef was shipped to the U.K. under contract.

The underlying purpose for these Wartime regulations and the Meat Board consequently set up in 1943 was to direct the meat industry so that export to the U.K. might be facilitated.[23] By 1948, meat was in abundance. In 1949, the Board expunged all its wartime regulations. The response of the cattle producers was to agitate for the removal of the ban on export of cattle to the U.S. In that same year (1948) the sale of cattle off farms, including shipments to yards, shipments direct to packers, and shipments direct on export were the largest on record. Direct exports, mainly to the U.S. outstripped the previous record high set in 1936[24] by

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[22] Ibid., p. 5.

[23] Leckie, op.cit., p. 27.

[24] i.e., under the Canada-U.S. Agreement.

83.7 percent.

The removal of the restrictions put on the shipments to the U.S. was probably accountable for the increased exports. In the same year the U.S. domestic production and total foreign acquisition of cattle and beef products also initiated a sharp upward trend.

The phenomenal increases in production and marketings of beef cattle in 1948 illustrates a very interesting interrelationship between Canada and the U.S. Exports to the U.S. in 1948 increased sharply because there were markets for the Canadian product there. This happened at the time production in the United States had also shown a sharp upward trend. What can be inferred from this?

Conditions in the United States provided markets for Canadian surplus beef cattle but available evidence does not seem to support the contention that the cause for increased production was the developments in the U.S. What appears to be the case was that the increased production in Canada was internally generated and only bears a fortuitous relationship with conditions in the United States. It has already been mentioned that under the stimulus of war time conditions, there was a pressing need for more Canadian meat. To meet these requirements, resources were irreversibly committed to beef cattle production. The encouragement given by the government under the Agricultural Price Stabilization Act was a further step which encouraged production. Additional to this, the Geneva Agreement involving many countries established a tariff rate of $1\frac{1}{2}¢$ per lb. for all classes of beef cattle. Concomittantly, quota restrictions came into effect. A quota of 400,000 head for cattle weighing 200-700 lbs.

and another 40,000 for those weighing over 700 lbs. were imposed. Other impediments to trade apart from tariffs and emergency regulations have been certain "acts of God". In 1952, there was an outbreak of 'foot-and-mouth disease' in Saskatchewan. The U.S. on February 25, 1952 placed an embargo on the importation into the country of Canadian cattle. During the period the prohibitions were in force, parallel developments took place in Canada which resulted in Canada taking action to impose import restrictions so as to protect the domestic industry. On March 2, 1953, all these prohibitions and restrictions were removed. Since 1953, the following tariff rates have tended to be in force (Table 4.3). The fixity of these duties since they became operative should give a clue as to the main forces that have affected trade between Canada and the U.S. Two outstanding factors appear to be the relative prices in the two countries and possibly, the devaluation of the Canadian dollar in 1961. The spread between prices in the two countries after adjusting for transfer costs sets the pattern of flows across the border. The influence of these relative prices and price differentials on cattle exports will be statistically evaluated in a separate chapter.

Quota impositions appear to have had relatively negligible effects on trade between the two countries. As observed elsewhere in this study, these quotas have been exceeded only once; and besides, they are not really insurmountable barriers to trade. An additional levy is rather imposed on shipments exceeding the global quota.[25]

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[25] i.e., the tariff increases by 1¢ per lb. after certain totals have been received from Canada and Mexico.

TABLE 4.3

TARIFF RATES FOR CSTTLE AND BEEF PRODUCTS*

Classification	U.S. Rate	Canadian Rate
Slaughter and feeder under 200 lbs.	1½¢ per lb. in quota of 200,000 per year. 2½¢ per lb. over quota.	1½¢ per lb. No quota.
Slaughter and feeder 200-699 lbs.	2½¢ per lb.	1½¢ per lb.
Slaughter and feeder 700 lbs. and over.	1½¢ in quota of 400,000 year all sources. Max. 120,000 per qtr.	1½¢ per lb. No quota.
Dairy cows 700 lb. and over	1½¢ per lb.	1½¢ per lb.
Beef and Veal fresh and frozen lbs.	3¢ per lb.	3¢ per lb.

*Source: Livestock Market Review, 1962, Dept. of Agr., Ottawa Canada.

Economic implications of tariffs for beef cattle trade with the U.S.

High tariffs as often imposed by the United States on cattle imports have two main effects. First, they increase the total cost of shipping the product to the United States. Second, they lower the "effective" selling price of foreign beef cattle and beef offered for sale in the United States.

The nature of economic adjustment which might be effected by a high tariff is illustrated in Figure 4.2. The introduction of the tariff, ceteris paribus, will increase by an equal amount the ver-

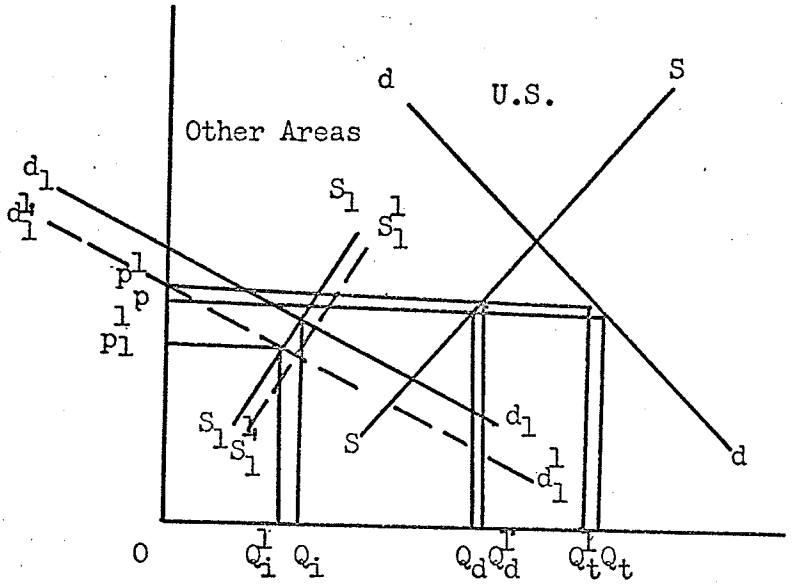

FIGURE 4.2

HYPOTHETICAL INTERNATIONAL BEEF AND BEEF CATTLE TRADE.

THE EFFECTS OF TARIFF IMPOSITION

tical displacement of the supply and demand functions in the "other countries". In Figure 4.2 the vertical distance between d_1d_1 and $d_1^1d_1^1$ measures the fixed tariff per unit of product. At the initial equilibrium position, the total quantity consumed in the United States is OQ_t of which the quantity produced domestically is OQ_d and the quantity imported is OQ_i. Now a fixed tariff is imposed. The effect will be to shift the demand and supply functions in the rest of the world to the positions shown by $d_1^1d_1^1$ and $s_1^1s_1^1$. Quantity exported to the United States will be reduced to Q_i^1; the price in the "other countries" will be Op_1^1. The domestic consumption and production in the United States will be OQ_t^1 and OQ_d^1 respectively. The sum total of all this will be that the price in the U.S. will be increased and that in the "other countries" lowered.[26]

The extent of the price rise in the United States and the price fall in the "other countries" will depend upon the respective demand elasticities. Tariff reduction will have the opposite effect.

The United States series of tariff barriers have not only reduced export earnings of countries like Canada which traded with her; they also have indirectly affected domestic prices of cattle in these other countries. For Canadian producers, some element of uncertainty has, at one time or the other, been introduced into the industry.

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[26]Martin W. Abel, "Price Discrimination in the World Trade of Agricultural Commodities", J.F.E., Vol. 48, No. 2, May 1966, pp. 198-99.

CHAPTER V

CATTLE CYCLES IN THE U.S. AND CANADA

In this chapter we shall be mainly concerned with time series data, or historical variables, as Schumpeter calls them. Cattle numbers on farms in the United States and Canada are our target variables and an attempt will be made to trace out all the relevant logical relationships between the cattle industries in the two countries.

Generally, the buying decisions of consumers determine the demand for beef. Producers' decisions, on the other hand, determine how many cattle they will breed and feed, which in turn determine the quantity of beef available to consumers. The total cattle inventories on farms from year to year are subject to the play of a diversity of forces. The number on farms each year will be the results of many influencing factors. Among these may be listed:

1. The circumstances affecting diverse cattle producers
2. Government policies
3. The weather
4. The level of prices of feeds
5. Electioneering promises
6. Existence of war and peace.

In studying the interrelationship between the two industries, it becomes necessary to classify these diverse factors into categories that are significant for comparison purposes and that correspond to realities in the field of study.

Mingled with the irregular movements are the effects of accidental and irregular factors. In time series analysis, this category is a catch-all for consequences of unpredictable events, such as floods, drought, foot-and-mouth disease, abnormally low prices and general business depression as well as the effects of countless minor events equally fortuitous though less violent in their incidence. Such events influence the value of the variables at any stated time, modifying the effects of long-term movements and cyclical factors.[1]

Cycles in general, in the sense used in economics, are difficult to define other than to say that they are periodic swings in the level of price or production, Cycles are mainly the alternating of rising and falling short-run trends in economic variables about a longer-run trend. Because of the gamut of forces operating regularly or irregularly, cyclical phenomena are often unpredictable, imprecise and unmeasurable. Prediction could in general be made only in broad ranges. As the underlying purpose of this study is to trace through the interrelationships of the beef cattle industries in the United States and Canada, we shall restrict ourself only to those forces relevant to the industry.

Conceptually, the cattle cycle rests on three pillars.[2] Firstly, producers tend to formulate production plans on current or recent prices which alternative opportunities might bring in. Secondly, production

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[1]F.C. Mills, Introduction to Statistics, Henry Holt and Co., 1956, pp. 336-382.

[2]Marshall, op. cit., p. 17.

plans take some time before they mature. There is an inevitable time lag in the biological process. This factor accounts for the relatively long cattle production cycle (three years from breeding to slaughter for mature steer and five years from time herd expansion begins to slaughter). In the third place, the resulting expansion or contraction in inventories may be directly related to slaughterings and indirectly to market price. All these could be explained by the familiar cobweb or recursive model.[3]

Cattle cycle theorists so far have shown a certain amount of disagreement as to the cause of cyclical phenomena inherent in the total inventories over the years. Some regard them as regular cycles which are generated mainly within the industry. Others argue that the cycles are no cycles at all, or at best they are merely the result of fortuitous forces or "succession of unrelated episodes" which are not cyclic in nature.[4] The cattle cyclical phenomenon attributable to the first

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[3] V. Waugh, "Cobweb Models", J.F.E., Vol. 46, No. 4, November 1964, pp. 732ff.

"Any model is recursive if it shows how certain initial conditions in period t+1 will affect conditions in period t+2" etc. Using prices (p_t) and quantities (q_t) measured as deviations from the respective 'normal' or equilibrium values in period t, Waugh derives the following equations:

Price $p_t = -a\, q_t$

$q_{(t+1)} = b\, pt = -ab\, q_t$

Hence $q_{(t+2)} = -ab q_{t+1} = (ab)^2\, q^t$ and

$q_{(t+4)} = (ab)^2\, q\ (t+2) = (ab)^4\, q^t$. i.e. $q_{(t+2k)}$ $(ab)^{2k}\, q^t$

$(ab)^2 < 1$, means the system converges

$(ab)^2 > 1$, means the system diverges

$(ab)^2 = 1$, means the system is continuous.

[4] Geoffrey Shepherd and Eleanor Shepherd, Marketing of Corn Belt Products, Ames, Iowa 1935, pp. 86-90. See also J.A. Hopkins Jr., A Statistical Study of Prices and Production of Beef Cattle, Iowa Agr. Expt. Stn., Res. Bull. 101, 1926, pp. 351-54.

school of thought could be accounted for entirely by the response of cattle producers to price. Producers regulate their production programs by the profitableness of their enterprise. This theory is useful for prediction purposes. The long-term trend of expansion of cattle production on the continent resulted naturally from the rapid growth in human population, and to the extent that it is a separate factor, the change in the proportion of the dairy component of the cattle inventory. Shepherd has discovered that if the cattle population and cattle price cycles are compared, it becomes clear that the two are very comparable. He contends that if each point on the population cycle is moved ahead by four years then each will correspond closely to a similar point on the price cycle.[5] The reason for this logical relationship could be that it takes about four years for increases in breeding to show up in the market and a similar period for liquidation for overexpanded herds. The inventory cycle could be used as an index of what cattle prices are likely to be in a stated future.

The other cyclical theory--known as "episodic" theory--explains that the major cattle price movements are not the result of an "inherent and self-perpetuating" tendency on the part of producers to expand or cut back production. Rather, the contention is that they are the result of forces outside the cattle industry, forces which are not regularly pre-

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[5]Shepherd, op. cit., p. 88. This has been shown to be the case in the U.S. L.P. Marshall also arrives at the same conclusion when the Canadian cattle production cycle and price cycle are compared. Vide Ibid., pp.20.

dictable or recurrent in character. The episodic theory explains beef cattle price movements by a series of unrelated events or episodes, each of which happens but once, and none of which could have been understood in a cyclic explanation.

It is necessary to point out at the onset that these two diametrically opposed theories do, together, explain the cyclical movements of beef cattle prices and inventories. There is need to combine the major parts of both theories by using a suitable model.

We assume as a matter of convenience that there is a pattern of change inherent in the cattle inventories which repeats itself (with more or less variation) in successive cycles. The conventional way of expressing these cycles has some serious drawbacks. Waugh has demonstrated that errors are likely to be compounded when forecasts are made recursively over a period of years.[6] Waugh's equations referred to in footnote (3) are all linear, but Hotelling[7] and Bean[8] have shown that the actual functions are not linear for the reasons that output will be elastic for small changes but increasingly inelastic for large changes because of the nature of frequency distribution of costs.

Samuelson[9] discusses Leontief's paper which outlines the conditions

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[6]Waugh, op. cit.

[7]Harold Hotelling, "Edgeworth's Taxation Paradox and the Nature of Demand and Supply Functions", Journal of Political Economy, Vol. 40, 1932.

[8]L.H. Bean, "The Farmer's Response to Prices", Journal of Farm Economics, Vol. 11, July 1929.

[9]P.A. Samuelson, Foundations of Economic Analysis, Atheneum, New York, 1965, pp. 390-91.

for divergence and convergence in the general case where the slopes of the two functions need not be constant. Samuelson, however, points out that "this is more an indication of a solution than a solution per se since the functions in question may be very complicated functions".[10]

Another defect of the cobweb model or any related model (say moving averages) is that it may fail to reveal hidden cycles. This is of crucial importance in the cattle industry as technological advance and improved production techniques etc. have conspired to shorten appreciably the cattle cycle. These hidden periodicities (shorter cycles) are swamped by the longer cycles which are the ones we commonly speak of. Professor J.A. Schumpeter distinguishes three major types of oscillations:[11] Kondratieff cycles with a period of somewhat less than 60 years, Juglar cycles with a period of less than 10 years, and Kitchen cycles with a period of about $3\frac{1}{2}$ years. A modified Fourier Analysis has proved adequate in revealing these hidden periodicities. It has been found out by the application of this model that with respect to the historical data for cattle on farms, there are more than one type of oscillations present. The Fourier analysis has the added advantage of being able to (1) isolate and compound, where necessary, the most important factors which influence

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[10] Ibid., p. 390.

[11] J.A. Schumpeter, Business Cycles, Vol. 1 (New York, 1939) pp. 161ff. See also, N.D. Kondratieff, "The Long Waves in Economic Life", Review of Economic Statistics, Vol. 17 (1935) pp. 105ff, and Gerhard Tintner, Econometrics, John Witey & Sons, Inc., New York, 1962, pp. 216ff.

cattle production; (2) measure the impact of these factors on cattle production; and (3) facilitate testable predictions; and (4) formulate cyclical indexes exhibiting the effect of those factors indentified on cattle production. It is a compromise for the two cyclical theories discussed previously.

Factors affecting cattle production.

Decisions of both producers and consumers play an important part in setting beef prices and indirectly in determining beef production. The total production is influenced by many factors, some of which are:

1. Demand. There are many aspects of this factor. The most influential considerations are consumer income, population, consumers' tastes and preferences and the supply of competing meats. Price-induced expansion and contraction of production is the resultant of the operation of demand and supply forces. Over time, demand can be stimulated or discouraged by the efficiency with which product is provided to satisfy it.[12]

2. Technology. As beef cattle production is not a primary enterprise but is based on the conversion of raw materials the output capacity of the industry is determined, to a great extent, by the supply of raw product at its disposal. "Production of meat animals as practiced has continued to require 'husbandry'. Mechanization, impersonal and efficient, has not proved a ready replacement."[13] Apart from the effect of feed

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[12]Breimyer, op. cit., p. 29.

[13]Ibid., pp. 32-35.

efficiency on productivity gains in beef animals, capital investment has played a leading role. A rising output per cow is in evidence.

3. Episodic forces and other influences. Included in these are Government policies, prices of feed, the weather, existence of war and peace, abnormally low or high cattle prices in the United States (from the Canadian point of view) etc. These forces yield a composite influence on cattle production.

4. Random influences. These include all the other factors influencing production noted earlier in this chapter. Included also are observation and tabulation errors, floods and drought.

There may be several unidentified factors. Thus, in the absence of a precise knowledge, we assume that the residuals left over after subtracting the trend and the cycles are normally and independently distributed.[14]

The Model and method of analysis.

The foregoing factors all could be grouped into one equation thus:[15]

$$Y_t = A_t + BT_t + I_c + E_t \qquad (1)$$

where Y_t = Cattle numbers on farms or output

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[14] M.H. Yeh and L.D. Black, Weather Cycles and Crop Predictions, Tech. Bull. No. 8, Nov. 1964. Dept. of Agr. Economics, Univ. of Manitoba.

[15] Ibid., p. 3. For full treatment of the application of Modified Fourier Analysis to Economic Data, see pp. 18ff. The predicted value of output was represented by the equation:

$$\hat{Y} = a_t + bt_t + I_c$$

Where the first two terms on the right hand side of the equation represent the trend and I_c the sum of the individual cycles or the composite inventory cycle.

T_t = A variable representing technological change reflected by the slope of the function.

A_t = Inputs, represented by the intercept of the equation.

I_c = Sum of episodic, price, weather and other influences or the composite inventory cycle.

E_t = Random residual. (The t_s represent time.)

Using simple harmonic functions, the composite cycle could be represented by the following equation.

$$I_c = \sum_{k=1}^{j} \frac{1}{N} C_k \left[\text{Sine} \left[\beta + \left(\frac{\pi}{N} k \right) (T - To) \right] \right] \qquad (2)$$

when $\frac{1}{N} C_k$ = the amplitude of cycle

β_k = the phase angle of cycle

$\frac{\pi k}{N}$ = the frequency of cycle

k = the index of each individual cycle.

It has been shown that with the use of charts or of the most sophisticated methods of Fourier analysis, it is comparatively easy to show that almost any record of the past is made up of some combinations of swings. The same is true also for a wide variety of artificial series generated by a random process with no built in cyclical behaviour whatsoever.[16] To circumvent this difficulty, and also to obtain a population of residuals having a mean equal to zero a linear regression was fitted to our data, using the first two terms of equation (1). The estimated values were subtracted from the original to obtain a series that is considered random in nature. The deviations thus became the data upon

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[16]Benoit Mandlelbrot, Toward A Revival of the Statistical Law of Pareto (second draft), paper presented to the International statistical Conference, Ottawa, 1963, p. 15. Mimeo.

TABLE 5.1
AMPLITUDES(AK,BK,CK) AND ANGLE
OF CATTLE PRODUCTION CYCLES IN THE U.S.

AK	BK	CK	ANGLE	K
-9146.6440	0.0000	9146.6439	-2.5707	1
-177385.7000	-12769.6650	177844.7300	1.4989	2
-50226.1280	-812.9660	50232.7060	1.5546	3
-1958.5370	82823.0680	82846.2200	-.0236	4
59192.0400	-46303.3460	75151.1620	-.9069	5
42635.5390	-81291.7850	91794.0270	-.4830	6
81882.8470	54311.2810	98257.3950	.9851	7
-8997.3390	-3906.5154	9808.8210	1.1611	8
-1959.5420	-16029.5870	16148.9140	.1216	9
1088.8458	7835.3113	7910.6060	.1380	10
10847.5590	-2962.8737	11244.9160	-1.3041	1
10675.6770	-1053.3785	10727.5190	-1.4724	2
9370.6525	-1143.1989	9440.1287	-1.4493	3
2520.9041	2288.5841	3404.7869	.8336	4
3579.4599	-1221.1427	3782.0261	-1.2420	5
7120.0366	-10903.8630	13022.6390	-.5784	6
3448.0107	574.9325	3495.6149	1.4055	7
3546.1340	-7119.6206	7953.8709	-.4621	8
7775.2850	2591.2805	8195.7177	1.2491	9
-1962.3107	-2993.0769	3578.9903	.5803	20
5002.6950	-2594.9597	5635.6696	-1.0922	1
3426.4290	-3354.8976	4795.3886	-.7959	2
5140.5180	1123.5238	5261.8656	1.3556	3
1938.5830	-680.7793	2054.6445	-1.2330	4
5504.9470	-410.4193	5520.2250	-1.4963	5
647.5530	-4465.4233	4512.1313	-.1440	6
6124.8350	341.9347	6134.3721	1.5150	7
2793.5310	2852.6753	3992.6869	.7749	8
2168.4990	.0490	2168.4989	1.5707	9

Source: Computed based on Fourier Analysis. The meaning of the A_K, B_K, C_K and K is as defined in equation 2 above.

TABLE 5.2

AMPLITUDES(AK,BK,CK) AND ANGLE OF CATTLE PRODUCTION CYCLES IN CANADA

AK	BK	CK	ANGLE	K
-1011.6661	0.0000	1011.6660	-1.5707	1
-7786.0528	-7994.6161	11159.5920	.7721	2
5493.7731	-1650.0384	5736.2154	-1.2790	3
-3624.5434	13382.2240	13864.3860	-.2645	4
7560.3714	-7126.3496	10389.6130	-.8149	5
6837.3519	-1414.3409	6982.1014	-1.3668	6
4545.5870	4856.7735	6652.1131	.7523	7
-1690.6728	98.7863	1693.5563	-1.5124	8
2456.0042	-1879.4465	3092.6163	-.9176	9
-2056.1702	-208.4417	2066.7084	1.4697	10
494.5199	-608.2733	841.0242	-.6285	11
-110.3377	-759.5769	767.5490	.1442	12
1297.2091	-526.5622	1400.0068	-1.1851	13
-887.8050	1553.3031	1789.1194	-.5192	14
-677.5083	-2226.4908	2327.2899	.2953	15
928.5066	-730.5546	1181.4544	-.9041	16
-355.3708	-581.3130	681.3320	.5487	17
206.7028	841.1506	866.1757	.2409	18
707.9771	-240.9190	747.8459	-1.2427	19
-55.1468	-398.2185	402.0188	.1376	20
-626.5959	-294.9849	692.5594	1.1308	21
413.6737	1053.7927	1132.0799	.3740	22
603.7292	334.0796	689.9986	1.0653	23
-145.1212	358.7602	387.0000	-.3843	24
-156.6417	-576.9898	597.8745	.2650	25
-54.4917	759.5238	761.4760	-.0716	26
-174.5938	275.1071	325.8326	-.5655	27
65.1478	187.9952	198.9634	.3335	28
-589.5013	.0110	589.5012	-1.5707	29

Source: Computed. See footnote of table 5.1.

which the Fourier analysis was applied to determine whether there were any harmonic components in them.

The amplitude (A_k, β_k and C_k) and phase angle (β_k) of cattle cycles in the United States and Canada are shown in Tables 5.1 and 5.2. Because several cycles have been revealed, judgement was used to select the most appropriate ones. The method adopted was to select three or four C_k values to be used to calculate the individual cycles and the composite cycle. The cyclical effects on total cattle inventories at K = 4, 9, 15 and for Canada and K = 4, 7 and 16 for the U.S. were determined.[17] These cyclical values are shown in Tables 5.3 and 5.4. The predicted values of the data used are plotted in Figures 5.1 and 5.2. These predictions were made on the assumption that the same cyclical pattern existed throughout the period under study. The predicted quantities for the Canadian cattle inventory are very close to the actual cattle numbers. Because of a relatively longer cycle embodied in the U.S. data (i.e., k=2) the predicted quantity follows a slightly different course,

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[17] The duration of a cycle can be derived by the total number of observations divided by the radians per year or $\frac{2N}{k-1}$ i.e. the duration of a cycle of k=4 for 57 observations is given by $\frac{2(29)}{4-1} = \frac{58}{3} = 18\frac{2}{3}$ years. The year a cycle started is found by setting $\beta_k + \frac{\pi}{N}k\,(T-To) = 0$. i.e. for k=4, the year the Canadian cycle started can be derived by setting $-.2645 + \frac{3.1416}{29}(4)\,(T-1934) = 0$ or T = 1934.6 or approximately July 1934.

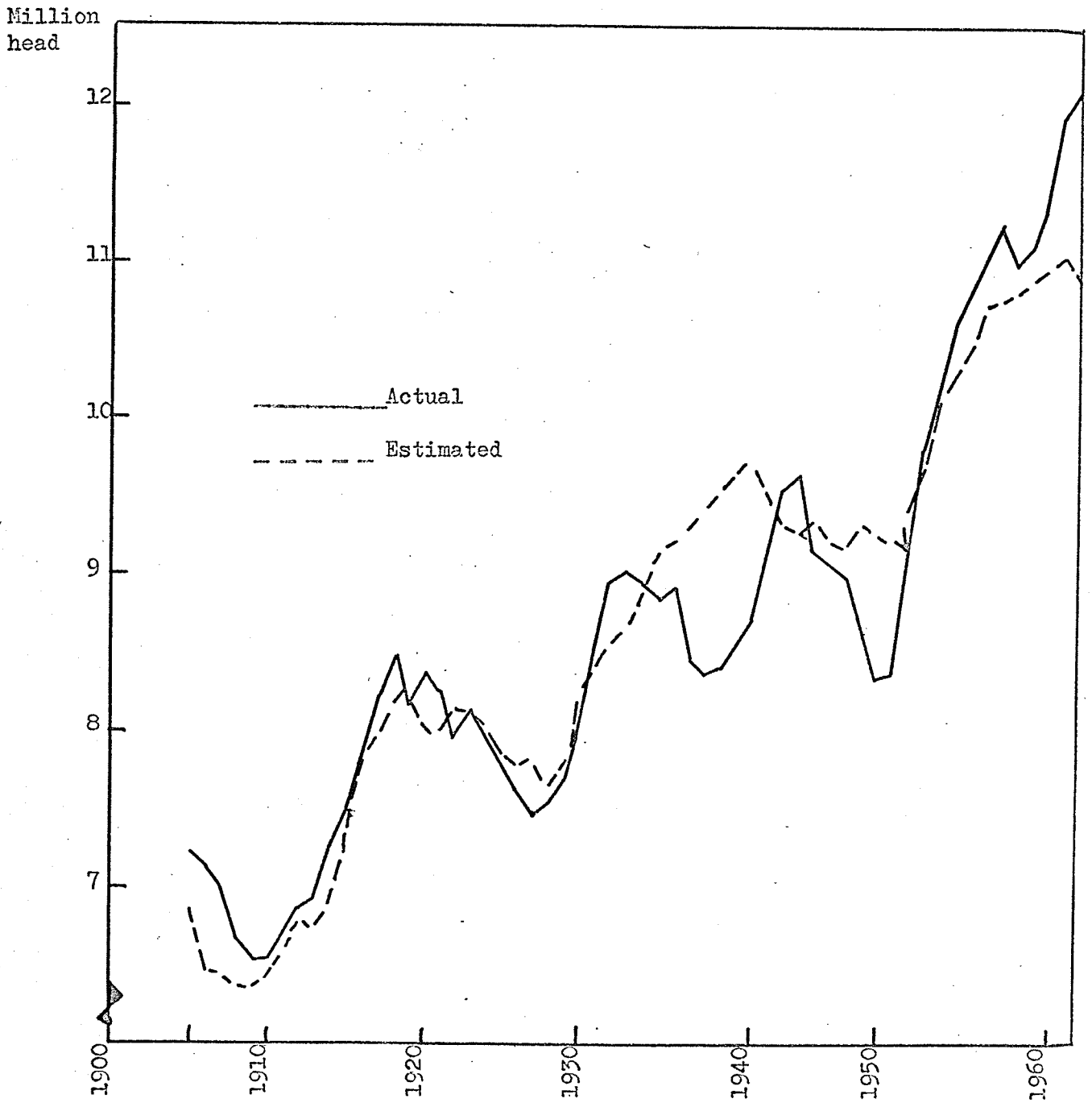

Figure 5.1. Actual and Estimated Number of Cattle on Farms, Canada, 1906-62.

Source: Computed using annual data based on Fourier Analysis. Details of the calculations are described in the text.

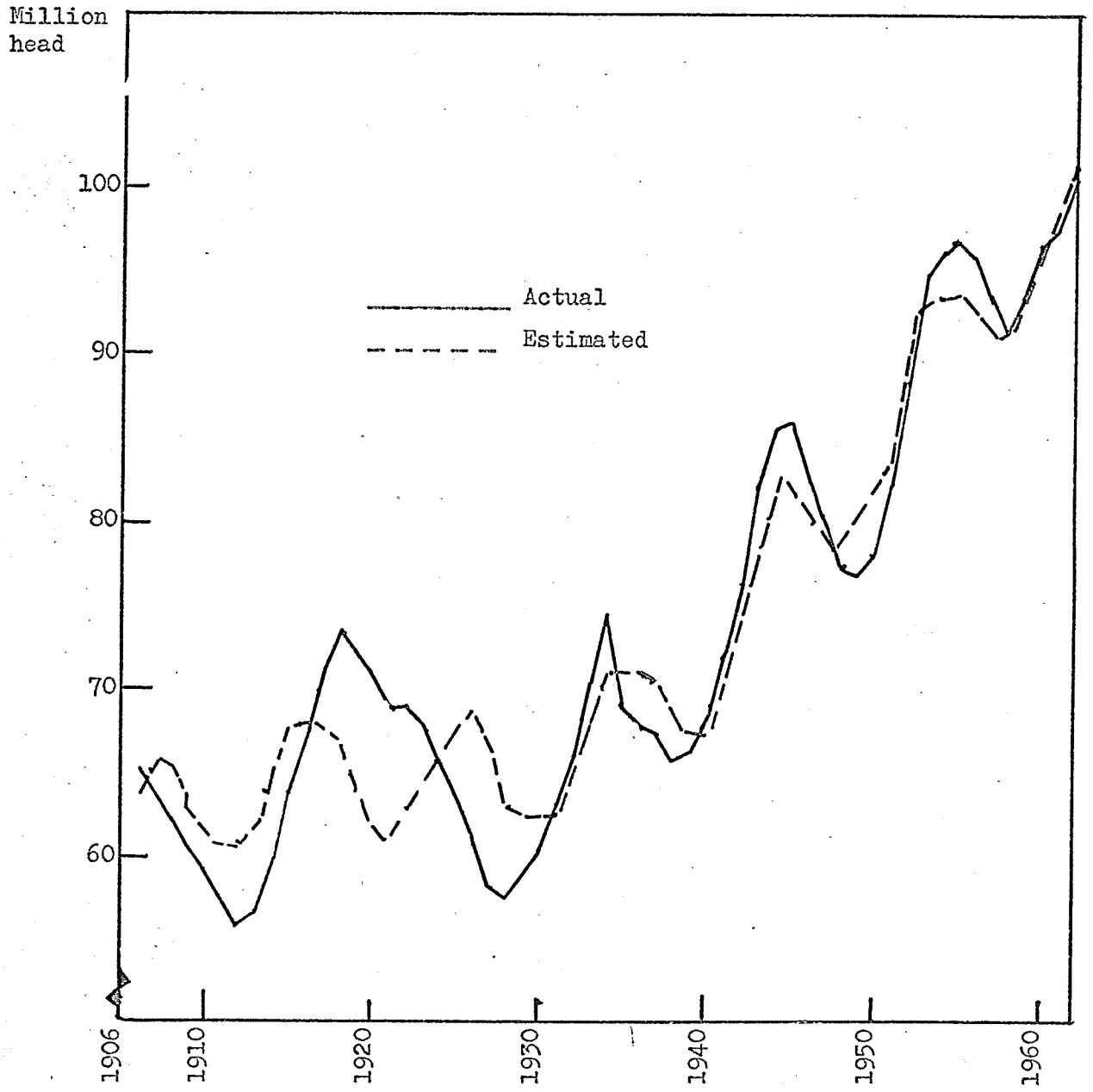

Figure 5.2. Actual and Estimated Number of Cattle on farms, United States, 1906-62.

Source: Computed using annual data based on Fourier Analysis. Details of the calculations are described in the text.

TABLE 5.3

INDIVIDUAL CYCLICAL EFFECTS ON CATTLE PRODUCTION IN CANADA AT K(4,9,15)

K,4	K,9	K,15
129.447	87.713	-24.189
-35.669	2.208	-79.519
-196.782	-84.959	24.189
-335.810	-108.151	79.519
-437.149	-49.903	-24.189
-489.425	45.922	-79.519
-486.771	107.168	24.189
-429.485	87.713	79.519
-323.996	2.209	-24.189
-182.145	-84.959	-79.519
-19.850	-108.151	24.189
144.671	-49.903	79.519
292.957	45.922	-24.189
408.362	107.168	-79.519
477.936	87.713	24.189
493.870	2.209	79.519
454.374	-84.959	-24.189
363.883	-108.151	-79.519
232.552	-49.903	-24.189
75.121	45.922	79.519
-90.741	107.168	-24.189
-246.419	87.713	-79.519
-374.441	2.209	24.189
-460.438	-84.959	79.519
-494.758	-108.151	-24.189
-473.550	-49.903	-79.519
-399.194	45.922	24.189
-280.035	107.168	79.519
-129.447	87.713	-24.189
35.669	2.209	-79.519
196.782	-84.959	24.189
335.810	-108.151	79.519
437.149	-49.903	-24.189
489.425	45.922	-79.519
486.771	107.168	24.189
429.485	87.713	79.519
323.996	2.209	-24.189
182.145	-84.959	-79.519

CONTINUED

K,4	K,9	K,15
19.850	-108.151	24.189
-144.671	-49.903	79.519
-292.956	45.922	-24.189
-408.362	107.168	-79.519
-477.936	87.713	24.189
-493.870	2.209	79.519
-454.375	-84.958	-24.189
-363.884	-108.151	-79.519
-232.553	-49.903	24.189
-75.121	45.922	79.519
90.740	107.168	79.519
246.419	87.714	-24.189
374.440	2.209	-79.519
460.437	-84.958	24.189
494.758	-108.151	-24.189
473.550	-49.903	-79.519
399.194	45.922	24.189
280.035	107.168	79.519
129.447	87.714	-24.189

SOURCE

THE INDIVIDUAL CYCLICAL VALUES WERE CALCULAIED BY PERFORMING A SUITABLE OPERATION ON THE HARMONIC EQUAIION GIVEN IN THE TEXT. A SELECTED K VALUE WAS USED IN EACH CASE TO COMPUTE THE CYCLICAL VALUES

TABLE 5.4

INDIVIDUAL CYCLICAL EFFECTS ON CATTLE PRODUCTION IN THE U.S. AT K(4,7,16)

K,4	K,7	K,16
-1793.789	2924.309.	-254.259
1702.724	3495.766	415.460
1420.557	2541.892	161.226
978.956	478.894	-451.563
427.482	-1793.060	-60.107
-171.967	-3282.638	465.023
-752.117	-3339.878	-44.024
-1247.855	-1939.807	-455.165
-1603.541	306.675	145.949
-1779.257	2419.342	422.483
-1755.281	3476.361	-240.555
-1534.304	3016.515	-368.616
-1141.126	1240.453	323.099
-619.877	-1079.867	296.264
-29.055	-2924.307	-389.441
565.026	-3495.766	-209.057
1095.692	-2541.893	436.255
1503.386	-478.898	111.367
1742.350	1793.057	-461.193
1785.764	3282.636	-8.093
1628.755	3339.879	463.005
1288.946	1939.809	-95.587
804.475	-306.670	-441.601
229.714	-2419.339	194.474
-370.828	-3476.361	398.052
-929.751	-3016.517	-283.610
-1384.325	-1240.455	-334.544
-1683.531	1076.862	358.524
-1793.789	2924.306	254.260
-1702.725	3495.766	-415.460
-1420.558	2541.895	-161.226

CONTINUED

-978.958	478.900	451.563
-427.485	-1793.055	60.108
171.966	-3282.635	-465.023
752.116	-3339.880	44.023
1247.853	-1939.811	455.165
1603.540	306.668	-145.948
1779.257	2419.338	-422.483
1755.281	3476.361	240.554
1534.304	3016.518	368.616
1141.128	1240.457	-323.098
619.879	-1079.860	-296.265
29.058	-2924.304	389.440
-565.024	-3495.767	209.058
-1095.691	-2541.896	-436.255
-1503.385	-478.904	-111.368
-1742.349	1793.054	461.193
-1785.764	3282.634	8.093
-1628.756	3339.882	-463.006
-1288.948	19399813	95.586
-804.476	-3069665	441.601
-229.716	-24199334	-194.473
370.825	-34769360	-398.053
929.749	-30169520	283.609
1384.323	-12409459	334.544
1683.530	10769857	-358.523
1793.789	29249302	-254.261

SOURCE
THE INDIVIDUAL CYCLICAL VALUES WERE CALCULATED BY PERFORMING A SUITABLE OPERATION ON THE HARMONIC EQUATION GIVEN IN THE TEXT. A SELECTED K VALUE WAS USED IN EACH CASE TO COMPUTE THE CYCLICAL VALUES

at least during the two major war periods. It is, however, significant that the predicted quantity for the United States cattle numbers on farms is closer to the actual numbers.

The precision of the prediction may be explained by the standard deviation of the random residuals, i.e.,

$$S = \left(\frac{\sum_{i=1}^{\hat{}} e_i^2}{n-3} \right)^{\frac{1}{2}}$$

where $e = \hat{Y}-a-bx-I_c$, and $n = (2N-1)$ representing the total number of observations. The standard deviations for residuals for the U.S. cattle and the Canadian cattle inventories are $\pm$ 4004.15 and $\pm$ 512.58 respectively. These are relatively small and are less than 6% of the long-run average production of cattle.[18]

Much more revealing results from this model are the cyclical

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[18] A growth model--a modified Gompertz Curve-- was formulated for prediction purposes. The model was

$$\hat{Y} = ab^x - k$$

where $k = [M_2^2 - (M_1 \times M_3)] \div [(M_1 + M_3) - 2M_2]$.

M_1 = The mean of the first third of the series.

M_2 = The mean of the second third of the series.

M_3 = The mean of the last third of the series.

For the Canadian cattle inventory--1907 to 1963--the predicted equation was $\hat{Y} = 648.6(1.064)^x + 6338$

$S = \pm 594.5$

$x = 1, 2, \ldots 57$. 1907 = 1 etc.

The gain in precision by using the Fourier analysis has not been demonstrated. This should not render nugatory the application of the latter model. Some gain in precision is expected if a curvilinear rather than a linear model is used in equation 1. Besides, the magnitude of the composite cyclical values depends upon the number of individual cycles selected: In our analysis judgement was used to select these cycles and we feel a trial and error procedure should improve the precision of the predictions.

indexes. These are shown in Table 5.5 shown on page 74 and 75. The cyclical indexes for cattle inventory range from -7% to +7% for Canada and -12% to +12% for the United States. These results suggest that annual fluctuations in cattle inventories are appreciably influenced by year-to-year variations of weather (which affect prices of feed), episodic and other influences.

The cyclical indexes for the average prices received by farmers in the United States are also very revealing. Some interesting relations are brought out when these are compared with the United States inventory indexes. The patterns of these indexes when plotted illustrate the correlated shifts of both prices and output of cattle over the years. In an indirect manner, the results show that both the demand and supply curves for beef cattle shifted together. The results of the plotting, shown on Figure III make a very clear picture. The correlated shifts of supply and price in a negative manner are revealed.

Spectrum analysis was performed on the residuals for the United States and Canadian cattle inventories to determine whether the cyclical fluctuations in the two series coincide in timing or whether cycles in one series consistently precede or lag behind cycles in the other. The method employed was to determine the correlation between the two series for concurrent observations and by making successive pairings with varying leads and lags.[19] The correlation figures do help bring out the typical

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[19]The residuals from the U.S. cattle inventory were treated as one variable. The residuals obtained from the Canadian cattle inventory were also treated as another variable. Correlation for concurrent observations were calculated and then the Canadian series was lagged one year, etc.

TABLE 5.5

CYCLICAL INDEXES OF CATTLE PRODUCTION IN CANADA AND IN THE U.S. , U.S. CATTLE IMPORTS, U.S. CALF AND CATTLE PRICES AND CANADIAN CATTLE EXPORTS 1906-62

U.S. INVENTORY	CANADA INVENTORY	U.S. IMPORTS	U.S. CALF PRICES	CANADA CATTLE	EXPORTS
112.2755	102.0656	106.5957			
113.9828	98.5029	66.6759			
112.2425	97.4507	77.4454			
108.3939	95.3459	73.5067		158.0814	
105.5243	94.2450	114.4645	141.5892	148.2440	
103.8022	94.1246	106.9844	126.6808	137.5294	
102.5267	95.4438	97.1427	124.6202	133.9452	
103.2815	97.3895	157.4646	129.6444	123.3627	
106.4876	95.8183	113.4936	122.5022	106.8003	
108.9980	95.7946	68.9733	125.3344	104.9988	
108.7182	99.2329	47.2930	135.0545	117.9865	
107.0488	101.5907	88.5380	123.5530	124.2964	
104.6594	103.8190	112.5707	110.9186	121.7593	
100.5208	105.2415	120.7893	112.6836	125.0227	
96.1048	106.4009	139.6693	104.9995	127.9089	92.0852
94.6008	107.1017	85.0719	97.7588	113.0537	92.9540
95.8143	108.8305	112.2289	107.9714	89.8418	92.6223
97.2338	101.8552	99.4955	106.6168	79.4856	89.3115
98.6289	102.8338	55.8418	90.8217	77.3446	108.0751
100.3957	101.8953	61.4875	88.2932	69.5350	113.5212
100.2858	100.0812	110.9845	84.5907	66.2244	101.0293
96.8472	97.4259	158.1562	71.4966	79.2970	105.4520
92.6159	95.5293	113.0634	76.2335	92.2847	109.8053
89.9858	95.0292	115.9329	185.8140	88.2950	100.7518
88.2929	92.5596	75.3728	76.1185	79.3536	89.4359
87.5555	92.8230	67.1552	70.7577	77.3352	87.7400
89.5720	96.6216	102.8616	76.2042	69.6671	96.2062
93.4447	98.4883	80.3329	61.9243	51.0297	94.9494

CONTINUED

U.S. INVENTORY	CANADA INVENTORY	U.S. IMPORTS	U.S. CALF PRICES	CANADA CATTLE EXPORTS
95.6970	99.4070	95.0648	58.4107	41.9185	98.8984
95.5477	99.7047	122.3385	73.3191	51.7559	104.7441
94.6874	101.1403	164.6774	75.3797	62.4706	103.7075
92.9116	103.9902	99.0127	70.3555	66.0547	115.1505
89.5871	104.0372	59.5118	77.4977	76.6372	110.5615
87.2482	105.0964	77.7444	74.6655	93.1996	91.7148
88.3676	107.6014	67.3173	64.9454	95.0011	96.5905
91.4299	106.4874	120.2258	76.4469	82.0134	99.6368
94.3484	103.6721	117.9554	89.0813	75.7035	89.9680
97.6008	100.3922	114.4477	87.3163	78.2406	87.2525
100.7594	98.8205	111.2460	95.0004	74.9772	96.2212
101.1751	99.0958	125.6133	102.2411	72.0911	108.3961
98.7224	96.6848	92.6880	92.0285	86.9463	106.3769
96.5432	95.3994	26.8270	93.3831	110.1581	105.9284
95.9226	96.1933	89.8150	109.1782	120.5143	106.0164
95.8685	94.7930	112.5530	111.7067	122.6553	102.3017
97.2555	93.6390	134.2240	115.4092	130.4649	103.6700
101.4605	93.7939	131.0869	128.5033	133.7755	95.5378
106.2594	96.5699	100.2533	123.7664	120.7029	81.3631
108.5537	101.0128	88.7995	114.1860	107.7152	94.7636
108.8197	101.8424	80.0279	123.8814	111.7049	102.3802
108.4412	102.7640	100.4138	129.2422	120.6463	94.9114
106.5479	105.0826	50.5635	126.7957	122.6647	100.2265
103.4182	104.8446	99.5141	138.0756	130.3328	110.9955
102.2293	104.3722	157.6266	141.5892	148.9702	114.3429
104.2204	104.1764	130.8580		158.0814	103.8636
107.0460	105.0037	106.5900			99.1223
109.4911	105.8396				92.0852
112.2755	102.0656				

CORRELATION TABLE FOR SUCCESSIVE PAIRING OF RESIDUALS

Time Lag	t	(t-1)	(t-2)	t-3	t-4
Correlation	.35	0.43	0.32	0.16	0.02

time interval between the United States and the Canadian cattle cycles. On the basis of these findings we conclude that the Canadian cycle lags behind the United States cycle by approximately one year. These results compare very well with actual time lag in cattle inventory upturns and downturns in Canada and in the United States. As is obvious in Table 5.6 the magnitude of all upswings in the respective series has exceeded all the downturns in absolute and percentage terms.[20] This phenomenon is largely attributable to the general expansion of the cattle industries in the two countries. The growth element represented by the trend equation embodied accounts for a very large proportion of the long-run output on farms. R.G. Marshall argues that the mentioned phenomenon is also inherent in the nature of the cyclical movements.[21] A given increase in production does not necessarily ensure that a decline will take place pari passu. In the expanding phase of the cycle, producers are optimistic and they commit resources almost irreversibly to their enterprise. The contributions of the resource inputs formulated in our model are substantial, indicating that a major portion of the production of cattle

[20]Except for the 1945-1950 downswing in Canada which exceeded the previous upswing in absolute numbers, not percentage wise.

[21]Marshall, op. cit., p. 17.

TABLE 5.6

THE DURATION AND MAGNITUDE OF CYCLICAL MOVEMENTS IN CATTLE INVENTORIES IN UNITED STATES AND CANADA, 1906-1962

Cycle	Duration of Upswing and Downswing		Change from Low to High (+) High to Low (-).(No. 000 head)	%
	. . . . . UNITED STATES			
1912-1928	1912-1918	6 years	+ 17,365	+ 31.0
	1918-1928	10 years	- 15,718	- 20.6
1928-1938	1928-1934	6 years	+ 17,047	+ 29.9
	1934-1938	4 years	- 9,120	- 12.2
1938-1949	1938-1945	7 years	+ 20,324	+ 30.6
	1945-1949	4 years	- 8,743	- 10.2
1949-1958	1949-1955	6 years	+ 19,762	+ 25.0
	1955-1958	3 years	- 5,318	- 5.2
1958	uncompleted			
	. . . . . CANADA			
1910-1928	1910-1919	9 years	+ 1,736	+ 26.7
	1919-1928	9 years	- 793	- 9.7
1928-1939	1928-1934	6 years	+ 1,612	+ 21.7
	1934-1939	5 years	- 696	- 7.7
1939-1950	1939-1945	6 years	+ 1,258	+ 15.0
	1945-1950	5 years[a]	- 1,290	- 13.4
1950-1958	1950-1958	8 years	+ 2,647	+ 31.7
1958-1959	1958-1959	1 year	- 275	- 13.1
1959	uncompleted			

[a] Note: For the beef component the magnitude of the downswing was - 777 or 13.8%. The milk component of the cattle inventory probably accounted for this extraordinary phenomenon.

in the two countries was dependent on previous levels of resource inputs.[22]

Other cyclical characteristics

1. Rates of change in cattle numbers. These rates of change measure the rate at which producers increase or decrease their herds. In Figure 5.3a the rates of change of cattle inventory in the United States and in Canada are compared. In Figures 5.3b and 5.3c the rates of change of beef cattle on farms are compared with their respective total inventories. Because of the relatively long cattle production cycle, farmers cannot very quickly and readily respond to increased prices. Hence, in the upswing, the year to year change increases slowly and gathers momentum. Except for 1949 in the United States and 1950 in Canada, this has been the distinguishing feature of the cattle build up and contraction. Almost always, the rate of increase turns down about two years before the total inventory numbers began to decelerate. One thing also clear from the plottings is that variations in the rates of change are more extreme in the U.S. than they are in Canada.

Trends and annual rate of adjustment in inventory by class of cattle.

Because of the structural changes taking place in the cattle industry in both countries, it has been found necessary to compare how these changes affect the different classes of cattle on farms. A trend equation $Y = AB^x$ was formulated to deal with the period covering 1941-1963.[23]

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[22] This is represented by the intercept of the trend equation, $Y_t = a_t + bT_t$.

[23] Data of classification in prior period are not considered comparable with the data for the period, 1941-1963.

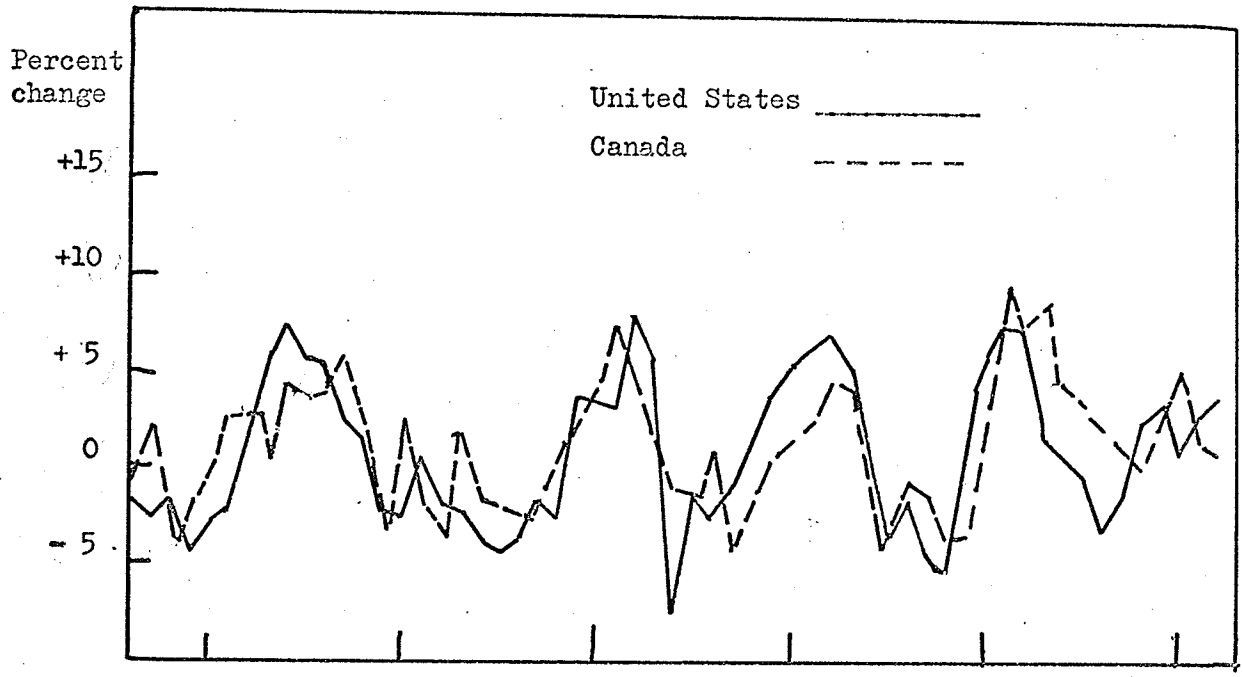

Figure 5.3 a Annual Percentage Change in Numbers of Cattle on Farms, U. S. and Canada, 1906-62.

Source: Based on annual data from Livestock and Animal Products Statistics, Canada Department of Agriculture, and from Livestock and Meat Situation, United States Department of Agriculture.

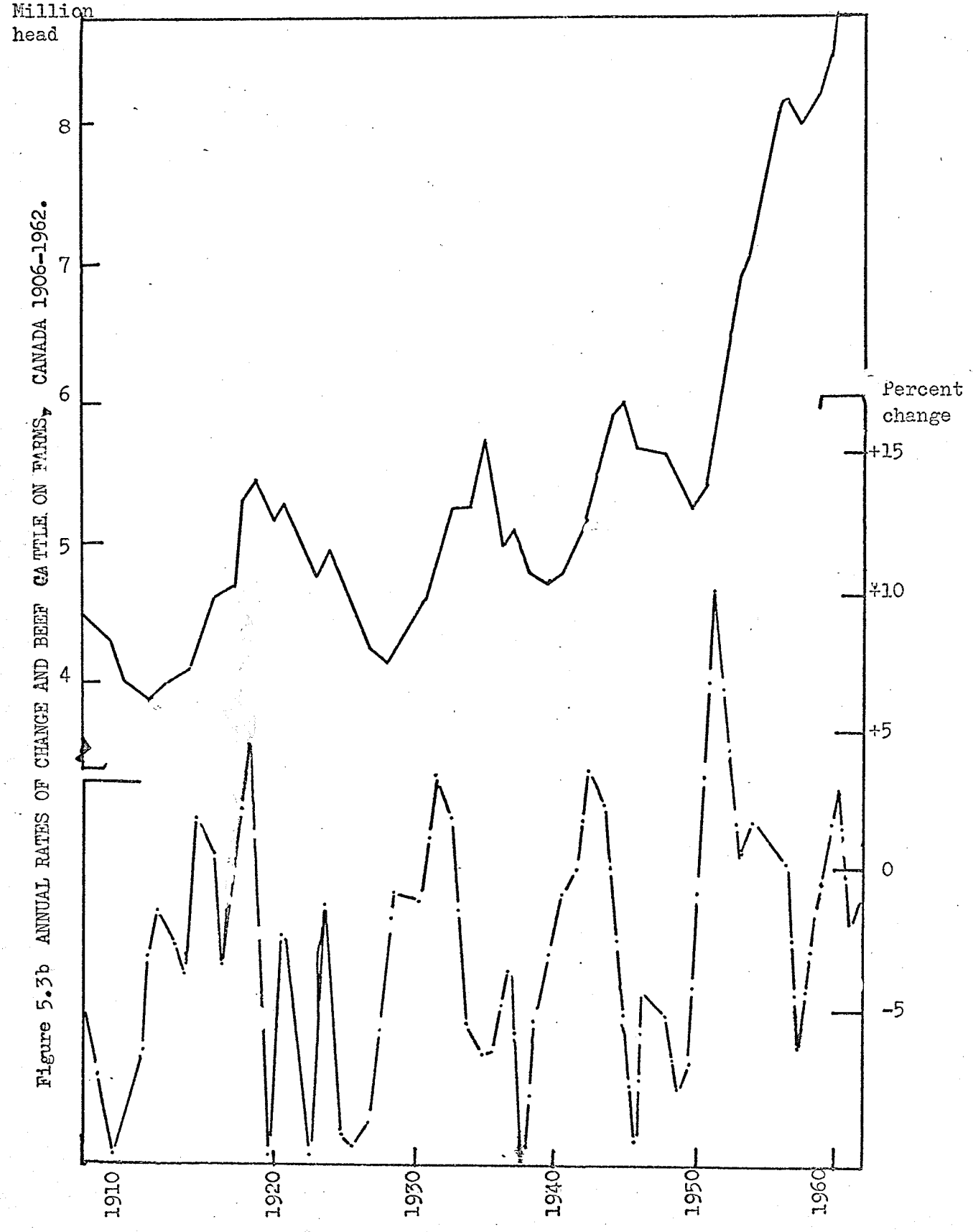

Figure 5.3b ANNUAL RATES OF CHANGE AND BEEF CATTLE ON FARMS, CANADA 1906-1962.

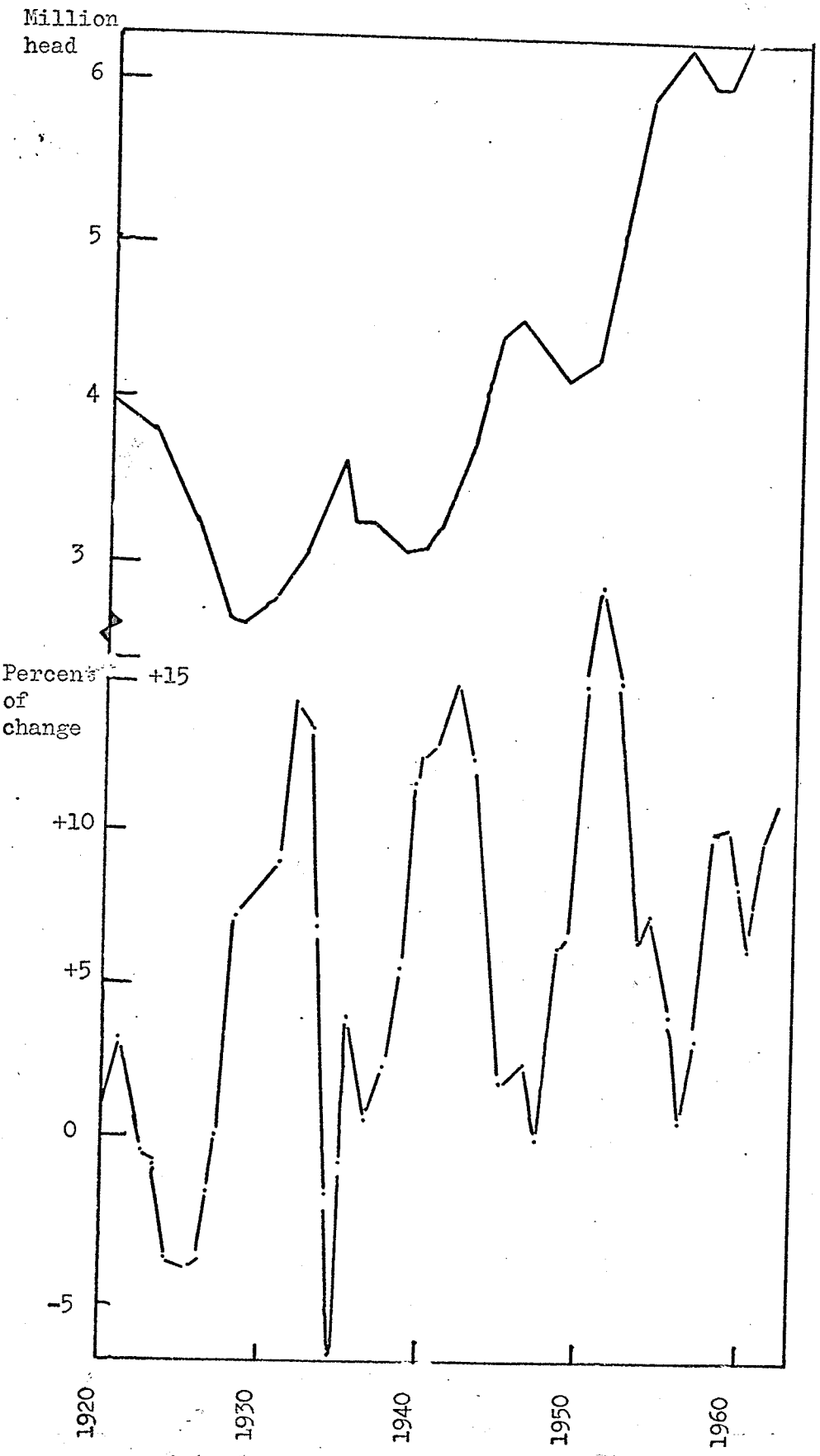

Figure 5.3c ANNUAL RATES OF CHANGE AND BEEF CATTLE ON FARMS, UNITED STATES, 1920-1962.

In logarithmic form, the above equation was written thus:

$$\log \hat{Y} = \text{Log } A + X\text{Log } B$$

This is a compound interest type of equation, x representing years numbered serially (in our example, 1-23 for the period 1941-1963). The coefficient B, when subtracted from 1 and multiplied by 100 gives the rate of change or annual rate of adjustment. (Table 5.7)

There are some close similarities between the two series of results shown. The rate of increase for the bull components in Canada is relatively small. That of the United States has been declining. The introduction of artificial insemination in the industry may account for this phenomenon.

The milk cow components of the cattle numbers in the two countries have been declining as well. The decline in milk cow numbers has been shown to be relatively greater in the United States than in Canada. On the other hand, milk heifers in Canada are declining faster in Canada than those across the border.

With respect to the beef components, except for calves, the rates of increase in Canada are greater than those in the United States. In sum, the changing roles of the beef and dairy components are brought out clearly by this model.

Each class of cattle in the two countries, as percentage of the total inventories for the same period has been plotted in Figure 5.4. Again the changing roles of the beef and dairy components are revealed. All we can conclude is that there have been identical forces acting on the industry in Canada and in the United States. As no causal relation-

TABLE 5.7

TRENDS AND AVERAGE ANNUAL RATE OF ADJUSTMENT IN INVENTORY BY CLASS OF CATTLE ON FARMS IN THE UNITED STATES (JAN. 1) AND CANADA (JUNE 1) 1941-1963

$\hat{Y} = AB^{X}$*

Class of Cattle	Log Equation		Anti-Log Equation		Annual Rates of Adjustment	
	United States	Canada	United States	Canada	U.S.	Canada
Bulls	$\text{Log } \hat{Y}=3.2673-.0017x$	$\text{Log}\hat{Y} =2.3802+(.00146)x$	$\hat{Y}=1893(1.004)^{-x}$	$\hat{Y}=240(1.003)^{x}$	-0.4	+ .3
Steers	$\text{Log } \hat{Y}=3.7954+.011x$	$\text{Log } \hat{Y}=2.8651+.0115x$	$\hat{Y}=6242(1.026)^{x}$	$\hat{Y}=733(1.028)^{x}$	+2.6	+2.8
Beef Cows	$\text{Log } \hat{Y}=4.0886+.0176x$	$\text{Log } \hat{Y}=2.7395+.03x$	$\hat{Y}=12270(1.062)^{x}$	$\hat{Y}=548.9(1.072)^{x}$	+6.2	+7.2
Milk Cows	$\text{Log } \hat{Y}=4.4551-.0153x$	$\text{Log } \hat{Y} =3.5638-.0047x$	$\hat{Y}=28520(1.036)^{-x}$	$\hat{Y}=5672(1.011)^{-x}$	-3.6	-1.1
Beef Heifers	$\text{Log}\hat{Y} =3.6098+.0106x$	$\text{Log } \hat{Y}=2.4819+0.0225x$	$\hat{Y}=4063(1.024)^{x}$	$\hat{Y}=303.3(1.053)^{x}$	+2.4	+5.3
Milk Heifers	$\text{Log } \hat{Y}=3.7883-.0039x$	$\text{Log}\hat{Y}=2.9993-.0072x$	$\hat{Y}=y142(1.009)^{-x}$	$\hat{Y}=996.1(1.016)^{-x}$	-0.9	-1.6
Calves	$\text{Log } \hat{Y}=4.2396+.0086x$	$\text{Log } \hat{Y}=3.3043+.0054x$	$\hat{Y}=1736(1.02)^{x}$	$\hat{Y}=2015(1.013)^{x}$	+2.0	+1.3

*Where $\hat{Y}$ = Number of cattle by class on farms

X = Years numbered serially (1941-1963)

1,2,3. . . . . 23.

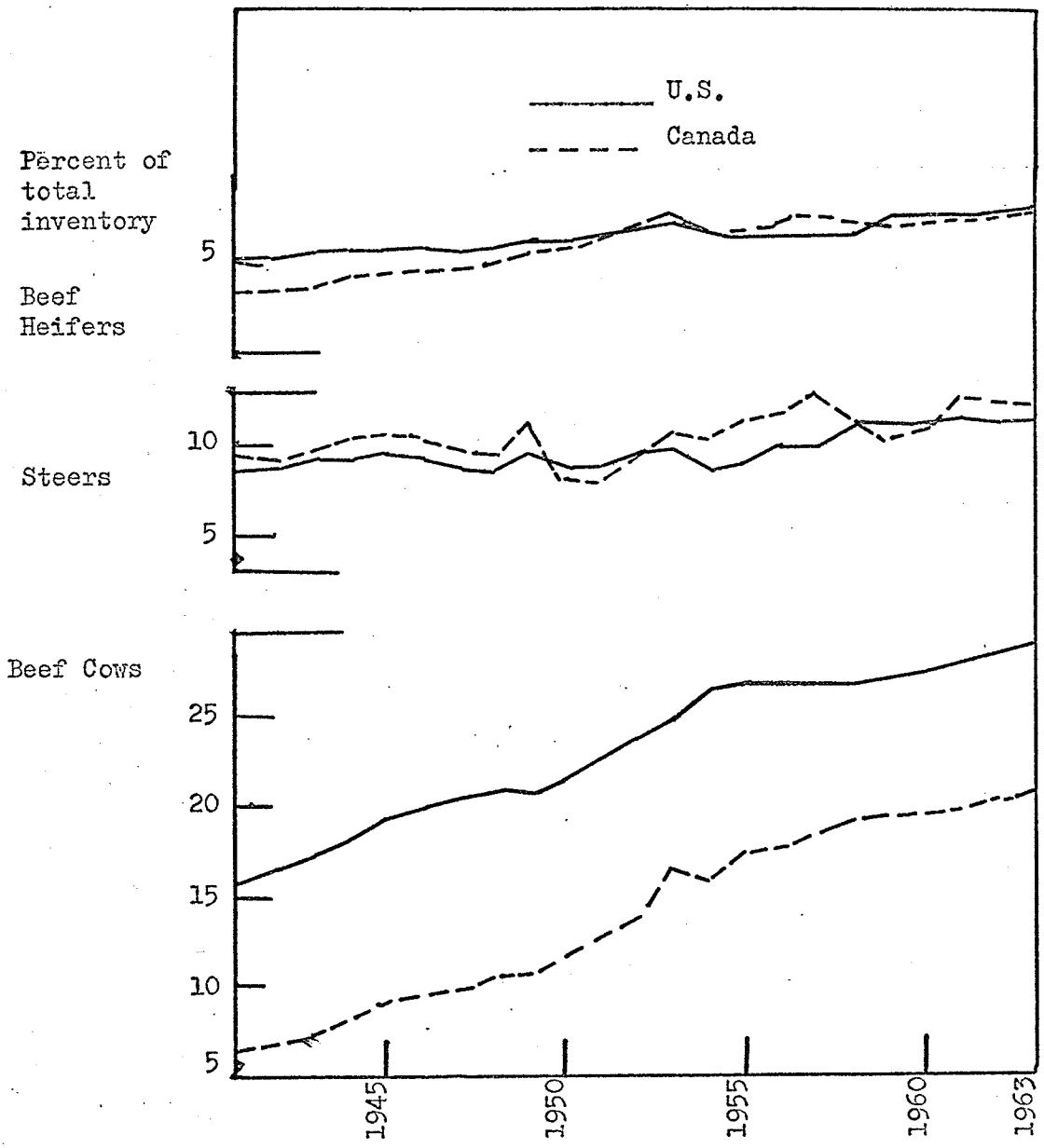

Figure 5.4a Beef Cows, Beef Heifers and Steers as percent of total inventories, Canada and U.S., 1941-63.

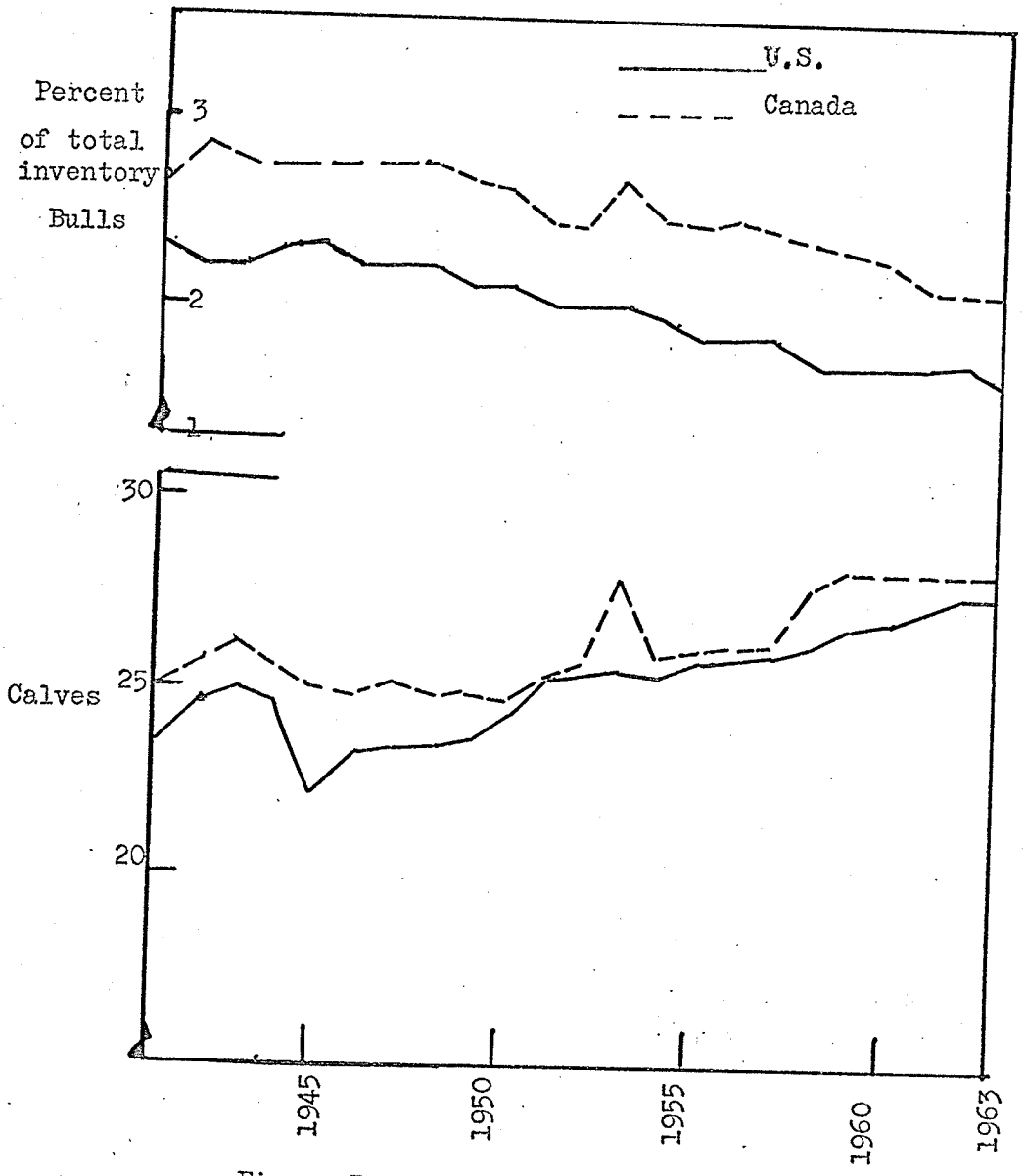

Figure 5.4b Bulls and Calves as percent of total inventories, Canada and U.S., 1941-63.

ship has been investigated, we cannot venture any conclusion to the effect that the series in the United States affect those in Canada.

Measuring and comparing productivity of cattle in the United States and Canada.

Beef and veal production can be increased in either of two ways: (1) by increasing the size of the cattle inventory; (2) by increasing output per head of animals already on farms or by combining both activities. In the United States and Canada, gains in productivity have been taking place and these might be attributed to a large number of factors.[24]

1. More calves are being born per 100 cows.
2. The beef components of the inventory are increasing as a proportion of the total inventory.
3. More calves are fed to maturity.
4. Death losses in cattle numbers are declining.
5. Changing relative importance of dairy and beef components.
6. Changes in slaughter weights.

These are all helpful guides in explaining the forces that tend to affect beef cattle production on the continent. Because cattle producers tend to respond to economic incentives and thus react to favourable or unfavourable circumstances, slaughter weights tend to move directly with cattle inventories. Cattle producers generally tend to feed available slaughter cattle to heavier weights when conditions are favourable and to lighter weights when the reverse is the case.

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[24] Cattle Market in Iowa, Iowa State Univ. Co-op. Ext. Service, M-929, May 1961, p. 13.

Fourier analysis, when applied to the slaughter weight data gives some interesting results. Cycles of medium and short-run are revealed, corresponding to similar cycles discovered for the total inventory. The results support the contention that, for the shorter cycles, slaughter weights tend to move directly with cattle inventories. (See K,4 in Table 5.3)

Average slaughter weights can also be used as a measure of productivity of cattle in the two countries. The actual and predicted values of these data are shown in Figures 5.5 and 5.6.

The fundamental objective of this chapter has been to trace out all the relevant interrelationships between the cattle industries in the United States and Canada and to demonstrate the methodological efficacy of applying Fourier analysis to cattle inventories for prediction purposes. In particular, our attention was directed towards testing the hypothesis that the Canadian cattle cycle is not internally generated, but is largely influenced by the cattle cycle in the United States. We can only speak in broad terms as it is difficult to trace out any direct causal relationship.[25] We have, however, revealed some cyclical characteristics which the two industries have in common.

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[25] Cause may be defined as a "relation between phenomenon. One event gives rise to the next; applying a certain factor brings out other definite changes; prolonging a given situation continues another." See Siu, op. cit., pp. 27ff. Causality is a nebulous concept. Cause is almost always considered as pre-existing effect. But sometimes the existence of cause cannot be observed in the effect. The familiar saying, "which came first, the chicken or the egg?" is a case in point. It is also exemplified by the acorn from which springs the great oak. In mathematics, the independent variables in an equation are considered as the cause.

Using p_t and u_{st} as prices in Canada and in the U.S., respectively,

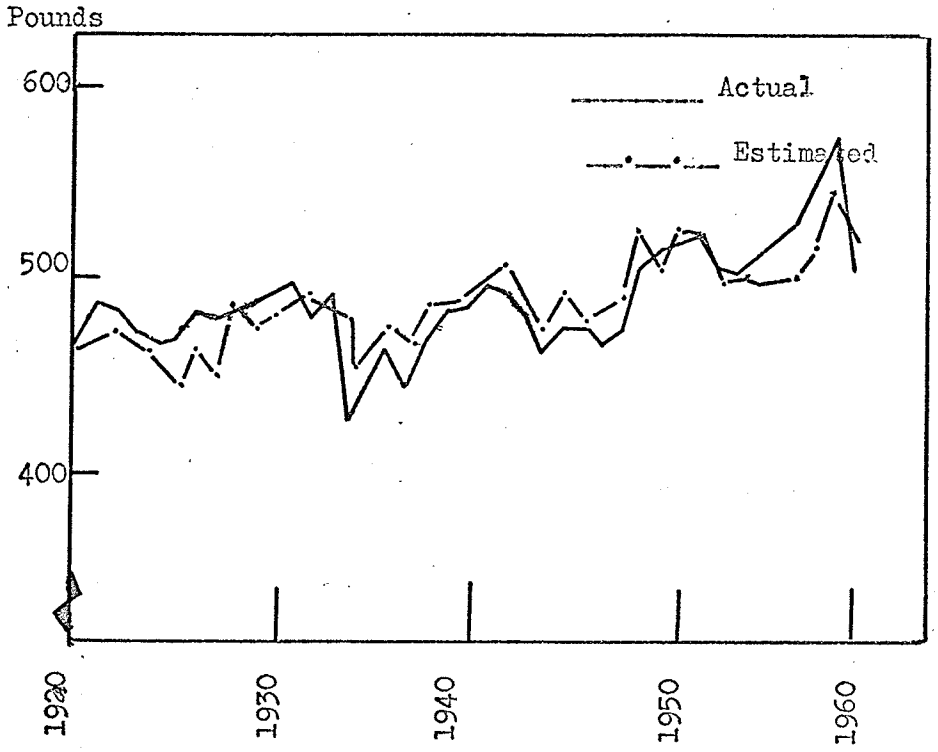

Figure 5.5a Average Dressed Weight of Cattle, U.S., 1920-60.

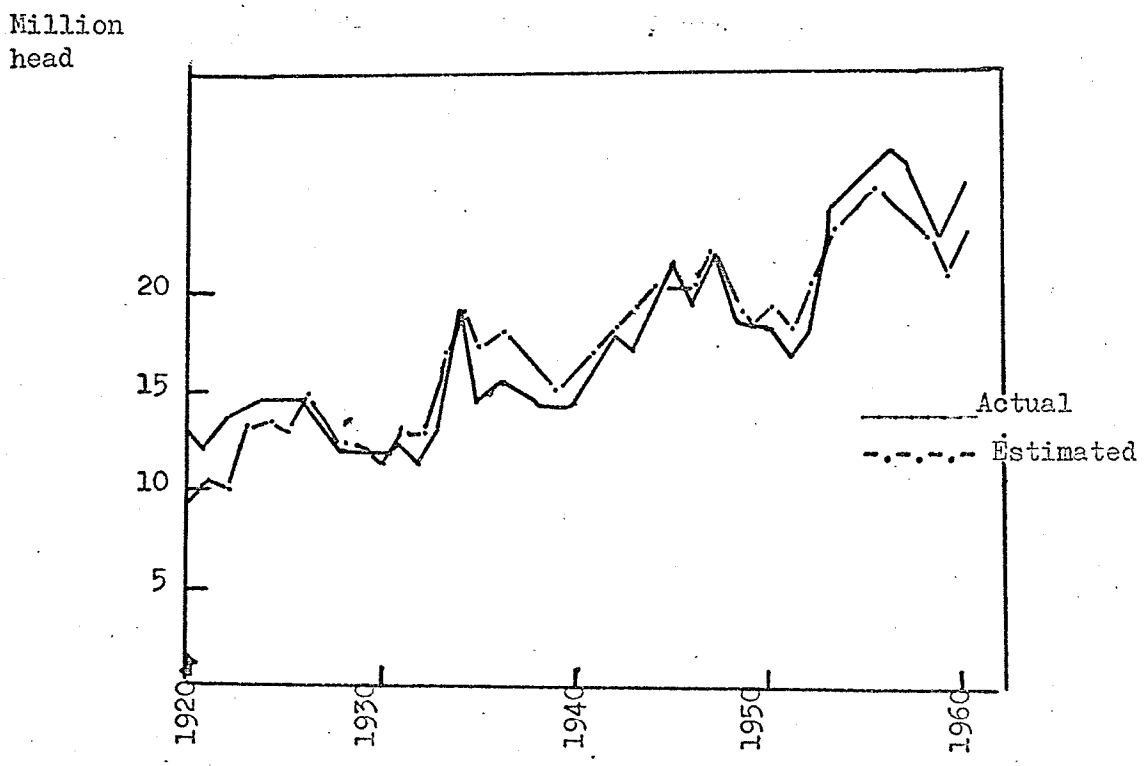

Figure 5.5 b Beef Cattle Slaughter U.S., 1920-60.

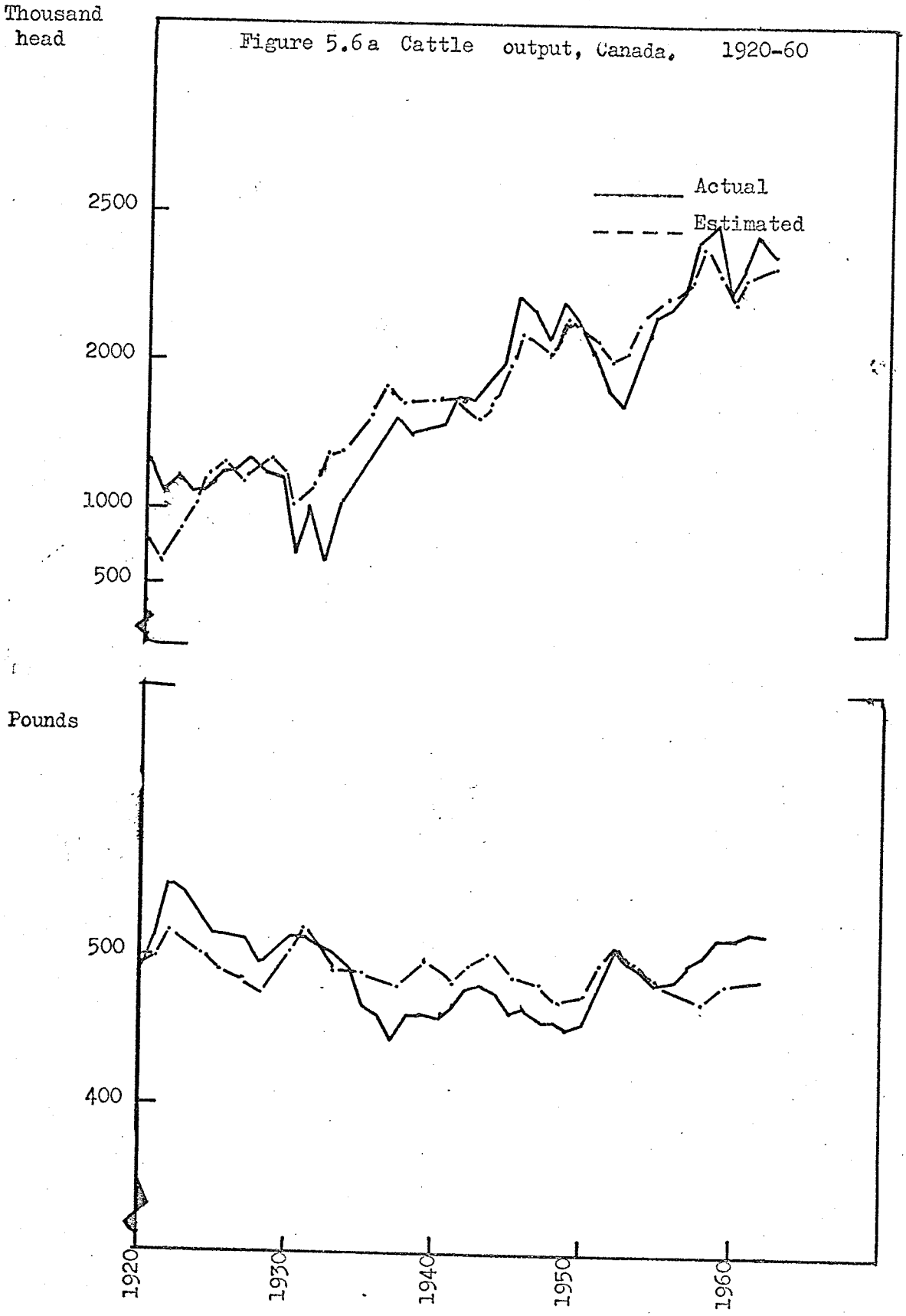

Figure 5.6 a Cattle output, Canada, 1920-60

Figure 5.6 b Average Dressed Weight of Cattle, Canada, 1920-60.

The episodic theorists claim, as noted already, that the cattle cycle is generated by forces completely outside the industry. The main practical interest in cycles stems from the need for forecasts. A cyclical theory attributed to unrelated episodes will, of course, make such a task impossible.

We assumed at the onset that there is a pattern of change inherent in the inventory series which repeats itself (with more or less variation) in successive cycles. In other words, we assumed that year-to-year variation in weather, feed prices etc., give rise to corresponding variation in cattle production. Our criterion of trustworthiness, therefore, lies in the replicability in time. After isolating the trend values from our data-- which were attributed to technological factors and previous resource inputs--spectrum analysis was performed to find out whether cycles really existed. On the basis of our findings, we were able to predict, with a

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measured a s deviations from the 'normal' or equilibrium values in period t, and q_t and I_t as quantities in Canada and in the U.S. also measured as deviations from the 'normal', the following recursive equations can be derived:

Canada

$$p_t = a\,u_{st} - b\,q_t \quad \text{..... i}$$

$$q_{t+1} = c\,p_t = c\,(a\,u_{st} - b\,q_t) \quad \text{..... ii}$$

$$= ac\,u_{st} - bc\,q_t \quad \text{..... iii}$$

$$q_{(t+2)} = ac\,u_{t+1} + (bc)^2 q_t \quad \text{..... iv}$$

U.S.

$$u_{st} = -kI_t \quad \text{..... v}$$

$$I_{t+1} = q\,u_{st} = -qk\,I_t \quad \text{..... vi}$$

$$I_{t+2} = q\,u_{st} = (gk)^2 I_t \quad \text{..... vii}$$

Hence $$q_{t+2} = \frac{ac}{g}\,[(gk)^2 I_t] + (bc)^2 q_t \quad \text{..... viii}$$

Which shows that supply and demand in the U.S. and Canada cause the cobweb phenomenon. Factors in the U.S. and Canada co-operate to produce one beef cycle phenomenon in Canada. The extent of the causality depends upon the magnitudes of the coefficients, a,c,g,k and b. Hence it depends upon the way we interprete it. If the independent variables in equation viii are taken to be the causal factors, it follows too that conditions in the U.S. co-operate to bring about the cattle cycle in Canada. However, it appears more appropriate to talk in terms of 'influence' rather than 'cause'/

high degree of accuracy the pattern of cattle production. The predicted values were in error by less than 5 percent of the long-run production on the average. Methodologically, the separation of the cattle cycles from random residuals was successfully achieved. Also, the hidden cycles of long, medium and short-period detected have been shown to have appreciably affected the annual variations of cattle production.[26]

It does not, necessarily, follow that cattle prices and production follow a somewhat regular pattern as assumed implicitly in our model. There are many influences which may retard or hasten the cyclical movement. If this were not the case, then the durations of the cyclical upswing and downswing will tend to follow a sinusoidal pattern and our theoretical formulation will approximate the real world situation. But there have been several influences at work which have tended to modify the cattle cycle. These influences have caused the beef cattle cycle at times to be interrupted and reversed in several particulars instead of completing its normal cyclical course. These influences are attributed to unrelated events or episodes, each of which happened but once, and none of which would have been comprehended in a cyclic explanation. Among the influences which retard or hasten cyclical movements may be listed:

1. Drought with its accompanying shortage of feed and fodder.
2. Abrupt changes in domestic and foreign demand may hasten or retard cyclical movements of prices.

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[26] i.e., as developed by the cyclical indexes.

3. Changes in marketing and production policies, sometimes supported by government action may influence the duration of a cycle.

In Canada, the downturn in inventories in the late 1930's, and particularly in 1937 was influenced by drought conditions as well as abnormally low prices. In the United States, the effect of severe drought in 1934 was a major factor in causing the premature downturn in cattle inventories. War time policies affecting both meat and feed grains as observed in the previous chapter, influenced the upturn in cattle numbers in Canada.[27] The downturn in the second half of the 1940's was to a greater degree caused by the high opportunity cost of converting grain into feed and the general producer expectations of a sharp decline in beef prices after the war.

Since 1950 in Canada and 1949 in the United States, there have been some unique changes in cattle numbers and marketings. The unprecedented length of the upswing seems to defeat any prediction that one could make as regards the cattle cycle.[28] From 1950 to 1962 in Canada, cattle numbers increased by some 3.7 million or about 46 percent. Parallel developments also took place in the United States. In both countries the entire inventory increase is contained in the beef component, i.e., excluding milk cows and heifers. The obvious explanation appears to be the

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[27]Vide, chapter IV, pp. 18-20. Policies with respect to meat and feed grains largely accounted for the cattle build up in Canada. See also L. Marchall, op. cit., p. 19.

[28]This is not necessarily the case if all factors are reflected in the model.

expanding markets on the North American continent, particularly in the United States. The removal of beef cattle trade restrictions, which was made possible by the Reciprocal Trade Agreement was a factor in influencing production.

Historically, Canadian cattle prices have been strongly influenced by cattle prices in the United States.[29] There have been temporary deviations from this tendency, but the general picture has been that the two prices have been moving up and down together. A comparison of the cyclical indexes for inventories and prices helps to reveal the interaction of the two factors. High Canadian marketings are not necessarily associated with low domestic prices because the flow of surplus cattle to the south eases the downward pressure on domestic prices. To the extent that the Canadian prices are not independent but are largely influenced by prices in the U.S., there is a determinate causal relationship between the cattle price cycle in the United States and the price cycle in Canada. In this case, we can conclude that the Canadian beef cattle price cycle is indirectly generated in the United States.

It has not been possible in our analysis to confirm or refute the cyclical theories mentioned previously. The reason for cyclicality is not quite as apparent as is normally assumed to be. James H. Lorie stresses "the interrelationships among value, marketings and numbers on farms (or production)".[30] This is clearly a 'cobweb' phenomenon.

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[29]Marshall, op. cit., p. 20.

[30]James H. Lorie, Causes of Annual Fluctuations in the Production of Livestock and Livestock Products, Chicago, University of Chicago Press, 1947.

J.A. Hopkins, on the other hand, attributes the major swings in production to episodic influences.[31] All we can venture to say is that there is a truly cyclical nature of cattle production in Canada and in the U.S. (as revealed by the application of the Modified Fourier analysis to the residuals), but the episodic influences are also present and they seem to affect the length or emphasize the degree of cyclical movements of cattle prices.[32] Cycles of long, medium and short-period (i.e., k = 4,7,15 and k = 4,9,16 for U.S. and Canada respectively) identified can partly be accounted for by the operation of episodic forces. i.e. whether the length of each cycle is longer or shorter than what a truly 'cobweb' phenomenon will bring about. In other words, the episodic influences can be considered a weighty factor in giving each historic cycle its own peculiar characteristics.

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[31]Hopkins, op. cit., pp. 351-54.

[32]F.L. Thomsen, Agricultural Prices, McGraw-Hill Book Co. Inc., 1936, p. 360.

CHAPTER VI

ELASTICITIES OF EXPORTS OF BEEF CATTLE TO THE UNITED STATES

In chapter I it was pointed out that the long stretch of border between the United States and Canada makes it possible for differing price differentials to exert different influences on shipments across the various points on the border. In this chapter an attempt will be made to estimate the precise price differentials and relative prices which will initiate flows of cattle across the border.

Sources of data.

The strategic variables used in this analysis were the relative prices and price differentials between the major cattle markets in the United States and Canada on one hand, and the numbers shipped monthly from Canada into the United States. These shipments were broken down into two classes to reflect movement in the slaughter and feeder cattle markets. The nature of the statistics relevant to estimating cattle shipments imposes limitations on the thoroughness with which models can be constructed. The statistics available from Canadian sources are culled from the "Weekly Livestock Market Report" published by the Department of Agriculture, Canada. The monthly data for other explanatory variables are not readily available; hence it was deemed expedient to formulate a theory in such a way that it could be tested and evaluated by readily available data.

The "Weekly Livestock Market Report" is about the only source which spells out separately the components of the cattle shipments from Canada to the United States. The sources of these flows i.e., whether from East

or West Canada are also specified.

The data from the United States sources were obtained mainly from the "Livestock and Meat Situation" and the "Livestock Products Statistics"--the annual supplements published by the Economic Research Service, U.S. Department of Agriculture.

The prices of choice steers at Toronto and Chicago were used to estimate the elasticities of fed cattle export response originating from both East and West Canada. On the other hand, the prices of good feeders and stockers at Toronto, Winnipeg, Chicago, Omaha and St. Paul were used to estimate export elasticities for feeder cattle.

Model

As an indicator of the nature of geographical flows, there were two choices open to us. One was to use monthly price ratios as independent variables and monthly exports of cattle as dependent variables in simple regression equations. The other technique employed price differentials for the same purpose. The absolute magnitudes of these price differentials generally provide a most convenient way to estimate the exact price differential that is expected to initiate a flow of cattle from Canada to the United States. Some analytical difficulties were encountered when using the real price differentials instead of the absolute figures.[1]

An assumption of ceteris paribus underlies all the analysis. For short period elasticity estimates, this assumption is fairly realistic.

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[1] i.e., by ignoring the plus or minus signs.

Later on in the next chapter, this assumption will be dropped when annual data are considered.

There appears to be two approaches for estimating seasonal supply and demand equations based on monthly or quarterly data. Either method requires separate supply equations to be derived for each season or month and then the coefficients in each equation are tested to see whether they differ significantly among months or seasons. By so doing the effect of any class differences could be determined.

The first model requires the use of the total (pooled) set of observations and the introduction of dummy variables as shift parameters.[2] The dummy variables allow for changes in the intercepts, changes in the slope coefficients or both. Zero-one variables are commonly used but there could be some variations when logarithmic transformations are used. The main advantage of using the dummy variable approach is that the pooling of the data increases the degree of freedom used for testing for the significance of the estimated pooled coefficients.

The other model, and the one used in this chapter, is to estimate separate equations for each class. Tests of hypotheses are made for the class differences in the estimated equations. The assumptions made in this connection are as follows:

1. The means of the disturbance terms in each class are zero.

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[2] Shaul Ben-David and William G. Tomek, Allowing for Slope and Intercept Changes in Regression Analysis. A.E. Res. Bull. 179, March 1965, Dept. of Agric. Econ., Cornell Univ. Agric. Station, p. 3. See also J. Johnston, Econometric Methods, McGraw-Hill Book Company, Inc. 1963, pp. 106-108, 115 and 136.

2. The variances are constant and independent of the independent variables.

3. The various values of the disturbance terms are independent.

For tests of hypotheses, the usual assumptions employed are that:

1. The error variances are the same for the sub-groups.

2. The error variances are normally distributed.[3]

In addition, it should be recognised that the least squares method when applied equation by equation, yields efficient estimates only if the disturbance terms of the separate equations are independent (zero covariance) or if the separate regressions have the same independent variables.

It may happen that these assumptions are not fully met.[4] It is, however, permissible to estimate for each equation the variances of the disturbance terms and covariances among the disturbance terms for the group equations.

Zeller and Scheffe have discussed the consequences of a violation of some of the assumptions.[5] Zeller also discusses a model which applies to a more general case where separate equations do not contain the same independent variables and where the covariances are not zero. In the

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[3] Shaul, op. cit., p. 4.

[4] Henry Scheffe, The Analysis of Variance, John Wiley and Sons, Inc., 1959. In Chapter 10, in particular, he discusses the consequences of a violation of some of the assumptions.

[5] A. Zeller, "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias", J. Am. Stat. Assoc. June 1962, pp. 348-351.

model being used here, the regression equations for each group of years will be pooled using regression analysis. Covariance analysis will be used to test for the homogeneity and the significance of the 'within groups' regression coefficients.

A simple linear regression model to estimate the coefficient 'b' was formulated as follows:

$$Q_{1i} = A_{R1i} + B_{R1i}R_{1i} + E_{R1i} \qquad (1)$$

$$Q_{nm} = A_{Rnm} + B_{Rnm}R_{nm} + E_{Rnm}$$

and $$Q_{1i} = A_{D1i} + B_{D1i}D_{1i} + E_{D1i} \qquad (2)$$

$$Q_{nm} \quad A_{Dnm} + B_{Dnm}D_{nm} + E_{Dnm}$$

where =

A_R = Intercept using price ratios as the independent variable

A_D = Intercept using price differentials as the independent variable

b_R = Regression coefficient using price ratios

b_D = Regression coefficient using price differentials

R = Price Ratio

D = Price differential

E_R = Error term using price ratio

E_D = Error term using price differential

Q = Numbers shipped in individual years.

Using S_i to represent price in a market in Canada and T_i to represent price in a market in the U.S., a regression equation using price ratios could be written as follows;

$$Q_R = A_R + B_R \left(\frac{S_i}{T_i}\right) + E_R \qquad (3)$$

and a regression equation using price differentials is represented by:

$$Q_D = A_D + B_D \left| T_i - S_i \right| + E_D \qquad (4)$$

Where $Q_D = Q_R$ = numbers shipped

More specifically, equations (1) and (2) could be written as follows:

$$Y = a_R + b_R X_R + E_R \qquad (5)$$

$$Y = a_D + b_D X_D + E_D \qquad (6)$$

Where $X_R = \frac{S}{T}$ and $X_D = T-S$ as above.

The elasticities estimated refer to the mean values of X_R and X_D respectively.

i.e. $$E_R = b_R \cdot \frac{\overline{X}_R}{\overline{Y}_i} \qquad (7)$$

and $$E_D = b_D \cdot \frac{\overline{X}_D}{\overline{Y}_i} \qquad (8)$$

$$\overline{Y}_i = \Sigma Y_i / n$$

ϵ_R and ϵ_D represent the elasticities estimated from price ratios and price differentials respectively.

For the beef cattle shipments between two marketing points in Canada and in the United States, these two elasticities were estimated. The relationship between them could be demonstrated mathematically as follows:

Letting b_{pR} and b_{pD} as the pooled regression coefficients for the price ratio and price differentials, equations (7) and (8) could be re-written as follows:

$$\epsilon_R = b_{pR} \cdot \frac{\overline{\left(\frac{S_i}{T_i}\right)}}{\overline{Y}_i} \qquad (9)$$

$$\epsilon_D = b_{pD} \cdot \frac{\Sigma \left| T_i - S_i \right| / n}{\bar{Y}_i} \qquad (10)$$

From (9), $$\bar{Y}_i = \frac{b_{pR} \cdot R_i}{n \epsilon_R} \qquad (11)$$

and from (10) $$\bar{Y}_i = \frac{b_{pD} \cdot D_i}{n \epsilon_D} \qquad (12)$$

$$\therefore \frac{b_{pR} \cdot R_i}{n \epsilon_R} = \frac{b_{pD} \cdot D_i}{n \epsilon_D} \qquad (13)$$

hence we have $$\frac{b_{pR}}{b_{pD}} = \frac{\epsilon_R \cdot D_i}{\epsilon_D \cdot R_i} \qquad (14)$$

Equation (14) could be arranged in several ways as follows:

$$\epsilon_R = \frac{b_{pR} \cdot R_i \ \epsilon_D}{b_{pD} \cdot D_i} \qquad (15)$$

$$\epsilon_D = \frac{b_{pD} \cdot D_i \ \epsilon_R}{b_{pR} \cdot R_i} \qquad (16)$$

and $$\frac{\epsilon_R}{\epsilon_D} = \frac{b_{pR}}{b_{pD}} \cdot \frac{R_i}{D_i} \qquad (17)$$

where $R_i = \Sigma \left(\frac{S_i}{T_i} \right)$, $D_i = \Sigma \left| T_i - S_i \right|$, ϵ = Elasticity. In the context these relationships always hold.

There are two situations where either of the two elasticity estimates ceases to be useful. Firstly it is possible for the price ratio to remain the same but the differentials in absolute terms vary. e.g.

Year	1	2	3
Toronto price	20	40	80
Chicago price	30	60	120
Ratio $\frac{S_i}{T_i}$	.66	.66	.66
Differential $T_i - S_i$	10	20	40

Secondly, the differential remains the same but the ratios vary over time. e.g.

Year	1	2	3
Toronto price	20	30	40
Chicago price	30	40	50
Differential	10	10	10
Ratio	.66	.75	.80

These are the differences inherent in the elasticity estimates with respect to price differentials and price ratios. It is, however, clear from the illustrations that the above situations are important only when large changes are considered. These are possible for annual prices ratios and price differentials. But the period of 1 year embodied in our analysis is such that only marginal variations in prices take place. Generally, the differentials between two markets in the U.S. and Canada fluctuate around the total marketing costs of about $3. The difficulties described above are therefore not likely to arise.

These elasticities, whether estimated from price ratios or price differentials can be used to predict the pattern of geographical flows of beef cattle across the border. Estimates based solely on price differentials have an added advantage in that they do help in measuring

the profitability of the export trade. Aside from this consideration, it is only a matter of judgement as to whether one is to use the elasticities based on relative prices or price differentials.

Although the two markets in the United States and Canada are spatially separated, the existence of a differential is no guarantee that trade will take place. In theory, for trade to take place, the marketing costs included in each transaction must be less than the differential. Otherwise there can be no advantage in effecting trade. The principal components of these marketing costs are the tariff rates, the exchange factor and transportation and handling costs. The last item includes freight, local handling charges, custom brokers, and commission charges. It has been estimated that these together vary between $1.50 and $1.75 per hundredweight of cattle shipped.[6] There are marginal variations in these figures, depending upon the method adopted in each instance. These quoted prices are only conservative estimates and a separate study is needed to estimate them precisely.

As already noted, the tariff for fed cattle, for example, is $1\frac{1}{2}¢$ per lb. or $1.50 per hundredweight. All the U.S. prices used in this study were multiplied by the appropriate exchange factor to convert into Canadian dollars. The price differentials and price ratios used here were adjusted for exchange rates. The remaining two components of costs amount to some $3.00 per hundredweight. Whether trade, in theory, will take

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[6] A Letter on Canadian Livestock Products, published by the Meat Packers Council of Canada, No. 2, March-April 1960.

place or not will depend upon whether the differential is higher than or lower than $3.00 per hundredweight.

The above conclusion can be interpreted to be an ideal one. It depends on the assumption of rationality in behaviour. In practice, it does not always work. There are positive evidences to the fact that trade takes place at times even when the differential is within the "no trade" region. Examples from the monthly shipments of slaughter cattle from Eastern Canada and corresponding monthly price differentials between Chicago choice steers and Toronto choice steers, will suffice to illustrate this point. (Table 6.1).

TABLE 6.1

MONTHLY SHIPMENTS OF BEEF CATTLE TO THE U.S. AND CHICAGO-TORONTO PRICE DIFFERENTIAL

Month	1960		1962	
	Shipments	Differential[a]	Shipments	Differential[a]
	Number	$	Number	$
Jan.	0	1.48	0	.96
Feb.	26	2.56	2	2.89
Mar.	466	3.82	1070	3.80
Apr.	415	3.58	1729	3.57
May	1624	3.44	3433	2.59
June	785	1.96	581	1.09
July	91	.63	19	.75
Aug.	57	.35	18	1.77
Sept.	1	.46	31	2.76
Oct.	0	.71	45	2.24
Nov.	5	1.24	19	2.96
Dec.	7	1.80	614	2.84

Source: Compiled from the Livestock and Meat Trade Report, Weekly Market Review, Canada Department of Agriculture.

[a] In $ Canadian. The differential was calculated to be Chicago choice steer prices minus Toronto choice steer prices.

Not too strong a case can be developed to support this contention, however. The slaughter cattle shipments used in our analysis were assumed to be of choice grade throughout. This is not altogether true as cattle of other grades too are exported. As the above figures show, there were shipments at times when the differentials were lower than $3.00 per hundredweight. It is conceivable that these figures show exports of slaughter cattle that were not of the choice grade. Again, we can only speculate, as the available statistics do not specify the various components of slaughter cattle exports. However, judging from the numbers shipped in May of 1962 and June of 1961, it is difficult to conclude that some choice slaughter steers were not involved.

How do we explain this anomoly? Any tangible explanation strikes at the root of perfect competition postulates. Enough of this was discussed when the assumptions underlying the theoretical model were introduced in Chapter 3.

Generally, buyers in the United States initiate the cattle trade with Canada. They issue orders to commission firms in Canada who maintain a close liason with the parent body in the U.S. Slaughter cattle, for example, are bought on orders for packers in the United States but some are also exported from feed lots in Ontario to public markets in the United States on consignment. These large packing companies may be prompted by motives other than profit maximization attributed to the homo economicus. The adherence to a traditional source of supply and the desire to appease and retain their clients in Canada could motivate their decisions to keep on buying from Canada at the time the

price differential appears to preclude such a move. There is also the fact noted earlier that cattle prices vary from day-to-day, week-to-week and month-to-month. The volatility of these prices could make it possible for the differentials to drop substantially while a particular consignment is enroute.

A different situation exists for feeder cattle. Order buyers in the prairies report that cattle prices must be at least $5.00 per hundredweight below those in the United States Corn Belt before export to that market can be profitable. (This figure includes the exchange factors) For feeders, the prospective prices of fed cattle for a particular lot of cattle purchased now may be a more weighty consideration than the current price differential. (Feeder buyers in the U.S. will, of course, buy at home if it is more profitable for them to do so.) Besides, the operation of the Chicago Beef Cattle Futures has introduced more complexities into the price making forces for feeder cattle. The impact of the Beef Cattle Futures Market on the market in both countries need to be investigated by a separate study. The Chicago Futures market is ignored in this analysis as it was not in operation during the period under consideration.

Broadly speaking, before starting a new feeding program, the operator will have three major things to concern himself about: the fed cattle prices from three months to a year in the future, the feeder cattle prices themselves, and the cost of converting feed into meat. The available supply of cattle and the demand for beef influence these factors. Considering these facts, it is probably true that trade takes place at

the time the differential does not encourage such a move.[7]

Beef cattle trade between the U.S. and Canada as a consequence of geographical location, relative prices and price differentials has already been discussed. Other factors such as adherence to a traditional market and seasonal conditions also appear to be important. The rest of this chapter will be devoted to discussing the theoretical soundness and the practical reasonableness of the conclusions drawn from the operation of these factors.

TABLE 6.2

EFFECTS OF SELECTED FACTORS ON BEEF CATTLE SHIPMENTS FROM CANADA TO THE UNITED STATES, 1960-65[a]

Selected Factor	Elasticity of Exports of Beef Cattle to the U.S.		
	Slaughter Cattle		Feeder Exports
	From West	From East	From West
Effects on shipments of a one percent change in:			
Toronto-Chicago Choice Steer			
Price ratio	-6.41	-15.73	-
Price differential	.452	1.52	-
Toronto-Chicago Good Feeder			
Price Ratio[b]	-	-	-3.91
Price differential	-	-	.58
Winnipeg-Omaha Good Feeder			
Price ratio	-	-	-7.90
Price differential	-	-	.85
Winnipeg-St. Paul Good Feeder[b]	-		
Price ratio	-	-	-1.80
Price differential	-	-	.04

[a]Based on statistical regression analysis using monthly data.

[b]Coefficients do not differ significantly from zero when tested at the 5% level.

[7]In the sense that the differential must cover total handling costs before shipments can be profitable.

The elasticities of export response estimated from the simple regression equations are shown on Table 6.2. The elasticities are greater for slaughter cattle shipments than for feeder cattle shipments. For feeders, separate elasticities were estimated for exports originating in Western Canada based on Winnipeg--Omaha and Winnipeg--St. Paul price ratios and price differentials. Estimates were also made for the same volumes of shipments and Toronto-Chicago feeder cattle price ratios and price differentials. A similar procedure was adopted to estimate elasticities for fed cattle shipments. In general, cattle prices in the Prairies tend to be based on the Toronto market minus freight and handling costs to that market. The Toronto market serves as an important outlet for prairie cattle competitive with the markets in the United States. The levels of prices in Toronto and Chicago are important indicators of the direction of flow, of shipments from West Canada. Six year monthly averages of shipments from Canada to the U.S. are plotted in Figure 6.1.

Statistical bases for conclusions

The regression analysis for fed cattle shipments to the U.S. using Toronto and Chicago choice steer price ratios will be used in this section to illustrate the procedure followed. In all, six regression equations using monthly data for individual years for the period 1960-1965 were run. The symbols 'x' and 'y' were used to represent deviations from the means--X being the price ratio and Y the numbers exported.

$$\Sigma x^2 = \Sigma(X - \overline{X})^2$$

$$\Sigma y^2 = \Sigma(Y - \overline{Y})^2$$

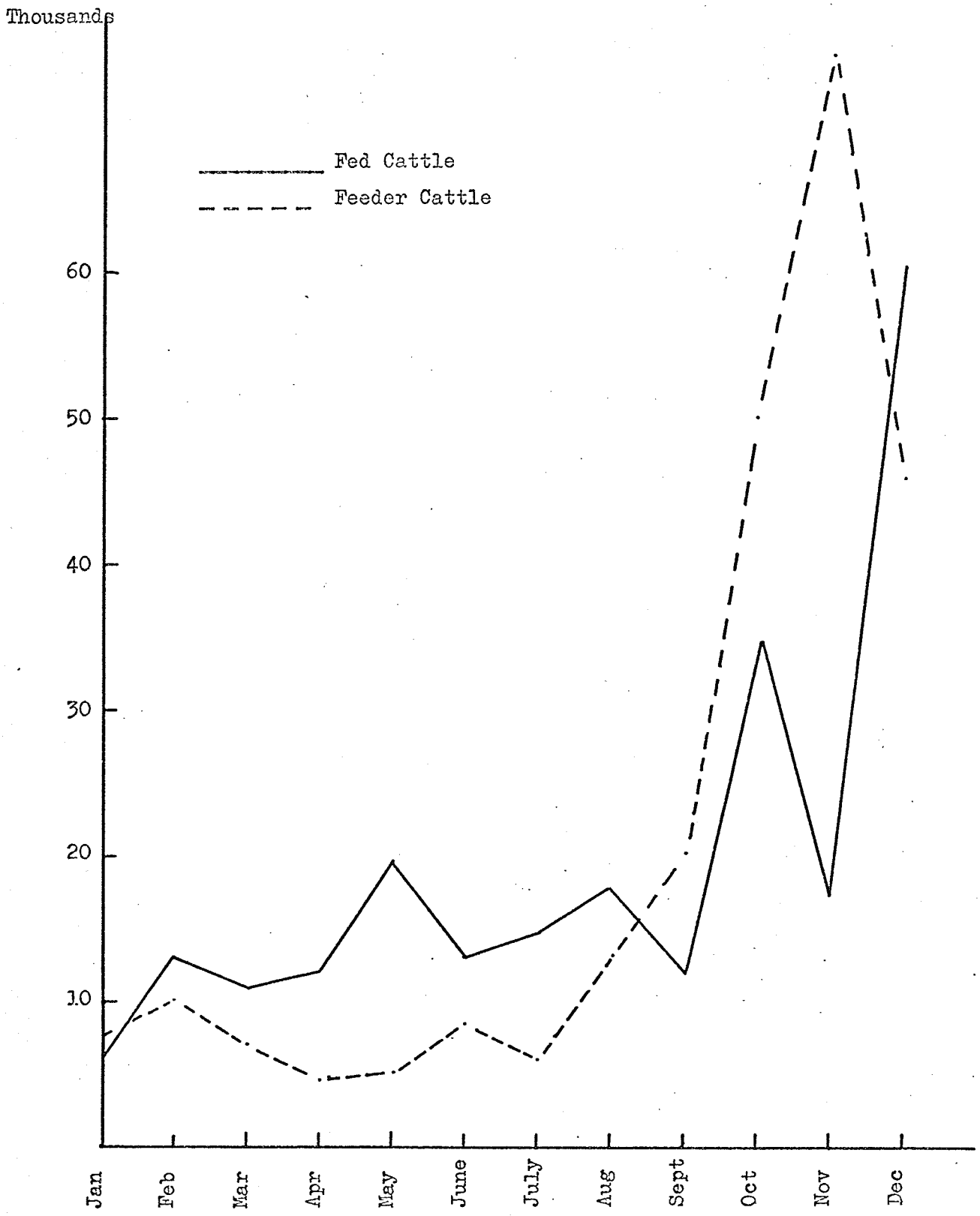

Figure 6.1. Six Year Averages of Beef Cattle Exports to the U.S., 1960-65.

Source: Based on data obtained from Weekly Livestock Market Report.

$$\Sigma xy = \Sigma(X-\bar{X})(Y-\bar{Y})$$

The regression 'b' for each individual year is measured as follows:

$$b_i = \frac{(\Sigma xy)_i}{(\Sigma x^2)_i}$$

To facilitate pooling, the columns showing the Σx^2 were summed up and those for Σxy were also added together. The pooled regression coefficient was therefore shown to be represented by

$$b_p = \frac{\sum_{i=1}^{6} (\Sigma xy)_i}{\sum_{i=1}^{6} (\Sigma x^2)_i}$$

The total regression coefficient, b_T, was computed from the 72 observations taken together. (Table 6.3)

Statistical test of significance

Referring to the analysis of covariance table, it could be observed that only three of the within-year regression coefficients are significant at the 5% level.[8] By pooling, we obtain a regression estimate which, upon further testing, could be used as the working coefficient to obtain the supply elasticities.

We have three major tasks to perform here. First we test to find out whether pooling is permissible. Secondly we investigate to find out whether the pooled regression coefficient is significnat or is a better estimate than the total regression coefficient. And thirdly, we shall test for the significance of the distances between the regression lines.

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[8] See Table 6.4.

TABLE 6.3

REGRESSION ANALYSIS

SLAUGHTER CATTLE SHIPMENTS FROM WESTERN CANADA (1960-1965)

PRICE RATIO (CHOICE STEER) TORONTO-CHICAGO

Year	x^2	xy	b	a	$\bar{x}$	$\bar{y}$
1960	331.15	- 62.09	- .19	20.03	93.49	2.50
1961	106.45	- 25.87	- .20	22.80	95.71	3.14
1962	129.15	- 2.64	- .02	3.81	92.06	1.94
1963	257.59	- 35.10	- .14	13.96	96.75	.77
1964	648.39	- 78.00	- .12	12.70	97.05	1.03
1965	61.22	- 7.52	- .12	13.80	89.76	2.02
Pooled Regression	1,533.95	-211.23	- .14	—	94.14	2.02
Total Regression	2,033.79	-301.79	- .15	15.96	94.14	2.02
		PRICE DIFFERENTIALS				
1960	17.40	9.24	.53	1.27	1.84	2.25
1961	36.77	14.19	.39	2.51	1.61	3.14
1962	11.15	.48	.04	1.92	1.01	1.94
1963	12.41	7.96	.64	0.03	1.16	.77
1964	15.14	9.78	.64	-	-	1.03
1965	6.15	5.38	.87	.26	2.87	2.02
Pooled	99.02	47.03	.47	-	1.74	2.02
Total	120.70	66.42	.55	.93	1.74	2.02

TABLE 6.4

ANALYSIS OF COVARIANCE Fed Cattle Shipments from Western Canada

Year	TSS=Σy^2	SSR=$b\Sigma xy$	SSE=$\Sigma y^2 - b\Sigma xy$	D.F.	Numerator	Denominator	F Ratio
PRICE RATIO (CHOICE STEER) TORONTO-CHICAGO							
1960	29.16	11.64	17.52	10	11.64	1.75	6.64*
1961	82.23	4.49	77.73	10	4.49	7.77	0.58
1962	21.88	0.05	21.83	10	0.05	2.18	0.02
1963	9.05	4.78	4.27	10	4.78	.43	11.20**
1964	19.58	9.38	10.19	10	9.38	1.02	9.21**
1965	80.84	.92	79.92	10	.92	7.99	.12
Within years	-	-	211.46	60	-	3.52	-
Diff. between slopes	-	-	22.24	5	4.49	-	1.26
Pooled Regression	242.74	9.04	233.70	65	9.04	-	2.57*
Distance between lines	-	-	19.54	5	3.91	-	1.11
Total regression	277.10	44.58	253.24	70	44.58	-	12.83**
Residual			230.99	65	-	3.56	
PRICE DIFFERENTIALS							
1960	17.53	4.91	12.62	10	4.91	1.26	3.89
1961	82.23	5.48	76.75	10	5.48	7.67	0.71
1962	19.02	0.02	19.01	10	0.02	1.90	0.01
1963	9.05	5.11	3.94	10	5.11	0.39	10.95*
1964	19.65	6.32	13.32	10	6.32	1.33	4.74
1965	80.84	4.71	76.13	10	4.71	7.61	0.62
Within years	-	-	201.78	60	-	3.36	-
Difference between slopes	-	-	4.21	5	.84	-	2.39
Pooled regression	228.33	22.34	205.99	65	22.34	-	6.64
Distance between lines	-	-	39.78	5	7.96	-	2.36
Total regression	282.23	36.56	245.67	70	36.56	-	10.42**
Residual	-	-	241.46	65	-	3.75	

** Significant at 1% level * Significant at 5% level

The size of the vertical distance between the lines is taken to represent the impact of seasonal conditions on the shipments for the period considered.

An analysis of covariance table is set up as shown in Table 6.4.[9] TSS represents the total sum of squares given by

$$\Sigma(Y - \bar{Y})^2 \quad \text{or} \quad \Sigma Y^2 - \frac{(\Sigma Y)^2}{n}$$

SSR indicates the sums of squares attributed to regression and is also given by

$$\frac{(\Sigma xy)^2}{\Sigma x^2} \qquad = b_{\Sigma xy}$$

SSE, the sum of squares due to error is thus

$$\text{SSE=TSS-SSR} \quad \text{or} \quad \Sigma y^2 - b\Sigma xy$$

The SSR attributed to the pooled regression is given by

$$b_p \sum_{i=1}^{6} (\Sigma xy)_i$$, where b_p is the pooled regression coefficient.

To find out whether the pooled regression coefficient (b_p) is warrantably a useful measure, we test for the homogeneity of the six 'within-year' regression coefficients. This is done to find out whether the b's could be considered to be estimates of a common β.[10] We are concerned here to find out whether the six lines have the same slope, not that they are the same line. Geometrically, this means that the regression

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[9]See Ostle, Bernard, Statistics in Research, 2nd Ed. 1963, p. 203. See also K.L. Kinsman, 'A Note on the Elasticity of Supply', Australian Quarterly Review of Agric. Economics, Vol. XVIII, No. 2, p. 81.

[10]Torrie and Steal, Principles and Procedures of Statistics, McGraw-Hill Book Company, 1960, p. 173.

lines are parallel.

For each regression equation, the values of the TSS, SSR and SSE are computed. This procedure makes it possible to eliminate variations within years and variations due to pooled regression, thus leaving us with the sum of squares due to differences between the regression coefficients. We test this by the mean square 'within-years' to obtain our F-ratio, which, if significant, rejects the hypothesis of the homogeneity of the regression coefficients. In the above illustration, and in subsequent ones, the null hypothesis is accepted and thus pooling is warranted.

Next we employ the F statistic to tes t for the significance of the pooled regression coefficient (b_p). We do this by making use of an estimate of variance based on the sum of squares within years. To obtain this, we total the residual sums of squares for the individual years and, in our example, this has 60 degrees of freedom. Divided by the mean square 'within years', we obtain the required F-ratio.

The hypothesis being tested here is that B=0. A large F-Value indicates that B is different from zero and a small value of B shows that B=0. The hypothesis of B=0 implies that the means of all the arrays are equal regardless of the value of X. If this is true, we conclude that in our model, the average shipments do not vary with the price ratios. All we can then infer is that our model has not worked.

In some cases, the pooled regression coefficient has been shown to be not significant at 5% level. Very little or no confidence can therefore be placed on the estimated elasticities. Whenever the pooled regression coefficient has been shown to be not significant but the total

regression coefficient is significant, the latter is used to estimate the elasticity.

We next test whether it is permissible to obtain a regression based on a maximum of 71 degrees of freedom. In our illustration, the sums of squares left for testing the total regression (230.9983) is the residual from the total sums of squares (277.0997) and the difference between regression coefficients (22.2406). With 65 degrees of freedom, the estimate of the variance is 3.52. The F ratio is 12.8, and the regression is highly significant.

After removing the residual sums of squares we are left with that portion of it which is due to variations 'within years'. The remainder (19.5364), is due to distances between lines of the regression equations for the individual years. The F ratio of 1.1087 is not significant and hence, the total regression coefficient could also be used.

The term 'distances between lines' provides a useful tool for evaluating the influences of seasonal conditions on shipments. Using the equation $Y-\bar{y} = b_p (X-\bar{X})$, regression lines have been drawn for each year. Straight lines are drawn through the mean values of X and Y. The vertical distances between the lines are attributed to differences in the number of shipments for the various years after making allowance for the effect of differences in the average price ratios characterizing those years. Generally, it is assumed that the residual differences are the results of seasonal conditions.

For the years considered it is possible, using this technique to measure objectively a particular season's effects on shipments. This is

done by adjusting the average monthly shipments for each year in such a way as to discount the effect of variations in price due to either the price ratio or price differential. To do this, we read from the graph (Figure 6.2) at the points of intersection with the various regression lines, the height of the ordinate standing on the six-year average price ratio or differential.[11] The adjusted averages are shown on Table 6.5. Taking each column of figures separately, the differences between the adjusted averages for the various years can be interpreted as a measure of differences attributable to seasonal conditions between years.

On the basis of this analysis, it could be inferred that seasonal conditions for the period are improving, or are stable. The statistical test of significance for differences between lines are, in the above illustration, not significant. But this is only a statistical measure. The actual values, represented by the numerical size of the differences for the years and the vertical distances are substantial. Lack of significance of the statistical measure could be explained by the fact that, on the average, the differences tend to cancel out. For example, the seasonal influences are large between 1960 and 1961. The period 1961-1962 shows greater seasonal affects. The 1962-63, and 1963-64 period show some improvement while the influences for 1964-65 period are substantial.

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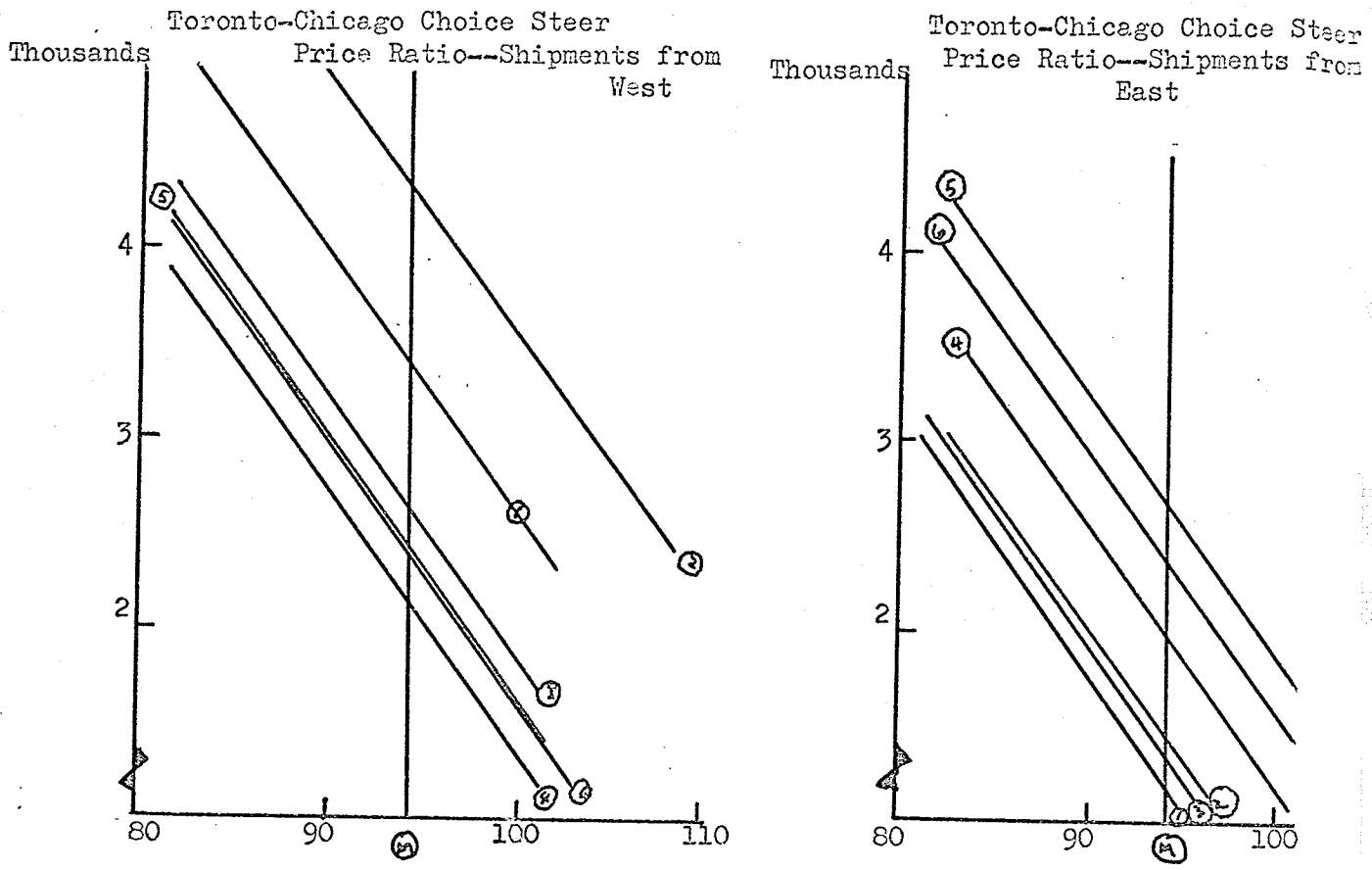
[11] Ostle, Bernard, op. cit., pp. 199-200. He discusses the technique of adjusting values of the dependent variables to take account of differences among associated values of the independent variable. See also K.L. Kinsman, op. cit., pp. 82-83.



Feeder Cattle Shipments from Western Canada

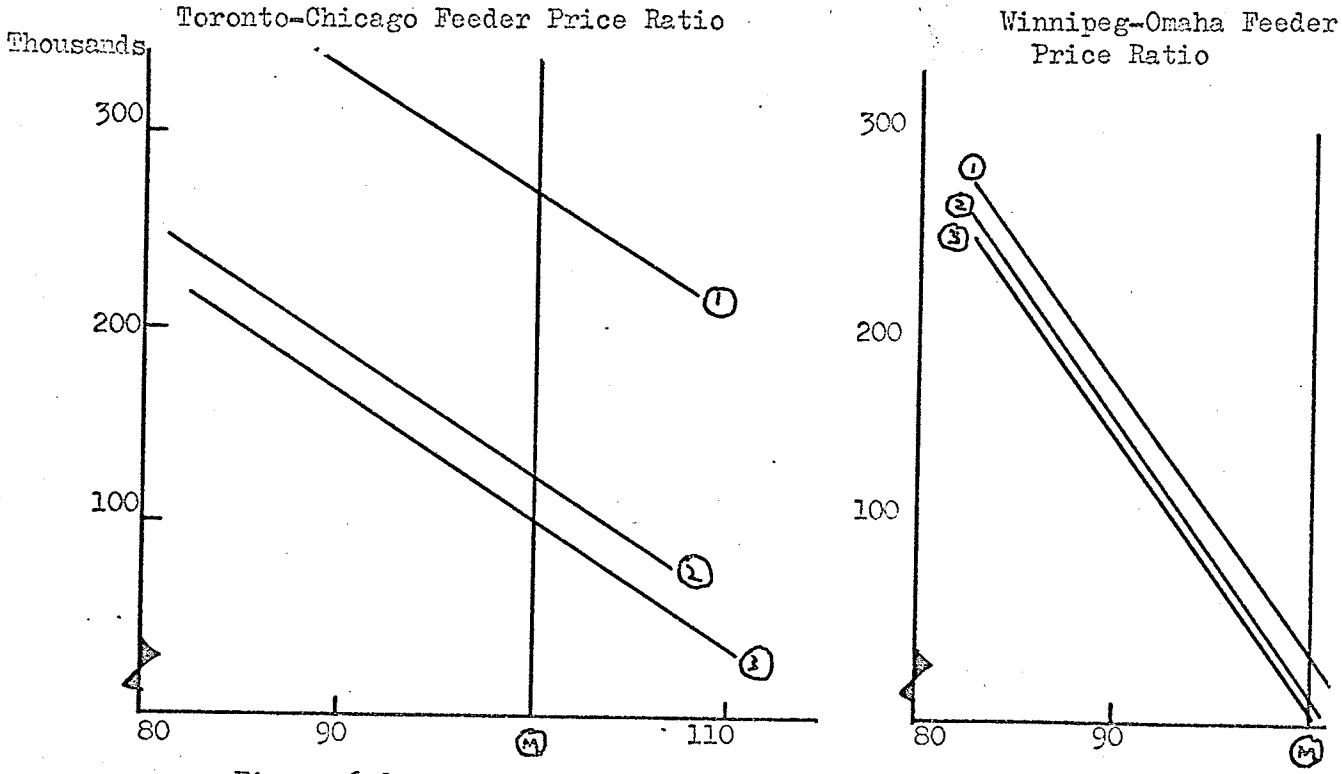


Figure 6.2. Adjustment for Seasonal Variations After Eliminating Influences Due to Price Ratio.

TABLE 6.5

AVERAGE MONTHLY SHIPMENTS OF BEEF CATTLE BY YEARS
ADJUSTED FOR DIFFERENCES IN THE AVERAGE PRICE RATIO*

Years	Fed cattle shipments		Feeder cattle shipments	
	From West Canada	From East	Tor.-Chic. R.	Wpg.-Omaha R.
1960	240,000	190		
1961	334,000	470		
1962	165,000	350	27,000	37,720
1963	114,000	980	12,500	16,800
1964	142,000	1,680	10,000	9,020
1965	140,000	1,380		

*It is clear from these figures that seasonal conditions were steadily improving for feeder cattle shipments whereas in the same period seasonal conditions were improving for fed cattle exports, they showed some instability in the years preceding.

Interpretation of Results (Table 6.2)

1. The elasticity of export response with respect to relative prices of Toronto choice steers and Chicago choice steers is in the order of -6.41. In the context this means that when Toronto and Chicago choice steer price ratio increases by 1 percent, the slaughter cattle exports originating from West Canada to the United States will decrease by 6.41 percent. Conversely, if the ratio decreases by 1 percent, shipments from the same source will increase by 6.41 percent.

The elasticity based on price differentials for the same market and shipment from the same source is .45. This also could be interpreted to mean that if the absolute price differential changes by 1 percent, ship-

ments of slaughter cattle across the border from West Canada will change by .452 percent. It is to be noted that an increase in the price differential could mean either that Toronto price remains constant but Chicago price increases or both prices increase or decrease together but Chicago price increases more or decreases less than the relative increase or decrease in Toronto price.

2. The elasticities of slaughter cattle exports from East Canada with respect to Toronto-Chicago choice steer price ratios and price differentials are -15.74 and 1.52 respectively. This is a highly elastic measure indicating that shipment reinforces the price sensitivity between the two markets.

3. The export response elasticities for fed or slaughter cattle are higher than those for feeders. The elasticity for feeder cattle shipments (1962-63) with respect to Toronto-Chicago good feeder price ratios and price differentials are -3.9 and .58 respectively. Here, the total regression coefficients were used to estimate these elasticities. The pooled regression coefficients are not shown to be significant.

4. Most of the feeder cattle shipments from the Prairies go to the adjacent U.S. Corn belt. Kansas City, Omaha and St. Paul absorb most of the exports. The supply elasticibies with respect to Winnipeg-Omaha good feeder price ratios and price differentials were estimated to be -7.85 and .849 respectively. In both estimates, the total regression coefficients were used. Omaha prices used were the averages for the two weights for good feeders and stockers.[12]

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[12]From U.S. Sources. See Livestock and Meat Situation, 1963 U.S.D.A.

5. The elasticities estimated for feeder cattle shipments for the period 1960-63, with respect to Winnipeg-St. Paul price ratios and price differentials are -1.89 and .044 respectively. Good feeder prices for St. Paul used in the estimates were collected from a Canadian source, the "Weekly Market Situation". Some caution is needed in interpreting the results as the regression coefficients are not significant at the 5% level.

Tables 6.6 to 6.13 show the computations made in testing the significance of the co-efficients used in computing the elasticities referred to above.

TABLE 6.6

REGRESSION ANALYSIS

SLAUGHTER CATTLE SHIPMENTS FROM EASTERN CANADA TO U.S., 1960-65

Year	Σx^2	Σxy	b	a	$\bar{x}$	$\bar{y}$
PRICE RATIO TORONTO–CHICAGO						
1960	331.15	-16.94	-.05	5.07	93.49	.29
1961	106.45	6.24	.06	- 5.40	95.71	.21
1962	127.68	-16.21	-.13	12.32	92.09	.63
1963	257.59	-40.18	-.16	15.73	96.75	.63
1964	648.39	-125.10	-.19	19.97	97.05	1.25
1965	61.22	-21.58	-.35	33.65	89.76	2.01
Pooled regression	1532.48	-213.77	-.14	-	94.14	.83
Total regression	2030.96	-262.96	-.13	13.01	94.14	.83
PRICE DIFFERENTIALS						
1960	17.26	4.18	.24	- .16	1.83	.29
1961	6.08	- 1.35	- .22	.45	1.11	.21
1962	11.15	4.02	.36	- .22	2.35	.63
1963	8.94	8.36	.94	- .37	1.07	.63
1964	15.14	20.86	1.38	-1.15	1.74	1.25
1965	5.55	8.41	1.37	-1.92	2.87	2.01
Pooled regression	64.13	44.49	.69	-	1.83	.83
Total regression	94.13	64.66	.69	- .42	1.83	.83

TABLE 6.7

COVARIANCE ANALYSIS

SLAUGHTER CATTLE SHIPMENTS FROM EASTERN CANADA 1960-65

Year	TSS	SSR	SSE	D.F.	Numerator	Denominator	F. Ratio
PRICE RATIO							
1960	2.64	.87	1.78	10	.87	.18	4.88
1961	2.31	.37	1.95	10	.37	.19	1.88
1962	11.88	2.06	9.82	10	2.06	.98	2.10
1963	11.40	6.27	5.13	10	6.27	.51	12.21*
1964	46.07	24.14	21.93	10	24.14	2.19	11.01*
1965	32.26	7.60	24.65	10	7.60	2.47	3.08
Within years	-	-	65.93	60	-	1.10	-
Difference between slopes	-	-	10.81	5	2.16	-	1.97
Pooled regression	106.56	29.82	76.74	65	29.82	-	27.14**
Distance between lines	-	-	23.17	5	4.63	-	4.22
Total regression	133.93	34.03	99.91	70	34.03	-	23.84**
Residual			89.10	65	-	1.39	
PRICE DIFFERENTIAL							
1960	2.64	1.01	1.63	10	1.01	0.16	6.21*
1961	2.31	.30	2.01	10	0.30	0.20	1.48
1962	11.88	1.45	10.43	10	1.45	1.04	1.39
1963	11.40	7.82	3.58	10	7.82	0.36	21.85**
1964	46.07	28.73	17.34	10	28.73	1.73	16.57**
1965	32.26	20.74	32.26	10	20.74	3.23	5.55*
Within years	-	-	67.24	60	-	1.12	-
Difference between slopes	-	-	8.46	5	1.69	-	1.51
Pooled regression	106.56	30.86	75.70	65	30.86	-	27.8**
Distance between lines	-	-	14.41	5	2.88	-	2.57
Total regression	134.52	44.42	90.10	70	44.42	-	34.51**
Residual			81.65	65		1.26	

**Significant at 1% level

*Significant at 5% level

TABLE 6.8

REGRESSION ANALYSIS

FEEDER CATTLE SHIPMENTS FROM WESTERN CANADA (1962-64)

Year	Σx^2	Σxy	b	a	$\bar{x}$	$\bar{y}$
PRICE RATIO, TORONTO-CHICAGO						
1962	109.64	3345.18	30.51	- 2676.26	97.18	288.86
1963	235.87	3386.32	14.36	- 1292.59	99.23	131.96
1964	490.97	- 544.46	-11.09	1235.66	104.73	74.35
Pooled regression	836.48	1287.04	1.54	-	100.38	165.05
Total regression	1201.67	- 7732.87	- 6.44	810.99	100.38	165.05
PRICE DIFFERENTIAL, CHICAGO-TORONTO						
1962	511.26	-10264.47	-20.08	458.00	8.43	288.86
1963	285.96	2666.58	9.33	37.93	10.08	131.96
1964	1321.53	-6349.46	- 4.80	140.41	13.75	74.35
Pooled regression	2118.75	-13947.4	- 6.7	-	10.75	165.05
Total regression	2296.95	-20402.08	- 8.88	260.56	10.75	165.05

TABLE 6.9

ANALYSIS OF COVARIANCE

FEEDER CATTLE SHIPMENTS FROM WESTERN CANADA (1962-64)

Year	TSS	SSR	SSE	D.F.	NUMERATOR	DENOMINATOR	F. RATIO
			TORONTO-CHICAGO, PRICE RATIO				
1962	250058.52	486.16	201440.60	10	486.16	20144.06	2.41
1963	120066.43	60374.64	59690.81	10	60374.64	5969.08	10.11**
1964	1343238.10	1022063.38	1241171.40	10	1022063.38	124117.14	0.82
Within years	-	-	1502302.80	30	-	50076.76	-
Difference between slopes	-	-	209081.00	2	104546.00	-	2.09
Pooled regression	1713363.00	1980.24	1711383.00	32	1980.24	-	.04
Distance between lines	-	-	248025.00	2	124013.00	-	2.48
Total regression	2009171.00	49761.81	1959408.60	34	49761.81	-	.86
Residual			1700565.80	32		54500.00	
			TORONTO-CHICAGO, PRICE DIFFERENTIAL				
1964	1343238.10	206076.72	1137161.40	10	206076.72	113716.14	1.81
1962	250058.52	24866.23	225192.30	10	24866.23	22519.23	1.10
1963	120066.43	30506.27	89560.15	10	3056.27	8956.01	3.41
Within years	-	-	1451913.80	30	-	48730.46	-
Difference between slopes	-	-	255471.00	2	127736.00	-	2.62
Pooled regression	1713363.00	5977.86	1707385.00	32	5477.86	-	.12
Distance between lines	-	-	120569.00	2	60285.00	-	1.24
Total regression	2009171.00	181216.26	1827954.20	34	181216.26	-	3.37*
Residual			1572484.00	32		48900.00	

**Significant at 1% level *Significant at 5% level

TABLE 6.10

REGRESSION ANALYSIS

FEEDER CATTLE SHIPMENTS FROM WESTERN CANADA (1962-64)

PRICE RATIO, WINNIPEG-OMAHA

Year	Σx^2	Σxy	b	a	$\bar{x}$	$\bar{y}$
1962	6880.12	9206.76	1.51	164.50	82.13	288.86
1963	467.94	3420.23	7.31	-539.08	91.81	131.96
1964	353.60	-4965.35	-14.04	1411.61	95.35	72.68
Pooled regression	7701.66	7661.64	0.99	-	91.98	164.50
Total regression	1246.90	-17517.68	-14.05	1456.71	91.98	164.50
PRICE DIFFERENTIAL, OMAHA-WINNIPEG						
1962	1554.87	26837.83	17.26	-235.29	30.37	288.86
1963	3201.28	-8391.37	-2.62	191.20	22.60	131.96
1964	1069.75	8742.08	8.17	-27.36	12.24	72.68
Pooled regression	5825.90	27188.54	4.67	-	21.74	164.50
Total regression	7810.42	50191.70	6.43	24.82	21.74	164.50

TABLE 6.11

ANALYSIS OF COVARIANCE

FEEDER CATTLE SHIPMENTS FROM WESTERN CANADA (1962-64)

Year	TSS	SSR	SSE	D.F.	Numerator	Denominator	F. Ratio
PRICE RATIO, WINNIPEG-OMAHA							
1962	1343238.10	13941.24	1329296.90	10	13941.24	132929.69	.1048
1963	250058.52	24998.87	225059.11	10	24998.87	22505.97	1.1107
1964	111775.43	69724.99	42048.42	10	69724.99	4204.84	16.5812*
Within years	-	-	1596404.40	30	-	53213.48	-
Difference between slopes	-	-	101006.00	2	50503.00	-	.949
Pooled Regression	1705072.00	7661.64	1697410.00	32	7661.64	-	.1439
Distance between lines	-	-	61023.00	2	30512.00	-	.600
Total regression	2004530.40	246093.76	1758433.50	34	246093.76	-	4.7583*
Residual			1657431.40	32		51600.00	
PRICE DIFFERENTIAL, OMAHA-WINNIPEG							
1962	250058.52	463235.13	880003.02	10	463235.13	88000.30	5.264*
1963	250058.52	21,995.90	228062.61	10	21995.90	22806.26	.964
1964	111775.43	71,441.04	40334.38	10	71441.04	4033.44	17.712*
Within years	-	-	1148400.1	30	-	38280.00	
Difference between slopes	-	-	429789.00	2	214895.00	-	5.613
Pooled regression	1705072.00	126883.48	1578189.00	32	126883.48	-	3.3146*
Distance between lines	-	-	103795.00	2	51896.00	-	1.3556
Total regression	2004530.40	322544.16	1681984.60	34	322544.16	-	6.5199*
Residual			1262196.24			39100.00	

** Significant at 1% level

* Significant at 5% level

TABLE 6.12

REGRESSION ANALYSIS

FEEDER CATTLE SHIPMENTS FROM WESTERN CANADA (1960-1963)

PRICE RATIO, WINNIPEG-ST. PAUL.

Year	Σx^2	Σxy	b	a	$\bar{x}$	$\bar{y}$
1960	61.71	7.07	.11	1.95	92.21	12.51
1961	143.45	374.27	2.61	-209.12	91.39	29.32
1962	444.61	-60.39	-.14	42.31	98.85	28.88
1963	528.80	-824.45	-1.56	151.68	88.83	13.19
Pooled regression	1178.57	-503.75	-.43	-	92.82	20.97
Total regression	1834.79	-385.77	-.21	38.40	92.82	20.97
GOOD FEEDER PRICE DIFFERENTIAL, ST. PAUL-WINNIPEG						
1960	5.56	18.90	3.40	5.95	1.93	12.51
1961	8.77	-99.27	-11.31	52.53	2.05	29.32
1962	10.07	-163.56	-16.24	49.20	1.25	28.88
1963	40.85	214.75	5.35	-2.26	2.89	13.19
Pooled regression	65.26	29.19	.45	-	2.03	20.97
Total regression	80.75	-170.72	-2.11	25.26	2.03	20.97

TABLE 6.13

COVARIANCE ANALYSIS

FEEDER SHIPMENTS (1960-1963)

Year	TSS	SSR	SSE	D.F.	Numerator	Denominator	F. RATIO
PRICE RATIO, WINNIPEG-ST. PAUL							
1960	1150.76	.81	1149.95	10	.81	114.99	.01
1961	13269.09	976.49	12292.64	10	976.49	1229.26	.79
1962	13432.76	8.20	13424.55	10	8.20	1342.46	.00
1963	2500.59	1215.20	1285.38	10	1285.38	121.52	10.58**
Within years	-	-	28082.34	40	-	702.06	-
Difference between slopes	-	-	117.82	3	39.27	-	.06
Pooled regression	30353.19	215.30	28200.16	43	215.30	-	.31
Distance between lines	-	-	2827.15	3	942.38	-	1.34
Total regression	25454.11	81.11	25373.01	46	811.11	-	.15
Residual			25255.18	43		601.0	
PRICE DIFFERENTIAL, ST. PAUL-WINNIPEG							
1960	1150.76	64.19	1086.56	10	64.19	108.65	.59
1961	13269.09	1123.12	12145.97	10	1123.11	1214.59	.92
1962	13432.76	2656.68	10776.07	10	2656.68	1077.61	2.47
1963	2500.59	1149.45	1351.14	10	1149.45	135.11	8.51*
Within years	-	-	25357.95	40	-	633.90	-
Difference between slopes	-	-	4982.18	3	1160.73	-	2.63
Pooled regression	30353.19	13.05	30340.13	43	13.05	-	.02
Distance between lines	-	-	2824.78	3	941.59	-	1.49
Total regression	33525.86	360.95	33164.91	46	360.95	-	.50
Residual			28182.63	43		635.00	

** Significant at 1% level

* Significant at 5% level

CHAPTER VII

ECONOMIC-STATISTICAL ANALYSIS OF SUPPLY, IMPORTS AND EXPORTS OF BEEF AND BEEF CATTLE IN THE UNITED STATES AND CANADA

In Chapter VI we observed that exports of beef cattle from Canada to the United States are very responsive to the level of prices in the latter country. We shall try to introduce more variables which theoretically appear to be associated with the export movements.

In economic literature, the estimation of supply or demand elasticities is dependent on the basic theoretical conception of Marshall, who wrote that the analysis must be modified according to the time period allowed for adjustment to take place. Three distinct time periods are recognised:

1. The short period elasticities of supply.

The concept of supply used here normally represents market supply--supply already produced or in some stage or other of production. To be specific, it is the period so short that the quantity offered for sale by producers is independent of the price of the product. This period could be as short as possible (i.e. day, week, month or quarter), but generally it is taken to be no longer than one year. Producers rarely exercise reservation demands over perishable produce they bring to the market. Their motto seems to be "sell and repent".

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[1]B.P. Philpott, Fluctuations in Wool Prices 1870-1963, Agr. Econ. Research Unit Publication No. 13, Aug. 1965, pp. 4ff.

This interpretation of short-period elasticities needs some modification before we could apply it to beef cattle supply. The daily price fluctuations in beef cattle may not be substantial, but they do make a lot of difference to the producers. The timing of deliveries is very essential to these producers since even $1 difference in price at the time of selling could take a lot out of the producers' returns. If adequate market information is available producers can, upon the knowledge gained, decide whether or not to offer a particular lot of cattle for sale. Carcass beef cannot be treated in this way because it is expensive to store for long periods and besides, deterioration might set in. Producers in fact make independent decisions to market their produce and decide individually whether or not they will be influenced by their price expectations. If their expectations are not sanguine they may elect to with-hold their stock from the market and feed them to heavier weights. Depending upon the speed with which market news is disseminated, one day may be long enough to influence the decision of the producers. The implication is that if the "short-period" is meant to cover a period of a day to a year, in which supplies are relatively fixed in the Marshallian sense, it is difficult to apply the notion generally to beef cattle supply.

2. The long period elasticities

Generally, this is the period too short for the potential rate of production to adjust to price, but long enough for the rate of production within current potential to be adjusted. Because of the element of time involved, it is appropriate to drop the assumption of ceteris paribus in

order to embody in the analysis more factors that may explain the system. Again, because of the wide latitude of choice open to cattle producers, supply is not sufficiently inelastic to warrant its treatment in our analysis as predetermined with respect to price in a single year. The period is rather long enough for cattle producers to adjust to prices, though this might not be effected completely.

3. The very long period

This is a period long enough for the rate of production to completely adjust to prices. As applied to cattle supply, the production lag involved may correspond to one cyclical upswing or downswing. An estimate of very long run supply or demand elasticities for beef cattle would require an averaging of time series data comprising one cyclical upswing or downswing or both together with a demand or supply shifter in between them.

In this chapter, elasticities based on annual data will be estimated. On the basis of our argument we could call these "long-period" elasticities.

Supply and demand for beef cattle in the U.S.

Under the conditions depicted in our theoretical model,[2] the price of beef cattle in the United States will depend on domestic demand and total available supply. The kinked line S' S'' S''' in our model constitutes the sum of domestic supply S'S and the excess supply P_1Es. The latter represents the volume of beef imported into the U.S. at various

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[2]See Chapter III, p.

prices in the United States, ceteris paribus. The volume of beef imports into the U.S. was incorporated in our analysis in order to estimate its effects on the U.S. cattle prices. On the assumption that the higher the beef production in the countries which chiefly supply the U.S. market, the more beef exported to the U.S. two separate variables were introduced to reflect production in Canada and production in other areas.[3] As the impact of these factors on live cattle prices was the prime objective, variations of production in Canada could be expected to exert some influence on the U.S. market, though the point has already been recognized that Canada's exports to the U.S. are insignificant as compared with those of other countries.

Utility cow prices and choice steer prices at Chicago were used to determine the effect of foreign production and imports on the U.S. market. Because of the possible interdependence in the demand for fed cattle and beef cows, derivation of simultaneous demand and supply equations for the products might have been more appropriate. We, however, restricted our analysis by relating the prices of fed cattle and cows to the same variables in order to assess the degree of substitution between the two products.

A model using a multiplicative formulation was arbitrarily chosen in estimating the impact of the various factors on the U.S. prices. The basic algebraic form of the model was:

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[3]These countries are Australia, New Zealand, Argentina, Brazil, Mexico and Ireland.

$$Y_{1t} = AX_{1t}^{B1}X_{2t}^{B2}X_{3t}^{B3} + \ldots + e_t^{B_nX_{nt}}\varepsilon \qquad (1)$$

In logarithmic form the model was

$$\log Y_{1t} = \log A + B_1 \log X_{it} + B_2 \log X_{2t} + B_3 \log X_{3t} + \ldots$$

$$+ B_nX_n + \log 1_t + \log 1 \qquad (2)$$

Equation 2 could also be written thus:

$$\log \hat{Y}_{1t} = \log a + b_1 \log Y_{it} + b_2 \log X_{2t} b_3 \log Y_{3t} + \ldots$$

$$+ b_nX_{nt} \qquad (3)$$

The variables (using 1947-1962 data) for equation 3 were:

Y_{1t} = Deflated choice steer prices at Chicago

Y_{2t} = Deflated utility cow prices at Chicago

Y_{3t} = Per capita imports of beef into the U.S. in pounds.

X_{1t} = Per capita production of steer and heifer beef in the U.S. in pounds

X_{2t} = Per capita production of cow and bull beef in the U.S. in pounds

X_{3t} = Total beef production in Canada

X_{4t} = Total beef production in "Other" countries[4]

X_{5t} = Deflated per capita disposable income in the U.S.

X_{6t} = Per capita consumption of other red meats excluding poultry meat in the U.S. in pounds.

The data were pretested neither for auto-correlation nor multi-collinearity. Preliminary analysis conducted yielded coefficients which in terms of signs appeared theoretically implausible.[5] However, using first

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[4]As defined. vide supra.

[5]Joan Friedman and Richard J. Foote, Computational Methods for

differences yielded results which appeared more reasonable. In logarithmic form the equation was written thus:

$$\log Y_{1t}-\log Y_{it-1} = \log a+B_1 (\log X_{1t}-\log X_{it})+ B_2(\log X_t-\log X_{2t-1}) +B_3(\log Y_{3t}-\log Y_{3t+}) + \ldots + (\text{Log}l_t-\text{log}l_{t-1}) \quad (4)$$

or

$$\Delta \log Y_{1t} = \log a+B_1 \ \Delta\log X_{1t}+B_2 \ \Delta\log X_{2t} +B_3 \ \Delta\log X_{3t} + \ldots$$
$$\ldots + \Delta\log l_t \quad (5)$$

To facilitate analysis, equation (4) was written

$$\log\left(\frac{Y_t}{Y_{t-1}}\right)= \log a + B_1 \log\left(\frac{X_{it}}{X_{(t-1)}}\right)+ B_2 \log\left(\frac{X_{2t}}{X_{2(t-1)}}\right)+ \ldots + \log\left(\frac{E_t}{E_{(t-1)}}\right) \quad (6)$$

Empirical results

1. The demand relationship for fed cattle in the U.S. using annual data was [6]

$$\log Y_t = 4.61-1.36^* \Delta\log X_{1t}-.034 \Delta\log X_{2t}-.123^{\#} \Delta\log X_{3t}-.07^{\#}\Delta\log X_{4t} +.25^{\#} \Delta\log X_{5t}+.03 \Delta\log X_{6t}$$
$$(.590) \quad (.53) \quad (.42) \quad (.65) \quad (.820) \quad (.90)$$

$$R^2 = .92^{**} \qquad S = .022$$

Handling Systems of Simultaneous Equations, With Application to Agriculture, U.S.D.A. Agr. Handbook No. 94, 1962, p. 76, for discussion of tests to be made after completing a multiple regression analysis.

[6] Here and subsequent equations, * = Significant at 5% level; ** = Significant at 1% level; # = Significant at 10% level; ## = Significant at 20% level.

The effects of changes in the independent variables upon the choice steer prices at Chicago are:

1. A change of 1 percent in steer and heifer beef production is associated with, on the average, and by itself, a change in the opposite direction of fed cattle prices of 1.36.[7]

2. An increase of 10 percent in cow and bull production is associated with .3 percent decrease in choice steer prices at Chicago. This reflects the degree of competition between steer and heifer beef and cow beef for the consumer's dollar.

3. A change of 10 percent in beef production in Canada is associated with, ceteris paribus, a 1.2 percent decrease in choice steer prices at Chicago.

4. When other foreign production of beef increases by 10 percent, choice steer prices at Chicago decrease by 0.7 percent. Because of the interdependence of Toronto and Chicago fed cattle prices, variations in the production in Canada are expected, contra opinionem, to affect somewhat live cattle prices in Chicago. With the exception of Mexico, beef imports from other foreign countries into the U.S. come in a carcass form and thus directly affect the retail cuts of beef and indirectly the price of fed cattle. These results, therefore, appear reasonable.

5. A change of 10 percent in consumer disposable income is associated by itself with 2.5 percent change in fed cattle prices in the same direction.

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[7] The results are very close to those obtained in a similar analysis by the staff of the U.S.D.A. Vide, "The Import Situation for Beef and Veal", in Livestock and Meat Situation, LMS-134, Nov. 8, 1963, pp. 35ff.

6. With respect to the consumption of other red meats, the sign of the flexibility coefficient appears contrary to general economic principle. However, the coefficient does not significantly differ from zero.

Using utility cow prices as the dependent variable, the following demand equation was obtained.

$$\Delta \log Y_{2t} = \underset{(.48)}{2.69} \underset{}{-1.79^{**}} \Delta \log X_{1t} \underset{(.42)}{-.88^{*}} \Delta \log X_{2t} + \underset{(.34)}{.11} \Delta \log X_{3t}$$

$$+ \underset{(.49)}{.14} \Delta \log X_{4t} + \underset{(.64)}{3.05^{*}} \Delta \log X_{5t} \underset{(69)}{-.96^{*}} \Delta \log X_{6t}$$

$$R^2 = .98^{**} \qquad S = .017$$

1. On the average and by itself, 1 percent increase in the production of steer and heifer is associated with 1.8 percent decrease in cow prices.

2. An increase of 1 percent in cow and bull beef production is associated with .9 percent decrease in cow prices. These two results appear to indicate that price making forces at the lower grade beef level take their cue from the level of price changes of fed cattle.

3. An increase of 10 percent in Canadian beef production is associated with, other things remaining equal, 1.04 percent increase in the price of utility cows at Chicago. Similarly a change of 10 percent in total foreign production other than Canada is associated with 1.4 percent change in cow beef prices at Chicago. The signs of the coefficients appear to be contrary to all reasonnable expectations. It is expected that increased production in these foreign countries will cause more beef to be exported to the United States and thus ease the pressure on their domestic prices. With respect to Canada, however, the results could be accepted purely on logical grounds. We have already discovered that the

Canadian cattle production cycle lags behind that of the U.S. by approximately one year.[8] Increased cattle production, (i.e. cattle build-up) in Canada is somewhat associated with corresponding increases in the U.S. Increasing cattle build-up is accompanied by reduced cow slaughter and therefore high cow prices, ceteris paribus. Because parallel developments also take place in the U.S., increased beef production in Canada is associated with increased cow prices. This explanation, though circuitous, appears to account for the positive sign associated with the flexibility coefficient, Even here, the explanation itself reveals the intercorrelation between variables Y_{1t}, Y_{2t} and Y_{3t} in the analysis.

4. An increase of 1 percent in annual disposable income is on the average associated with 3 percent increase in the price of utility cows at Chicago.

5. The cross elasticity of cow beef with respect to pork and mutton is -.96, indicating that a 1 percent change in the consumption of other red meats is associated with .96 percent change in cow beef prices in the opposite direction. If one percent increase in the consumption of other red meats will, on the average, cause .96 percent decrease in cow prices, then one percent decrease in the consumption of other red meats will cause cow prices to increase (i.e. decreased consumption) by .96 percent. The degree of substitution between lower grade beef and other red meats is thus revealed.

Import response

This was estimated by relating per capita imports of beef and veal

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[8] Vide, Chapter V, p.

(including feeders converted to carcass weight) to the same factors. This is more or less a "mongrel" function. The estimated equation is:

$$\Delta\log Y_{3t} = \underset{}{-2.47} \underset{(1.70)}{-4.42^{*}}\,\Delta\log X_{it} \underset{(1.38)}{-3.23^{*}}\,\Delta\log X_{3t} + \underset{(1.14)}{.62^{\#}}\,\Delta\log X_{3t}$$

$$\underset{(1.64)}{-.73}\,\Delta\log X_{4t} + \underset{(6.70)}{16.8^{*}}\,\Delta\log X_{5t} \underset{(2.3)}{-6.79^{*}}\,\Delta\log X_{6t}$$

$R_2 = .73$ $\qquad$ $S = .5612$

1. An increase of one percent in steer and heifer production is associated with, and by itself, 4.4 percent decrease in imports of beef and veal into the U.S.

2. If U.S. cow and bull production increases by one percent, imports are expected to decrease by 3.2 percent.

3. An increase of one percent in the Canada beef production is associated with .6 percent increase in beef and veal exports to the U.S.

4. A change of one percent in total beef production in foreign countries other than Canada is associated with .7 percent change in imports of beef and veal into the U.S. in the opposite direction. The coefficient is not significant and therefore has a doubtful value.

5. In the context, an increase of one percent in personal disposable income is associated with, on the average, a 17 percent increase in imports of beef and veal into the United States.

6. One percent increase in the consumption of other red meats is, on the average, associated with a decrease of 6.8 percent in the imports of beef and veal into the United States.

II. Supply and demand relationship in Canada

A. Cobb-Douglas multiplicative function was used to estimate the

influences of several identified variables on the prices of choice steers and good feeder steers, in Toronto and Winnipeg. Several factors were also incorporated in the analysis to estimate the degree of export response of fed cattle and feeders from Canada to the United States. Again because feeders and fed cattle compete for the consumer's dollar, a much more encompassing model using simultaneous equation techniques would have been warranted.

The analysis covers the period 1955 to 1964 in most cases. The availability of data restricted the analysis only to this period and in any case the period prior to this one was often interrupted with regulations of the export trade in beef cattle. A period longer than the one under consideration would have rendered the analysis less workable. Preliminary analysis performed on the computation failed to yield tangible results in terms of the signs and magnitudes of the flexibility coefficients. The variables involved in the computations are as follows:

X_{1t} = Deflated choice steer prices at Chicago in $ U.S.

X_{2t} = Per capita slaughter of cattle in Canada.

X_{3t} = Per capita good feeder exports to U.S. in year (t-1)

X_{4t} = Per capita disposable income

X_{5t} = Ratio of beef to pork price

X_{6t} = Deflated choice steer price in Toronto in Canadian $.

X_{7t} = Per capita exports of fed cattle to the U.S. (in mos.)

X_{8t} = Deflated good feeder price, Chicago in $ U.S.

X_{9t} = Index of the price of feed

X_{10t} = Per capita output of feeders in Canada

X_{11t} = Deflated good feeder price in Toronto

X_{12t} = Deflated good feeder price in Winnipeg

X_{13t} = U.S. fed cattle slaughter as percentage of total cattle slaughter

X_{14t} = Per capita exports of feeders to the U.S.

X_{15t} = Supply shifter

Empirical results

A. Demand relationship, choice steer prices, Toronto

The demand for fed cattle in Canada was estimated as follows:

$$\Delta \log X_{6t} = -.17 + \underset{(.72)}{.54^{*}}\,\Delta \log X_{it} \underset{(,42)}{-.22}\,\Delta \log X_{2t} + \underset{(.05)}{.02}\,\Delta \log X_{3t}$$

$$+ \underset{(.79)}{.67\#}\,\Delta \log X_{4t} + \underset{(.21)}{.09}\,\Delta \log X_{5t}$$

$R^2 = .92^{*}$ $\qquad$ $S = .018$

1. In the context, an increase of one percent in the price of choice steers at Chicago is associated with .54 increase in the price of choice steers at Toronto.

2. A change of ten percent in cattle slaughter in Canada is associated with, on the average, 2 percent change in Toronto choice steer prices. The flexibility coefficient is not significant.

3. It has been argued that the more feeder cattle exported to the U.S. in one year, the more the chances are that fed cattle prices in the following year will be higher than Chicago price of choice steers.[9] This

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[9]See A letter on Canadian Livestock Products, published quarterly by the Meat Packers Council of Canada. Fall 1964, No. 4 P. 1.

happened in the 1963-64 period. Judging from the sign of the coefficient, our result seems to support this viewpoint. However, the result is not statistically significant.

4. If consumer disposable income increases by one percent, price of choice steers will increase by approximately .6 percent.

5. A change of one percent in the ratio of beef to pork prices is associated with .09 percent change in choice steer price at Toronto, in the same direction.

B. Demand relationship using good feeder steer price at Toronto as dependent variable

$$\Delta \log X_{11t} = 7.8 + \underset{(1.1)}{3.68^{**}}\ \Delta\log X_{6t} + \underset{(.73)}{1.13^{*}}\ \Delta\log X_{8t} + \underset{(1.1)}{3.6^{*}}\ \Delta\log X_{9t}$$

$$\underset{(.59)}{-.42^{*}}\ \Delta \log X_{10t}\ \underset{(.78)}{-1.3}\ \Delta\log X_{13t}$$

$$R^2 = .94^{*} \qquad S = .024$$

1. An increase of one percent in the price of choice steers at Toronto is associated with 3.7 increase in the price of feeder steers at Toronto.

2. Other things remaining equal, an increase of one percent in the price of good feeders at Chicago is associated with 1.1 percent increase in Toronto good feeder price.

3. A change of one percent in the index of feed prices is associated, and by itself, with 3.6 percent change in the price of good feeders in the same direction.

4. An increase in the output of feeders in Canada of one percent is associated with, on the average, a decrease of .4 percent in good feeder prices at Toronto.

5. A change of one percent in the U.S. fed cattle slaughter as percentage of total cattle slaughter in one year is associated with 1.3 percent change in the price of good feeder cattle at Toronto in the following year in the opposite direction. This knowledge should help cattle feeding operators to make a more meaningful judgement as regards the expected future prices of the cattle they are feeding now.

C. Demand relationship using good feeder steers at Winnipeg as the dependent variable

$$\Delta \log X_{12t} = 1.79 + \underset{(.73)}{1.1}\,\Delta \log X_{6t} + \underset{(.48)}{.21}\,\Delta \log X_{8t} + \underset{(.73)}{.45^{\#}}\,\Delta \log X_{9t}$$

$$- \underset{(.38)}{.06^{\#}}\,\Delta \log X_{10t} - \underset{(.51)}{.72} + \Delta \log X_{13t}$$

$$R^2 = .97^{**} \qquad S = .016$$

1. An increase of one percent in choice steer price at Toronto is associated with 1.1 percent increase in the price of good feeder steers at Winnipeg. With respect to Chicago good feeder prices, the flexibility coefficient does not differ significantly from zero.

2. A change of one percent in the index of feed prices is associated with .5 percent change in the price of good feeder steers at Winnipeg.

3. If the output of feeders increases by one percent, good feeder steer prices at Winnipeg is expected to decrease by .06 percent.

4. An increase of one percent of U.S. fed cattle slaughter as a percentage of total cattle slaughter is associated, and by itself, with a .72 percent decrease in good feeder price in Winnipeg.

D. Feeder exports to the U.S.

The standard errors of the regression coefficients, with the

exception of variable X_{10t}, are too large to be warranted. The results are shown below:

$$\Delta X_{3t} = \underset{(10.3)}{-50.97-21.4\ \Delta \log X_{6t}} \underset{(6.9)}{+16.3^{*}\Delta \log X_{8t}} \underset{(10.4)}{+19.7\ \Delta \log X_{9t}}$$

$$\underset{(1.75)}{+3.48\ \Delta \log X_{10t}} \underset{(7.4)}{+8.4+\ \Delta \log X_{13t-1}}$$

$$R^2 = .88\# \qquad S = .710$$

They are quoted here for comparison with the results of other analyses on the same level.

E. Fed cattle exports to the U.S.

An examination of the raw data revealed a relatively abrupt change in the level of per capita exports of slaughter cattle from Canada to the U.S. in 1958. In order to account for this, a discrete supply shifter (X_{15t}) was introduced. The estimated equation is

$$\Delta \log X_7 = .17 + \underset{(.74)}{.54^{*}\ \Delta \log X_1} + \underset{(.053)}{.02^{**}\ \Delta \log X_2} \underset{(.22)}{-.09\ \Delta \log X_3}$$

$$\underset{(.41)}{-.22\ \Delta \log X_{13(t-1)}} + \underset{(.795)}{.66\#\ \Delta \log X_{15}}$$

$$R^2 = .92^{*} \qquad S = .018$$

1. An increase of one percent in the Chicago price of choice steers is associated with an increase of .5 percent in exports of fed cattle to the U.S. other things remaining equal.

2. Similarly, an increase of one percent in beef cattle slaughter in Canada is, on the average, associated with .02 increase in slaughter cattle exports to the United States. Increased slaughter of cattle should in theory, be accompanied by reduced fed cattle prices, thus widening the U.S.-Canada price differential. Fed cattle from Canada,

therefore, flow there.

3. An increase of one percent in feeder cattle exports to the U.S. in one year is accompanied by a decrease of .09 percent in exports of slaughter cattle in the following year.

4. A change of one percent in U.S. fed cattle slaughter as a percentage of total slaughter is associated with .2 percent change in fed cattle exports to the United States. A discrete supply shifter was incorporated in the analysis. The positive sign of the coefficient indicates the possibility of upward shift in average annual per capita export of slaughter cattle from Canada to the United States.

CHAPTER VIII

INTER-MARKET PRICE ANALYSIS

An analysis of fed steer prices and feeder steer prices which prevailed in selected markets in Canada and the United States for the pre-war and post-war periods shows that there has been a strong association between these markets. (Table 8.1). The information in the table shows that there has been a strong price correlation between the markets listed. The shorter the distance between these markets, the stronger the association. For this tendency to hold, the two markets must handle a considerable quantity of cattle.[1] An examination of the correlation figures shows that the price association between Canadian and U.S. markets was stronger in the post-war than the pre-war period. Because of this tendency, it is expected that supplies available to these markets will move to areas offering the highest net returns. In this chapter, an attempt will be made to describe and analyse the geographical variations in prices received by the producers operating in selected Canadian and United States markets.[2] The period, 1959-64 was chosen, the most recent

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[1] John Siemens, A Study of Price Differentials Between Selected Canadian and United States Public Livestock Markets. Unpublished Master's Thesis, Dept. of Agricultural Economics, Univ. of Manitoba, April 1959, p. 34.

[2] The descriptive part of this chapter will be a summary of the views commonly expressed by the people connected with the industry in Canada. The major source of information was obtained from A Letter on Canadian Livestock Products, published by the Meat Packers Council of Canada.

TABLE 8.1

COEFFICIENTS OF CORRELATION OF GOOD STEER AND GOOD STOCKER AND FEEDER STEER PRICES IN SELECTED U.S. AND CANADIAN MARKETS, PRE-WAR AND POST-WAR*

	North Portland	St. Paul	Chicago	Calgary	Winnipeg
		Good Steers, Pre-war, 1935-40			
Toronto	.93	.59	.80	.99	.96
Winnipeg	.79	.68	.67	.95	
Calgary	.86	.62	.59		
Chicago	.67	.97			
St. Paul	.65				
		Good Steers, Post-war, 1949-55			
Toronto	.92	.85	.84	.99	.98
Winnipeg	.93	.87	.86	.99	
Calgary	.93	.81	.86		
Chicago	.95	.99			
St. Paul	.98				
		Good Stocker and Feeder Steers, Pre-war, 1935-40			
Toronto		.90	.91	.96	.97
Winnipeg		.93	.92	.95	
Calgary		.91	.93		
Chicago		.95			
		Good Stocker and Feeder Steers, Post-war, 1949-55			
Toronto		.90	.54	.98	.96
Winnipeg		.96	.63	.99	
Calgary		.93	.61		
Chicago		.99			

*Source: John Siemens, A Study of Price Differentials Between Selected Canadian and United States Public Livestock Markets, (unpublished Master's Thesis, Department of Agricultural Economics, University of Manitoba) April, 1959, pp. 35-39.

five year period for which complete data were available when this study was initiated.

Because of the interdependence of the major livestock markets in the United States and Canada, it is expected that the United States markets will be a dominant factor in the determination of cattle prices in Canada. Whenever relative shortages of supplies are experienced in the United States, the prices there are expected to rise relative to prices in Canada and this situation could generate flows of cattle from Canada across the border. When Canada is on export basis the price level in the United States establishes a floor below which the Canadian prices will not fall. Occasionally, when Canada experiences relative supply shortages, the Canadian prices tend to rise relative to the United States prices. When this happens, the influx of supplies from the United States will tend to dampen the rising Canadian prices. The general opinion in the cattle industry appears to be that the maximum price level in Toronto is established by the price level in Chicago plus the cost of shipping the animals North to Canada. Hence the current view is that the level of the U.S. price sets both the floor and the ceiling for the price in Canada. Within these outer limits, domestic forces are enough to account for the price gyrations that often occur in Canada.

A large cattle build up in Canada, if this is accompanied by a low price differential between the Canadian and the U.S. markets, will cause a decline in domestic prices. Under these circumstances, the belief that high Canadian marketings do not imply lower prices is not valid.

It is also accepted that it is not necessarily high marketings that cause prices to fall, but rather, the proportion of top grade cattle offered for sale is equally important. The reason is simply that choice and good grade cattle make up the bulk of the beef trade. An abundant supply of Blue and Red brand beef will tend, other things remaining equal, to depress the prices to levels that will stimulate consumption.[3]

Inter-year price variations between markets

The movement of prices to a lower or higher level than prevailed in a preceeding year has been termed an interseasonal price change.[4] This is different from a price change that is purely seasonal in character. Prices generally vary from marketing year to marketing year. Changes in supply and demand, and consumer purchasing power largely account for this phenomenon. These price changes can be decomposed into trends, cycles and residuals. The longer the period, the more effectively can cycles be revealed in annual marketing data. Our period of analysis in this chapter covers only six years and, therefore, it has not been deemed possible to isolate these factors with any precision. Inter-year price analysis helps in accounting for changes that result in price differentials between spatially separated markets when the price level changes from one

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[3] A Letter on Canadian Livestock Products, Summer 1963, No. 3.

[4] Theodore W. Schultz and A.G. Black. Variations in Swine Prices Within Iowa Including a Study in Statistical Procedure, Iowa Agr. Exp. Station Res. Bull. No. 161, Iowa, June 1933. We call this phenomenon 'inter-year' price change as this concept is less prone to misrepresentation since between seasons may mean, say, between fall and winter.

year to another.

In Figures 8.1 and 8.2 the average annual choice steer price differentials of Chicago, Omaha and Kansas City over Toronto and the same differentials inclusive of Toronto over Winnipeg respectively have been shown. These plottings reveal that the spread in the prices between the stated markets varies from year to year. The Toronto-Chicago price spread (Fig. 8.1) and the Winnipeg-Chicago price spread (Fig. 8.2) are greater than those shown for the other markets. The patterns of the price spreads appear the same for the other U.S. markets other than Chicago. As would be expected, the spread between Chicago and Winnipeg is greater than the price differential between Chicago and Toronto.

If we deduct that portion of price differences which are attributed to freight charges and other shipping costs, and tariffs, we would arrive at a fairly uniform price map for the area covered. After isolating those components attributed to geographic price variations, it will be necessary to test whether there are any important price variations among these markets. The widening and narrowing of the spread are expected to be closely related to the general price levels in Canada and in the U.S. and to the fluctuations in the value of the dollar.[5]

Intra-year price variation

Highest prices for top grade cattle usually occur in June, July and August in Canada. Lowest prices occur most often from January to

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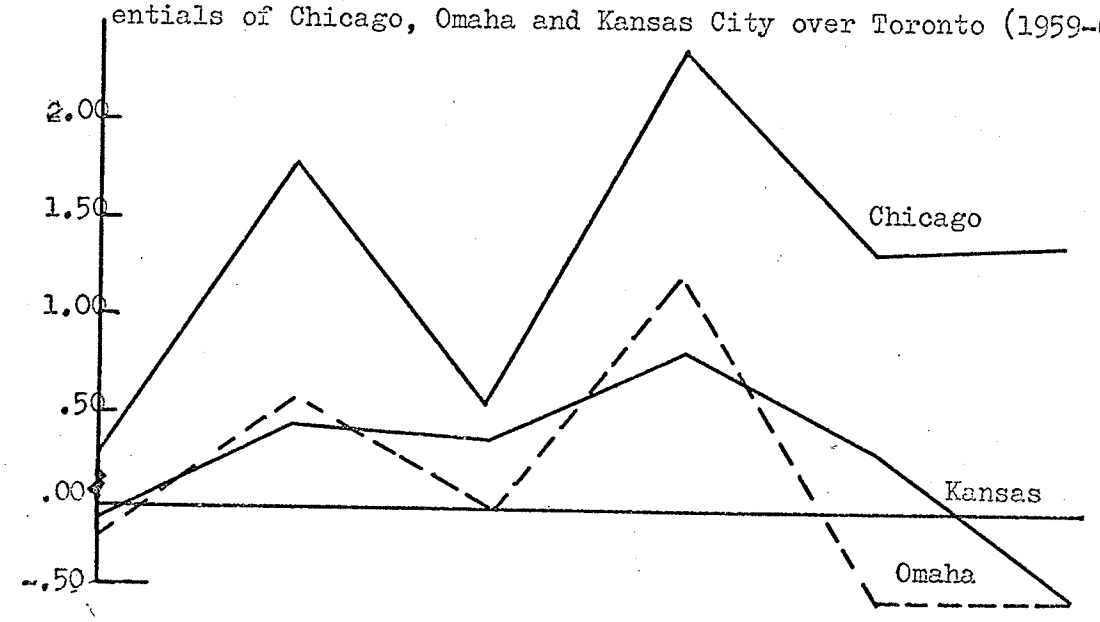
[5] i.e., if the two price levels do not move together pari passu. A third factor may be the variations in the costs of transportation and other handling charges.

Figure 8.1. Average Annual Choice Steer Price Differentials of Chicago, Omaha and Kansas City over Toronto (1959-64)



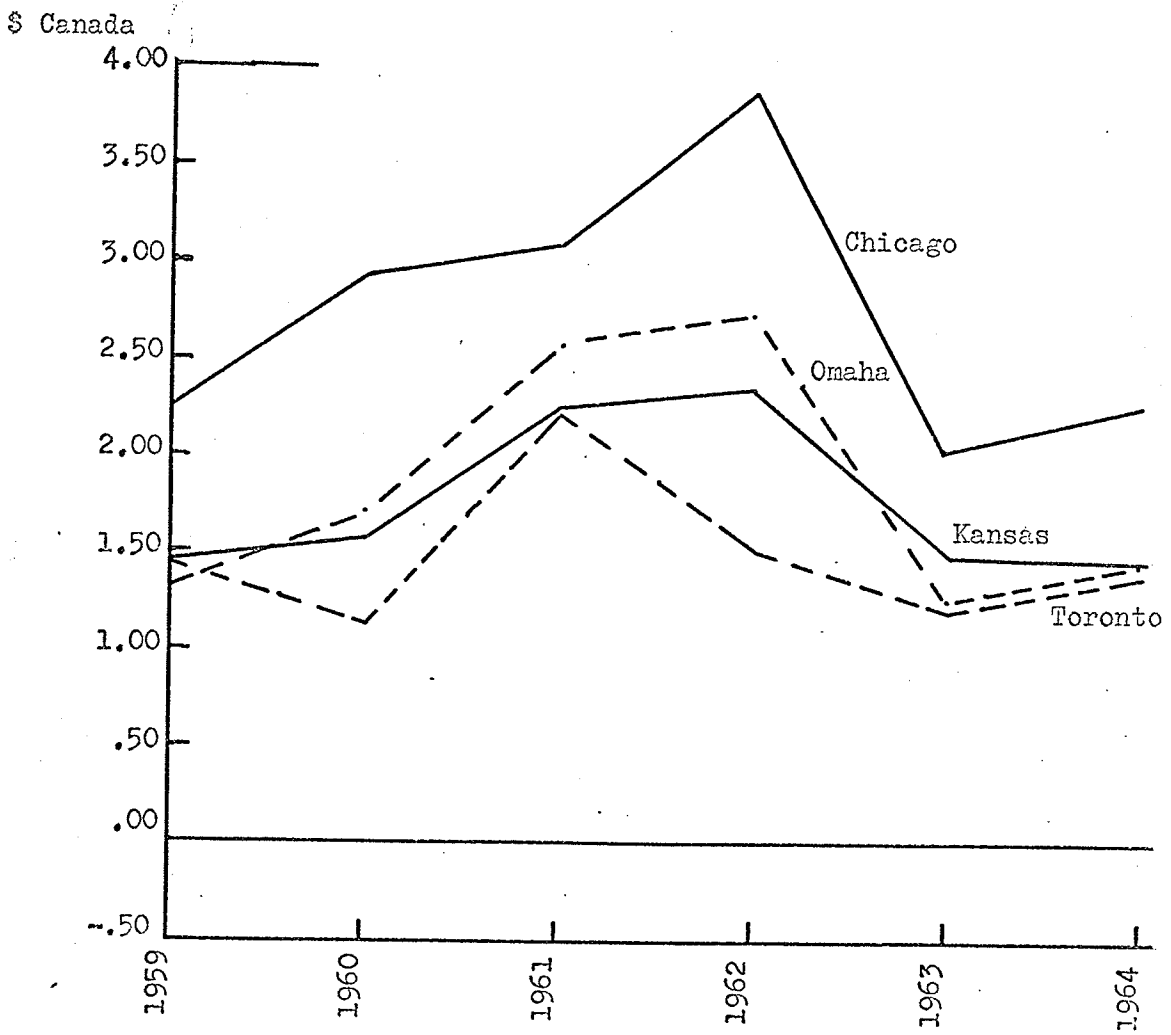


Figure 8.2 Average Annual Choice Steer Price Differential of Chicago, Omaha, Kansas, and Toronto over Winnipeg (1959-64)

Source: Figures 8.1 and 8.2 were computed from data obtained from Canadian and U.S. sources. See footnote Figure 5.3.

March and October to November. The pattern for feeder cattle is more varied, but October, March, April and May and occasionally July, are the low price months.

As shown on Figure 8.3, the spread in choice steer prices between Toronto and Chicago varies from month to month. Only for two months in 1960 were Toronto prices above those of Chicago. For most of the year, Toronto prices were higher than corresponding prices in the U. S. The price spread for the period generally reached the peak point in the spring months and the lowest point in the fall months. There were occasional departures from this tendency.

Beef cattle prices in Canada appear to be largely influenced by the following factors:

1. Total build up or depletion of supplies in Canada.
2. The proportion of top grade component in the total available supply.
3. Price levels in the United States.
4. Total slaughtering in Canada and in the United States.
5. Total cold storage holdings in the two countries.

The seasonal indexes of the last two items have been calculated. A period of ten years covering 1951-60 was arbitrarily used for the purpose. The data for a ten-year period were used because the more variations there are in the data, the larger the sample required to determine the degree of variability.

Meat is generally stored when production is seasonally heavy and prices seasonally low. It is moved out of storage into the retail channel

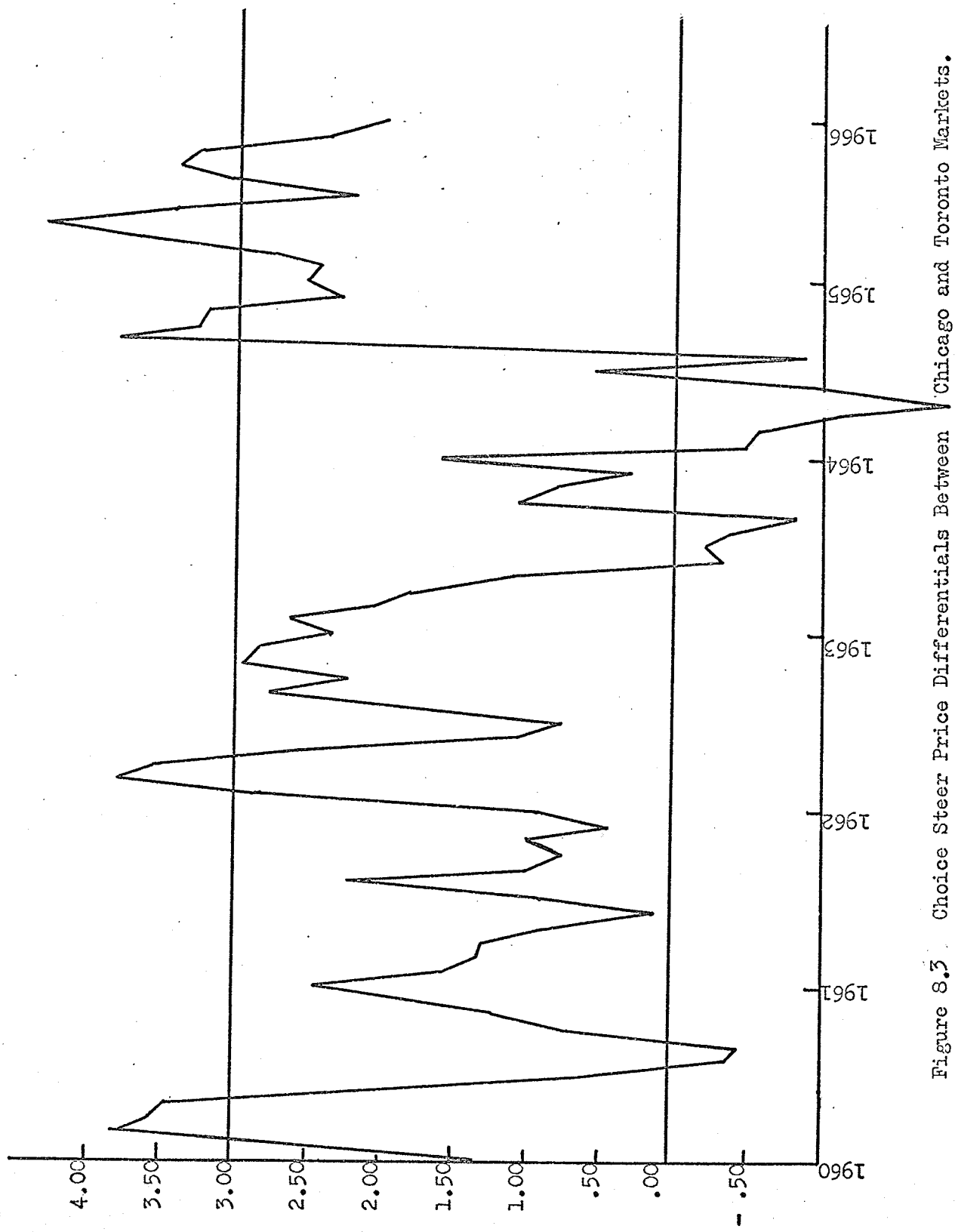


Figure 8.3 Choice Steer Price Differentials Between Chicago and Toronto Markets.

Source: Computed from monthly data obtained from Canadian and U.S. sources.

when the price situation improves. This helps in smoothing out prices and consumption over the year. (Table 8.2).

Indexes of cattle slaughter can, in the absence of more precise production data, be employed to indicate the pattern of supplies available to markets.

The results show that peak slaughter of cattle occurs in September in Canada and in October in the United States for the period considered. The normal seasonal pattern of slaughterings indicates that cattle slaughterings rise in the fall months and are below average in other months except June (108) and July (104) in Canada. More extreme variations are shown in the Canadian than in the U.S. slaughtering indexes. The respective ranges are 33 and 24 for Canada and the U.S. respectively. Still greater differences are shown in the variability of calf slaughterings in the two countries. The variations in the Canadian indexes are much greater. These seasonal patterns resulted mainly from the nature and organization of the cattle feeding industry. Some changes result from variations in the market demand for different weights of cattle and changes in feeding methods. The present day market demand in the U.S. is concentrated on choice grade (900-1200 pounds weight) as compared with 1100-1400 pounds in previous years. Because of this shift of emphasis, feeding patterns keep changing. Cattle feeders in the U.S. keep shifting their feeding pattern from yearlings and 2-year-olds to yearlings and calves. The feeding of 2-year-old steers has been declining.[6] A much

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[6] Cattle Marketing in Iowa, Iowa State Univ., Co-op. Exten. Service, Ames, Iowa, M-929, May 1961, p. 17.

TABLE 8.2

SEASONAL INDEXES OF INSPECTED CATTLE AND CALF SLAUGHTER AND COLD STORAGE HOLDINGS, U. S. AND CANADA, 1951-1960*

Month	Inspected Cattle Slaughter	Calf Slaughter	Cold Storage Holdings	Inspected Cattle Slaughter	Calf Slaughter	Cold Storage Holdings
	.....United States.....			.....Canada.....		
Jan.	104	88	132	96	55	111
Feb.	88	89	119	85	56	114
March	95	104	109	97	110	105
April	93	96	98	86	147	99
May	97	91	90	94	142	96
June	98	93	83	108	135	91
July	102	97	79	104	98	89
Aug.	105	103	80	96	91	87
Sept.	106	110	82	118	109	83
Oct.	112	121	91	106	90	94
Nov.	100	108	110	108	87	101
Dec.	98	100	126	99	74	116
Range	24	33	53	33	92	29

*Calculated from monthly data.

higher proportion of the cattle on feed are calves. In addition the availability of cheaper feed grains tend to shorten time on feed and quicken cattle turnover for slaughter.[7]

Statistical analysis

So far in the analysis we have assumed that the price differentials between spatially separated markets are significant. This assumption has been necessary for justifying the flow of beef cattle from one marketing centre to another. There are also temporal variations and some irregularity in the manner in which the "city"[8] prices respond to the general secular decline in cattle prices. An analysis of variance technique based on the one developed by Schultz and Black[9] will be employed to isolate the temporal and geographic variations in order to use the residual--which is attributable to sampling error for our analysis. The technique is similar in calculation to that developed by Foote and Karl Fox for investigating the presence of seasonality in monthly data. The only difference is that in the present analysis, "city" markets are used instead of years, so that the sum of squares between means of years becomes the sum of squares between localities. Thus the analysis breaks down the total sum of squares into three portions having their sources in (1) actual

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[7] Ibid., p. 7.

[8] Defined as livestock terminal markets at Chicago, Omaha, Kansas City, Toronto, Winnipeg and Calgary.

[9] Schultz and Black, op. cit., pp. 193-208.

geographic price differences which are accounted for by freight-rates, exchange factors, tariffs, and other handling charges involved in shipping (2) temporal price changes which affect all "city" markets alike and (3) the residual or sampling error.

The sum of squares between means of months isolates those price variations from the general means which are attributable to general market forces. Similarly, the sum of squares between means of "city" markets includes only those price variations due to geographical location of the cities. One major assumption in this analysis is that the market[10] affected cattle prices in the U.S. and in Canada simultaneously in the same direction and in like magnitude. This is a valid assumption for the reason that the markets under consideration are closely interrelated and that price making forces in one tend to affect the price levels in the other markets in the same direction. In our example, the mean square due to sampling error (interaction) measures the differential response of the annual prices to (1) geographical location and (2) secular trend in prices. If the results show a lack of uniformity in response to these conditions, it could be attributed to sampling error.

The analysis of variance technique serves to illustrate the point that by merely computing price differentials between localities we cannot conclude that there are significant price differences present. The general price change from month to month, affecting all localities alike

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[10] Market here refers to the 'continental' market comprised of the major U.S. and Canadian 'city' markets as listed previously.

could explain the heterogeneity in the prices. Schultz and Black have shown that the analysis of variance technique is effective in eliminating the effect of temporal changes in prices.

In using several years instead of one year, it is also possible to determine whether or not inter-year and intra-year movements of cattle prices exerted any influence on the price differentials between localities.[11] As an example, we could, by this analysis, investigate whether price differentials between "city" markets vary significantly within the marketing year and also whether the differentials behave differently between markets in some years than in others.

It has been found possible to use a range test for testing the homogeneity of the sample of means for the size of a sample under consideration. Newman-Keuls Sequential Range Test has been studied extensively and can be used to judge the significance of a set of differences. This method permits decision as to which differences are significant and which are not. It is a range test procedure and the error rate is applicable at each stage to tests involving the same number of means.[12]

Choice steer prices and good feeder steer prices which prevailed at Chicago, Omaha, Kansas City, St. Paul, Toronto, Winnipeg and Calgary for the years 1959-64 were used to test the significance of differences between the various markets. All the U.S. prices were converted into

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[11] Schultz and Black, op. cit., p. 202.

[12] Torrie and Steel, Principles and Procedures of Statistics, McGraw-Hill Book Company, 1960, pp. 110-111.

Canadian dollars. The results of the analysis of these prices using Newman-Keuls Range Test are shown in Tables 8.3 to 8.13. These results explain further the price differentials plotted on Figure 8.1 of this chapter. It can now be determined as to which differences are statistically significant and which are not. The test makes use of analysis of variance technique already described. The analysis determines the total variability of all the observations and breaks this down into two components of variability discussed previously.

The bulk of the work done in the field of analysis of variance assumes normal population distribution. Work has, however, been carried out along "non-parametric" lines in which no assumption as to the nature of the population is made.[13] We restrict our discussion in this chapter to this latter procedure.

The range test procedure allows us to determine simultaneously which price differences are significant and which are not. It also permits us to determine which market offers best returns from the point of view of producers. The differences adjudged significant and not significant at .05 level are shown in the triangular tables.

It is worth pointing out that some price differentials may appear to be statistically significant but not economically significant. The latter is a much more weighty factor and it determines geographical flows of beef cattle.

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[13] B.W. Lingren and C.W. McElcoth, Introduction to Probability and Statistics, the MacMillan Company, New York, 1959, p. 235.

The prices were converted into indexes based on the yearly average set equal to 100. This indexing would eliminate any trend that might have occured. The data then were statistically analysed using analysis of variance and Newman-Keuls Sequential Range tests to determine on which markets prices were significantly lower or higher than on other markets.

Price pattern

In 1959, significant choice steer price differences existed between the Western markets in Canada and the large consuming centres in the United States. The Chicago price averaged $2.53 and $2.26 per hundredweight over the Calgary and the Winnipeg markets respectively. While these prices differed significantly from a statistical standpoint, the obversed price spreads were not sufficiently large to encourage appreciable flows of cattle south. The Canadian beef cattle exports to the United States were sharply curtailed to less than half the record export figure of 1958. As regards the U.S. markets themselves, significant price differences did not exist between them. This is the normal pattern expected because some elements of costs involved in shipping cattle from Canada to the U.S., such as tariff changes, are absent between markets in the U.S.

In contrast with the previous year, cattle exports in 1960 were further down about 32 percent. Total slaughterings in Canada on the other hand, increased by 11 percent. This increase, together with a reduced export market, contributed toward stabilising prices at lower levels. The weakening of prices in Canada was a factor in widening the price spread between the Canadian markets and the Chicago market, (Tables

8.3 and 8.4.)

Nearly the same pattern as 1960 existed in 1961. Significantly higher prices were paid in Chicago, Kansas City, Omaha, and Toronto, but prices in Kansas City and Toronto were relatively lower when compared with prices in other markets in the United States. (Table 8.5.)

Two factors may have accounted for the relatively high price spread between the U.S. and the Canadian markets. The summer drought in Western Canada adversely affected the cattle industry. With the consequential increase in feed grain prices, feeding margins narrowed. Aided by the devaluation of the Canadian dollar in 1961, exports of feeders increased and this development helped to keep the Canadian prices at a higher level.

Higher beef cattle prices were the main feature of the industry in 1962. Scarcity of feed supplies and the devaluation of the dollar probably accounted for this higher price. Broadly speaking, the more cattle exported in the year, the higher the fed cattle prices in the year t+1. This tendency was apparent in 1962. Significant price differences existed between the U.S. and the Canadian markets. (Table 8.6)

Unlike 1962, price differences between Winnipeg and Omaha, Kansas City, and Toronto were not statistically significant in 1963. Increased marketings in Canada coupled with reduced exports depressed prices in Canada in 1963. (Table 8.7.)

In 1962 and 1963, the position of Winnipeg in relation to Omaha, Kansas City and Toronto changed as compared to 1961. With the exception of Chicago, price differences between Winnipeg and these markets were not

TABLE 8.3

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1959

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 26.83	Toronto 26.05	Kansas 26.01	Omaha 25.90	Winnipeg 24.57	Calgary 24.30
	Calgary	Winnipeg	Omaha	Kansas	Toronto		
Chicago	2.53*	2.26*	0.93	0.82	0.78	R_6 = 4.157 x .3136 = 1.3036	
Toronto	1.75*	1.48*	0.15	0.04		R_5 = 3.977 x .3136 = 1.2471	
Kansas City	1.71*	1.44*	0.11			R_4 = 3.737 x .3136 = 1.1719	
Omaha	1.60*	1.33*				R_3 = 3.397 x .3136 = 1.0653	
Winnipeg	0.27					R_2 = 2.827 x .3136 = .8865	

TABLE 8.4

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1960

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 25.52	Omaha 24.31	Kansas 24.18	Toronto 23.75	Winnipeg 22.60	Calgary 21.65
	Calgary	Winnipeg	Toronto	Kansas	Omaha		
Chicago	3.36*	2.92*	1.77*	1.34*	1.21*	R_6 = 4.157 x .245 = 1.0185	
Omaha	2.46*	1.71*	0.56	0.13		R_5 = 3.977 x .245 = .9744	
Kansas	2.33*	1.58*	0.43			R_4 = 3.737 x .245 = .9156	
Toronto	1.90*	1.15*				R_3 = 3.397 x .245 = .8323	
Winnipeg	0.75*					R_2 = 2.827 x .245 = .6926	

*Significant at .05 level.

TABLE 8.5

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1961

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 25.09	Kansas 24.55	Omaha 24.23	Toronto 24.20	Winnipeg 22.00	Calgary 21.65
	Calgary	Winnipeg	Toronto	Kansas City			
Chicago	3.44*	3.09*	0.89	0.54	$R_6 = 4.157 \times .4073 = 1.6931$		
Kansas	2.90*	2.55*	0.35		$R_5 = 3.977 \times .4073 = 1.6198$		
Omaha	2.58*	2.23*	0.03		$R_4 = 3.737 \times .4073 = 1.5221$		
Toronto	2.55*	2.20*			$R_3 = 3.397 \times .4073 = 1.3836$		
Winnipeg	0.35				$R_2 = 2.827 \times .4073 = 1.1151$		

*Significant at .05 level

TABLE 8.6

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1962

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 29.59	Omaha 28.40	Kansas 28.01	Toronto 27.20	Winnipeg 25.70	Calgary 25.60
	Calgary	Winnipeg	Toronto	Kansas	Omaha		
Chicago	3.99*	3.89*	2.39*	1.58*	1.19	$R_6 = 4.157 \times .5586 = 2.3013$	
Omaha	2.80*	2.70*	1.20	0.39		$R_5 = 3.977 \times .5586 = 2.2017$	
Kansas	2.41*	2.31*	0.81			$R_4 = 3.737 \times .5586 = 2.0688$	
Toronto	1.60	1.50				$R_3 = 3.397 \times .5586 = 1.8806$	
Winnipeg	0.10					$R_2 = 2.827 \times .5586 = 1.5650$	

*Significant at .05 level

TABLE 8.7

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1963

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 25.88	Kansas 25.34	Omaha 25.11	Toronto 25.05	Winnipeg 23.85
	Calgary	Winnipeg	Toronto	Omaha	Kansas	
Chicago	2.63*	2.03*	0.83	0.77	0.54	$R_6 = 4.157 \times .4126 = 1.7152$
Kansas	2.09*	1.49	0.29	0.23		$R_5 = 3.977 \times .4126 = 1.6409$
Omaha	1.86*	1.26	0.06			$R_4 = 3.737 \times .4126 = 1.5419$
Toronto	1.80*	1.20				$R_3 = 3.397 \times .4126 = 1.4016$
Winnipeg	0.60					$R_2 = 2.827 \times .4126 = 1.1664$

*Significant at .05 level

TABLE 8.8

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1964

CHOICE STEER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Chicago 24.93	Kansas 24.11	Omaha 24.10	Toronto 24.05	Winnipeg 22.68	Calgary 21.95
	Calgary	Winnipeg	Toronto	Omaha	Kansas		
Chicago	2.98*	2.25*	0.88	0.83	0.82	$R_6 = 4.157 \times .4063 = 1.689$	
Kansas	2.06*	1.43	0.06	0.01		$R_5 = 3.977 \times .4063 = 1.6159$	
Omaha	2.15*	1.42	0.05			$R_4 = 3.737 \times .4063 = 1.5183$	
Toronto	2.10*	1.37				$R_3 = 3.397 \times .4063 = 1.3802$	
Winnipeg	0.73					$R_2 = 2.827 \times .4063 = 1.1486$	

*Significant at .05 level

TABLE 8.9

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1959
GOOD FEEDER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment		Chicago	Kansas	Omaha	Toronto	St. Paul	Calgary	Winnipeg
Mean		26.86	26.11	25.99	25.12	24.06	23.22	23.01
	Winnipeg	Calgary	St. Paul	Toronto	Omaha	Kansas		
Chicago	3.85*	3.64*	2.80*	1.74*	0.87	0.75	R_7 = 4.302 x .4063 = 1.7479	
Kansas	3.10*	2.89*	2.05*	0.99	0.12	R	R_6 = 4.152 x .4063 = 1.687	
Omaha	2.98*	2.77*	1.93*	0.87			R_5 = 3.972 x .4063 = 1.6138	
Toronto	2.11*	1.90*	1.06				R_4 = 3.732 x .4063 = 1.5163	
St. Paul	1.05	0.84					R_3 = 3.392 x .4063 = 1.3782	
Calgary	0.21						R_2 = 2.822 x .4063 = 1.1466	

*Significant at .05 level

TABLE 8.10

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1961
GOOD FEEDER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment		Chicago	Omaha	Toronto	Kansas	St. Paul	Winnipeg	Calgary
		25.23	23.69	22.88	22.57	21.59	20.91	19.01
	Calgary	Winnipeg	St. Paul	Kansas	Toronto	Omaha		
Chicago	6.20*	4.52*	3.64*	2.64*	2.35*	1.54*	R_7 = 4.302 x .3250 = 1.3982	
Omaha	4.66*	2.78*	2.10*	1.10	0.81		R_6 = 4.152 x .3250 = 1.3494	
Toronto	3.85*	1.97*	1.29*	0.31			R_5 = 3.972 x .3250 = 1.2909	
Kansas	3.54*	1.66*	0.98*				R_4 = 3.732 x .3250 = 1.2129	
St. Paul	2.56*	0.68					R_3 = 3.392 x .3250 = 1.1024	
Winnipeg	1.88*						R_2 = 2.822 x .3250 = 0.9172	

*Significant at .05 level .

TABLE 8.11

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1962

GOOD FEEDER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Omaha 27.28	Kansas 26.06	Chicago 25.93	Toronto 24.90	Winnipeg 24.40	St. Paul 24.32	Calgary 24.20
	Calgary	St. Paul	Winnipeg	Toronto	Chicago	Kansas		
Omaha	3.08*	2.96*	2.88*	2.38*	1.35*	1.22*	R_7 = 4.302 x .3826 = 1.65	
Kansas	1.86*	1.74*	1.66*	1.16	0.13		R_6 = 4.152 x .3826 = 1.59	
Chicago	1.73*	1.61*	1.53*	1.03			R_5 = 3.972 x .3826 = 1.52	
Toronto	0.70	0.58	0.50				R_4 = 3.732 x .3826 = 1.43	
Winnipeg	0.20	0.08					R_3 = 3.392 x .3826 = 1.30	
St. Paul	0.12						R_2 = 2.822 x .3826 = 1.08	

TABLE 8. 12

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1963

GOOD FEEDER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Omaha 26.32	Kansas 25.59	Toronto 25.30	Chicago 25.19	Calgary 23.25	Winnipeg 23.20	St. Paul 22.53
	St. Paul	Winnipeg	Calgary	Chicago	Toronto	Kansas		
Omaha	3.79*	3.02*	3.07*	1.13	1.02	0.73	R_7 = 4.302 x .3202 = 1.38	
Kansas	3.06*	2.39*	2.34*	0.40	0.29		R_6 = 4.152 x .3202 = 1.33	
Toronto	2.77*	2.10*	2.05*	0.11			R_5 = 3.972 x .3202 = 1.27	
Chicago	2.66*	1.99*	1.94*				R_4 = 3.732 x .3202 = 1.20	
Calgary	0.72	0.05					R_3 = 3.392 x .3202 = 1.09	
Winnipeg	0.67						R_2 = 2.822 x .3202 = 0.90	

*Significant at 5% level

TABLE 8. 13

MEAN PRICES AND TRIANGULAR TABLE OF DIFFERENCES OF 1964 GOOD FEEDER PRICES, NEWMAN-KEUL'S RANGE TEST

Treatment Means		Toronto	Omaha	Chicago	Kansas	Winnipeg	Calgary	St. Paul
	St. Paul	Calgary	Winnipeg	Kansas	Chicago	Omaha		
Toronto	4.39*	2.10*	1.95*	1.51*	0.82	0.46	R_7 = 4.302 x .3797 = 1.63	
Omaha	3.93*	1.64*	1.49*	1.05	0.36		R_6 = 4.152 x .3797 = 1.58	
Chicago	3.57*	1.28*	1.13	0.69			R_5 = 3.972 x .3797 = 1.51	
Kansas	2.88*	0.59	0.44				R_4 = 3.732 x .3797 = 1.42	
Winnipeg	2.44*	0.15					R_3 = 3.392 x .3797 = 1.29	
Calgary	2.29*						R_2 = 2.822 x .3797 = 1.07	

*Significant at .05 level

significant. These were also years of reduced exports of cattle to the United States. Thus further evidence could be adduced to support the view that years of significant price differences are also years of increased exports, and strengthened Canadian prices. The results for good feeder and stocker price differences are given in the appendices.

Summary and implications

In the theoretical part of this study it was assumed that there was a price relationship between spatially separated markets dealing with a homogeneous commodity. A statistical test of significance has been used to measure the closeness of this interrelationship.

Broadly speaking, the tendency has been for the price difference to assume significant proportions as the distance between the markets increases. These differences are greater when nationally separated markets are considered. In our results it has been demonstrated that the price spread between the Canadian markets and Chicago are more significant than corresponding price differences between markets that are geographically closer together in the United States.

Price variations among markets can be expected because of differences in transportation and other handling costs from the supply areas to the consuming centres. However, apart from the Prairie markets vis-a-vis the Chicago market, the price spread between markets did not follow any consistent pattern. Throughout a greater part of the period under study, prices of choice and good feeder steers at Chicago were the highest, with the next highest varying between Omaha, Kansas City and Toronto. (Tables 8.3 and 8.7.)

In Figure 8.1, referred to previously, it is obvious that the price spread lines are not parallel. These deviations show that the spatially connected market is not a perfect market. Suppliers often do not have sufficient knowledge to compare prices in different markets and make informed decisions in choosing the best alternative outlets with the existing market information system.

The nature of the test applied

In applying the analysis of variance technique it was tacitly assumed that geographical factors accounted for the greater part of variations in cattle prices. This assumption has been necessary for using a simplified model needed to reveal some of the problems connected with the price interrelationships between United States and Canadian cattle markets.

But when dealing with nationally separated markets it would be better to consider the fact that other sources of variations not identified may affect the continental market per se or are peculiar to one national market alone. In this connection a much more sophisticated analysis of variance tool will be necessary.

In using the range test, there are a number of possible errors in the analysis:

1. It has not been possible to group the treatment means so that variation among units within groups will be less than variations among units in different groups.

2. The assumptions underlying the analysis of variance are not fully met.

All these difficulties make the validity of the results somewhat dubious. However, to the extent that some logical relationships have been revealed, the analytical procedure employed may be justified.

CHAPTER IX

SUMMARY AND CONCLUSIONS

Beef cattle production is a very important industry in North America. The volume of marketing is a dominant factor which affects prices. Because the income elasticity for beef is high, general economic conditions also affect the price of beef cattle. On the supply side, factors such as "weather, conditions, feed supplies, alternative production possibilities, general economic conditions" and certain episodic forces are important in influencing production.[1] Because of the strong economic ties between the U.S. and Canada and also because of the geographical propinquity of the two countries, there have been very close inter-relationships between beef consumption and production practices in the two countries. In the light of the need for adequate parameters to estimate how close and influential this relationship is, this study was initiated.

More specifically, the objectives of the study were:

1. To investigate whether the Canadian cattle production cycle is internally generated or is largely influenced by the cattle production cycle in the United States and to formulate a model that would facilitate testable predictions for the cyclical behavior of cattle numbers.

2. To examine and evaluate the spatial variations in cattle

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[1] Marshall, op. cit., p. 19.

prices paid to producers of both fed and feeder cattle.

3. To estimate and evaluate the supply and demand elasticities for fed and feeder cattle in Canada in a way that would reveal some of the aspects of the interrelationship between the beef cattle industries in the U.S. and in Canada.

The following hypotheses were formulated:

1. The Canadian cattle production cycle is not internally generated but is strongly influenced by the U.S. cattle cycle.

2. The level of U.S. cattle prices sets the boundaries of the cattle price changes in Canada.

3. Canadian cattle prices are very sensitive to the level and variations in cattle prices in the U.S.

In order to test these hypotheses, the following basic qualifying assumptions were made:

1. Large numbers of buyers.

2. Large number of sellers.

3. Perfect knowledge.

4. Rationality and consistency of behavior of buyers and sellers.

5. Absence of friction and hindrance to resource and product movements.

6. Product homogeneity.

Other assumptions were incorporated into the analysis to deal with specific problems.

The scope of the study was restricted to choice steer and feeder

steer prices and production, and inventory by class of cattle on farms in Canada and in the United States. The data used in the analysis were obtained from secondary sources, mainly from the United States Department of Agriculture publications and the Dominion Bureau of Statistics publications.

An attempt was made to trace the historical picture of the cattle trade between the U.S. and Canada. There was also a review of the historical fluctuations in cattle production and the particular circumstances which have at one time or another disrupted the cattle trade between the two countries. Three major disruptive circumstances examined were:

1. The 1920 emergency regulations which imposed exorbitant ad valorem duty of 30% on cattle imports into the U.S.

2. Series of beef agreements with the United Kingdom which reduced cattle exports from Canada to the United States.

3. From February 1952 to March 1953, an embargo was placed on Canadian exports of cattle to the U.S. because of the outbreak of foot and mouth disease in Saskatchewan.

A modified Fourier analysis was chosen as the operational technique on which the inventory data were analysed to derive the cattle cycles. The basic form of the equation was:

$$Y_t = A_t + BT_t + I_c + E_t \qquad (1)$$

where Y_t = cattle inventory on farms, T_t = technology, A_t = resource inputs, I_c = episodic, price, weather and other influences or the composite inventory cycle, and E_t is an error term. The first two terms of the

equation constitute a linear trend, approximating the effects of technology and resource inputs. The composite inventory cycle was expressed in the following harmonic equation:

$$I_c = \sum_{k=1}^{i} \frac{1}{N} C_k \left[\text{sine} \left[\beta_k + \left(\frac{\pi k}{N} \right) (T - T_o) \right] \right] \qquad (2)$$

where $\frac{1}{N} C_k$ = the amplitude of the cycle;

β_k = the phase angle of the cycle;

$\frac{\pi k}{N}$ = the frequency of the cycle; and

k = the index of each individual cycle.

Using data covering the 1906-62 period, a linear regression was used and the residuals were obtained by substracting the calculated trend value from the actual data. The Fourier analysis was then performed on the residuals to obtain the cycles. Cycles of long, medium, and short-period were identified. The sum of these cyclical values for each year (i.e. the composite inventory cyclical value) plus the trend value constitute the predicted cattle numbers on farms in each country.

Spectrum analysis was performed on the reduced data in order to determine the time lag between the U.S. and the Canadian cattle cycles. The results obtained from the correlation of time series analysis show the Canadian cycle lags behind that of the U.S. by approximately one year. However, an examination of the actual data reveal the following deviations from the above mentioned pattern.

1. The upturn of the U.S. cattle inventory in 1949 led that in Canada by two years.

2. The downturn of the U.S. inventory in the 1950's was of three years in duration while the contraction in Canada was only for one year.

3. The Canadian inventory fell relatively lower in 1945-50 than that in the U.S. but rose relatively higher from 1950 to 1962.

The above mentioned deviations have been attributed to:

a) differences in grain marketing and pricing policies in the two countries, and

b) the occurrence of severe drought in some sections of the United States cattle producing areas.[2]

The annual rates of increase of cattle numbers by class on the U.S. and Canadian farms were computed using data from 1941 to 1963. The results show that the way cattle producers respond to economic incentives and adjust their production is very similar in the two countries.

There has been no clear indication as to whether there is any causal relationship between the U.S. and the Canadian cattle cycles. However, with the exception of the three deviations mentioned above, it is clear that the two cycles move together. The general dependence of Canadian cattle prices on the price movements in the United States has been recognised in several studies. The sensitivity of the Canadian cattle prices to prices in the U.S. has been tested in the present study. Because prices and production interact to produce cycles, it follows necessarily that the U.S. cattle cycle greatly influences that of Canada.

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[2]Marshall, op. cit., p. 19.

A model based on pooled simple regression analysis was used to measure the degree of sensitivity of the Canadian beef cattle exports to beef cattle price movements in the United States. The estimated elasticities of export response with respect to price differentials and price ratios of selected markets in the U.S. and in Canada are high and significant. This suggests that an increase in beef cattle prices in the U.S. relative to beef cattle prices in Canada is likely to bring about an appreciable flow of cattle across the border. It also implies that reduced cattle exports to the U.S. will bring about an appreciable reduction in cattle prices in Canada. From the significance of these export elasticities, the hypothesis of the high sensitivity of the Canadian beef cattle prices to beef cattle prices in the U.S. may be accepted on the basis of empirical evidence.

In chapter VII, we attempted to show the relationship between imports, exports and cattle prices in Canada and in the United States based on statistical analysis using annual data. With respect to the U.S. , the analysis was conducted to measure the impact of cow beef production, steer and heifer production, imports and foreign production on fed cattle and beef cow prices. As indicated in chapter VII, fed cattle and cow beef prices in the U.S. are influenced primarily by fed cattle production. Beef and veal imports into the U.S. are greatly influenced by the production of steer, heifer and cow beef in the U.S. It was estimated that an increase of 10 percent in beef production in Canada is associated with approximately 1.2 percent decrease in choice steer and utility cow prices in the U.S. As far as Canada is concerned,

the most important factor influencing cattle prices is the movement of cattle price in the United States.

In chapter VIII, a statistical test of significance was employed to measure the closeness of the cattle price interrelationship between the two countries. All the prices were converted into Canadian dollars and into indices with the yearly averages equal 100. The data then were statistically analysed based on the analysis of variance and Newman-Keuls range test to determine on which market prices were significantly lower or higher than prices on the other markets.

In the absence of any institutional and political barriers, it is expected that after adjusting for those factors presumed to account for geographical variations there will be a uniform price map prevailing in the selected U.S. and Canadian markets. The price differentials plotted on Figure 8.1 will then tend to be approximately parallel to the x-axis. The wave-like movements of the price differentials reveal the extent to which the spatially connected markets do not operate according to concept of the perfect market.

Recommendations For Future Research

This study relied heavily on official statistics pertaining to cattle production and prices published by the Canada Department of Agriculture and the Dominion Bureau of Statistics. Some writers have highly commended the Canadian records on cattle production and marketing.[3]

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[3]C.L. Harlan, Canadian Livestock Industry, Foreign Agriculture

It is the opinion of the present writer that the official records stand in need of revision. The data on cattle slaughter should be recorded by class of cattle. Both the monthly and yearly summaries should be given. Beef cattle producers have been encountering recurring short-term price difficulties and it is necessary that they should be provided with information that will enable them to make the necessary short-term adjustments. Data on average dressed weights of cattle should be provided on a monthly, or possibly, on a weekly basis. Sizeable variations in average dressed weights, particularly at the time of large marketings, accentuate the fluctuations of beef production and hence, fed cattle prices. As a first step toward the stabilization of the income of producers, short-term variations in steer and heifer production should be eliminated. This would require more precise short-term adjustments in production and this will depend on the quality of statistical information that is made available to producers. It is recommended, therefore, that the Canada Department of Agriculture prepare and disseminate weekly and monthly market summaries and outlook reports covering such things as slaughter weights, number of cattle on feed, exports of feeders and fed cattle and their sources, and the profitability of cattle feeding operations as measured by the difference between choice steer prices and the prices of good feeders 9 to 12 months earlier. Also, a study should be initiated to asses the impact of the Chicago Futures market for beef cattle on the cattle industry in Canada.

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APPENDIX

APPENDIX A

TABLE 1

CATTLE PRODUCTION, ACTUAL, TREND, AND PREDICTED, CANADA 1906-62

ACTUAL	TREND	PREDICTED
7202.0000	6543.3213	6721.5213
7153.0000	6617.7321	6488.5841
6997.0000	6692.1429	6472.2269
6651.0000	6766.5538	6365.0548
6515.0000	6840.9646	6344.4946
6526.0000	6915.3754	6408.5214
6686.0000	6989.7862	6596.7362
6855.0000	7064.1971	6839.0011
6911.0000	7138.6079	6777.8609
7221.0000	7213.0187	6850.2277
7499.0000	7287.4296	7221.2536
7790.0000	7361.8404	7499.0704
8251.0000	7436.2512	7765.7122
8485.0000	7510.6620	7962.8410
8154.0000	7585.0729	8137.2749
8370.0000	7659.4837	8272.1387
8267.0000	7733.8945	8064.3495
7975.0000	7808.3054	7968.3504
8135.0000	7882.7162	8127.1902
7977.0000	7957.1270	8120.6320
7818.0000	8031.5378	8038.5468
7604.0000	8105.9487	7883.8917
7458.0000	8180.3595	7794.6805
7518.0000	8254.7703	7825.9493
7686.0000	8329.1812	7687.3122
7973.0000	8403.5920	7787.4520
8548.0000	8478.0028	8186.5558
8954.0000	8552.4136	8422.0086
9070.0000	8626.8245	8575.6725
8973.0000	8701.2353	8675.7623
8829.0000	8775.6461	8874.0221
8915.0000	8850.0569	9194.2919
8491.0000	8924.4678	9272.7538
8374.0000	8998.8786	9438.5386
8380.0000	9073.2894	9729.0534
8517.0000	9147.7003	9707.3603
8712.0000	9222.1111	9538.8981

CONTINUED

ACTUAL	TREND	PREDICTED
9122.0000	9296.5219	9330.3569
9544.0000	9370.9327	9269.1847
9632.0000	9445.3436	9367.3456
9174.0000	9519.7544	9233.7604
9085.0000	9594.1652	9197.2842
8984.0000	9668.5761	9340.1781
8641.0000	9742.9669	9293.7879
8343.0000	9817.3977	9268.6467
8363.0000	9891.8085	9356.4225
9152.0000	9966.2194	9670.3164
9806.0000	10040.6300	10128.0070
10170.0000	10115.0410	10273.9890
10603.0000	10189.4210	10427.8970
11011.0000	10263.8620	10702.3360
11265.0000	10338.2730	10756.2140
10990.0000	10412.6840	10789.8730
11058.0000	10487.0950	10847.3910
11337.0000	10561.5060	10993.1750
11934.0000	10635.9160	11139.6950
12075.0000	10710.3270	10888.5280

SOURCE.
COMPUTED, BASED ON FOURIER ANALYSIS GIVEN IN THE TEXT.

TABLE II

CATTLE PRODUCTION, ACTUAL, TREND, AND PREDICTED, U.S. 1906-62

ACTUAL	TREND	PREDICTED
65009.0000	54801.0530	63806.2910
63754.0000	55463.8320	65721.4970
61989.0000	56126.6120	65107.6100
60774.0000	56789.3910	62947.0950
58993.0000	57452.1710	61504.7770
57225.0000	58114.9500	60904.2390
55675.0000	58777.7300	60631.3550
56592.0000	59440.5090	61847.8200
59461.0000	60103.2880	64862.5590
63849.0000	60766.0680	67364.7450
67438.0000	61428.8470	67824.4710
70979.0000	62091.6270	67262.5670
73040.0000	62754.4060	66172.4940
72094.0000	63417.1860	63799.2920
70400.0000	64079.9650	61222.4840
68714.0000	64742.7450	60782.0030
68795.0000	65405.5240	62334.9990
68546.0000	66068.3030	64039.0570
65996.0000	66731.0830	65725.2950
63373.0000	67393.8620	67684.2130
60576.0000	68056.6420	68266.3220
58178.0000	68719.4210	66406.6190
57322.0000	69382.2010	63965.3580
58877.0000	70044.9800	62698.7060
61003.0000	70707.7600	62119.6090
63030.0000	71370.5390	62241.4300
65801.0000	72033.3180	64383.4960
70280.0000	72696.0980	67887.2160
74369.0000	73358.8770	70202.2550
68846.0000	74021.6570	70755.5240
67847.0000	74684.4360	70787.2240
66098.0000	75347.2160	70147.3040
65249.0000	76009.9950	68371.2710

CONTINUED

ACTUAL	TREND	PREDICTED
66029.0000	76672.7740	67318.2070
68309.0000	77335.5540	68802.1670
71755.0000	77993.3330	71711.4010
76025.0000	78661.1130	74515.1780
81204.0000	79323.8920	77563.8870
85334.0000	49986.6720	80543.7660
85573.0000	80649.4510	81511.5400
82235.0000	81312.2310	80375.0440
80554.0000	81975.0100	79439.1650
77171.0000	82637.7890	79646.6540
76830.0000	83300.5690	80269.7680
77960.0000	83963.3480	81950.0740
82083.0000	84626.1280	85697.5670
88072.0000	85288.9070	89880.8020
94241.0000	85951.6870	92226.5970
95679.0000	86614.4660	93084.5360
96592.0000	87277.2460	93469.6660
95900.0000	87940.0250	92743.5300
92860.0000	88602.8040	91110.4000
91176.0000	89265.5840	90901.0080
93322.0000	89928.3630	93024.4330
96236.0000	90591.1430	95760.0480
97139.0000	91253.9220	98216.5220
100002.0000	91916.7020	100921.9300

SOURCE.
COMPUTED, BASED ON FOURIER ANALYSIS GIVEN IN THE TEXT.

TABLE III

AVERAGE CATTLE PRICES RECEIVED BY FARMERS, U.S. 1909-59

ACTUAL	TREND	PREDICTED
6.4000	4.5296	9.5956
5.9700	4.8484	8.0984
6.4900	5.1672	8.1662
7.5100	5.4860	9.0970
7.8500	5.8048	8.5458
7.7000	6.1236	9.2096
8.3700	6.4424	10.7124
10.4000	6.7612	9.6302
11.7000	7.0801	8.4101
12.7000	7.3989	8.9439
11.8000	7.7177	8.3267
7.8500	8.0365	7.7635
7.6400	8.3553	9.3263
7.9000	8.6741	9.4801
7.8300	8.9929	7.8749
8.5900	9.3117	7.8857
9.3400	9.6305	7.7535
10.1000	9.9493	6.4773
11.8000	10.2681	7.3731
12.2000	10.5869	8.8589
9.6800	10.9057	7.9967
6.9500	11.2245	7.6625
4.9500	11.5434	8.2794
4.6400	11.8622	7.2242
4.9200	12.1810	7.1150
7.1600	12.4998	9.2498
7.2000	12.8186	9.8196
8.1000	13.1374	9.5264
7.9000	13.4562	10.7152
8.4000	13.7750	13.6890
8.8300	14.0938	9.8238
10.3000	14.4126	11.5436
12.3000	14.7314	13.4014
13.3000	15.0502	13.5052
12.4000	15.3690	14.7600
13.0000	15.6879	15.9609
15.2000	16.0067	15.0357
20.4000	16.3255	15.5195
24.4000	16.6443	17.7623
22.6000	16.9631	18.3891
26.3000	17.2819	19.1589
31.9000	17.6007	21.0727
25.8000	17.9195	20.8145
16.7000	18.2383	19.9663
16.5000	18.5571	21.4661
16.8000	18.8759	22.4379
16.1000	19.1947	22.4587
18.7000	19.5135	24.1515
25.3000	19.8324	24.8984

SOURCE.
COMPUTED, BASED ON FOURUER ANALYSIS GIVEN IN THE TEXT.

TBALE IV

AVERAGE CALF PRICES RECEIVED BY FARMERS, U.S. 1910-58

ACTUAL	TREND	PREDICTED
4.5000	2.4425	8.6005
4.8600	2.7689	7.8839
4.5700	3.0953	7.0743
5.4300	3.4217	7.0207
6.2000	3.7481	6.2251
6.5200	4.0745	4.7955
6.2600	4.4009	4.9309
6.7600	4.7273	6.6343
8.5400	5.0537	7.6297
9.8800	5.3801	7.6871
9.9700	5.7064	8.3594
8.7100	6.0328	8.9918
5.6300	6.3592	7.7432
5.7300	6.6856	5.6086
5.8400	7.0120	4.8370
5.8400	7.3384	4.9364
6.5300	7.6648	4.4348
6.7500	7.9912	4.4102
7.7200	8.3176	6.1226
9.5200	8.6440	7.8260
9.4700	8.9704	7.7294
7.7100	9.2967	7.1077
5.5300	9.6231	7.2201
4.2500	9.9495	6.7335
3.7500	10.2759	5.0839
4.1300	10.6023	4.4443
6.0400	10.9287	5.8137
5.8200	11.2551	7.2761
7.0000	11.5815	7.9825
6.5400	11.9079	9.4309
7.1400	12.2343	11.5133
7.5600	12.5606	12.0306
8.8200	12.8870	10.9800
10.7000	13.2134	10.6374
11.9000	13.5398	11.2328
10.8000	13.8662	11.2132
12.1000	14.1926	11.2336
14.5000	14.5190	13.1350
18.4000	14.8454	15.9224
22.2000	15.1718	17.3468
19.8000	15.4982	17.9002
23.3000	15.8245	19.0545
28.7000	16.1509	19.7319
24.3000	16.4773	18.6723
16.3000	16.8037	17.6217
16.0000	17.1301	18.3711
15.6000	17.4565	19.6455
14.9000	17.7829	20.1859
17.2000	18.1093	21.3553
21.9000	18.4357	23.6277
22.6000	18.7621	24.9201

SOURCE

COMPUTED, BASED ON FOURIER ANALYSIS GIVEN IN THE TEXT

TABLE V

AVERAGE DRESSED WEIGHT OF CATTLE, U.S. 1920-60

ACTUAL	TREND	PREDICTED	INDEXES
468.0000	457.7177	462.6687	101.0149
485.0000	459.2220	467.0620	101.6072
481.0000	460.7264	473.8424	102.6887
471.0000	462.2307	465.4077	100.6512
466.0000	463.7351	450.7801	97.3442
468.0000	465.2394	444.2224	95.6915
480.0000	466.7438	460.9558	98.8134
477.0000	468.2482	453.5572	96.9883
480.0000	469.7525	476.2575	101.3335
488.0000	471.2569	485.3079	102.8804
491.0000	472.7612	478.4622	101.1687
497.0000	474.2656	488.3226	102.8816
483.0000	475.7700	489.1120	102.7351
491.0000	477.2743	482.2283	101.0155
428.0000	478.7787	453.0057	94.7165
446.0000	480.2830	468.9870	97.6843
463.0000	481.7874	477.3724	99.0949
446.0000	483.2917	469.6167	97.1966
466.0000	484.7961	486.3651	100.3216
480.0000	486.3005	494.3995	101.6602
482.0000	487.8048	506.5038	103.8332
495.0000	489.3092	499.0912	102.0053
492.0000	490.8135	505.3675	102.9835
482.0000	492.3179	488.5139	99.2201
461.0000	493.8223	472.4513	95.6189
474.0000	495.3266	492.6936	99.4602
473.0000	496.8310	484.9970	97.5740
466.0000	498.3353	485.3563	97.3393
473.0000	499.8397	493.9607	98.7948
503.0000	501.3440	521.6190	104.1563
514.0000	502.8484	520.7974	103.6795
519.0000	504.3528	507.9178	100.7308
520.0000	505.8571	520.1851	102.9372
508.0000	507.3615	501.7815	98.8561
502.0000	508.8658	500.3128	98.2466
510.0000	510.3702	498.0162	97.4674
521.0000	511.8746	498.6676	97.2925
525.0000	513.3789	499.3839	97.1310
547.0000	514.8833	513.9403	99.8066
572.0000	516.3876	542.6146	105.3765
506.0000	517.8920	522.8430	101.0149

SOURCE.
BASED ON FOURIER ANALYSIS GIVEN IN THE TEXT

TABLE VI

AVERAGE DRESSED WEIGHT OF CATTLE, CANADA 1920-62

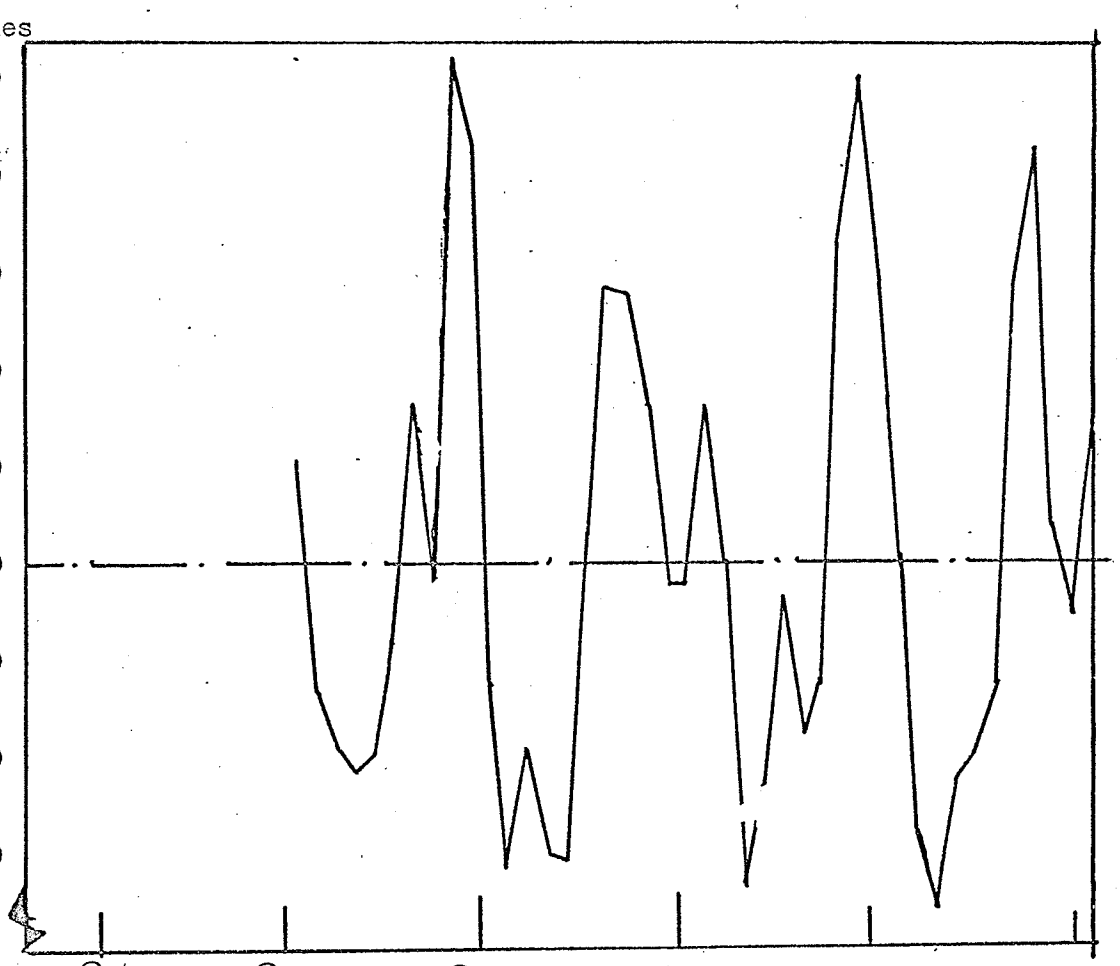
ACTUAL	TREND	PREDICTED	INDEXES
486.0000	499.7621	494.0971	98.8439
511.0000	499.2984	499.8004	100.1024
549.0000	498.8346	513.1126	102.9137
541.0000	498.3708	510.1698	102.4078
525.0000	497.9071	503.4761	101.1364
516.0000	497.4433	493.1183	99.1173
514.0000	496.9796	490.8656	98.7523
510.0000	496.5158	485.8918	97.8319
493.0000	496.0521	476.2711	95.9632
502.0000	495.5883	487.2263	98.2935
514.0000	495.1245	503.1715	101.6421
513.0000	494.6608	514.8818	104.1265
509.0000	494.1970	508.8350	102.9872
500.0000	493.7333	494.9413	100.2465
494.0000	493.2695	494.9415	100.3412
467.0000	492.8058	488.9548	99.2141
464.0000	492.3420	483.0840	98.1107
446.0000	491.8782	480.3682	97.6511
460.0000	491.4145	486.0355	98.9023
461.0000	490.9507	497.3517	101.3062
459.0000	490.4870	489.8190	99.8636
462.0000	490.0232	485.6342	99.1043
476.0000	489.5594	491.0734	100.3089
479.0000	489.0957	500.4257	102.3121
476.0000	488.6319	504.2909	103.1955
463.0000	488.1682	490.3072	100.4365
465.0000	487.7044	485.1874	99.4863
458.0000	487.2407	481.5667	98.8421
457.0000	486.7769	473.6149	97.3140
455.0000	486.3131	470.2861	96.7293
457.0000	485.8494	473.8234	97.5458
481.0000	485.3856	495.7326	102.1115
503.0000	484.9219	505.0049	104.0983
496.0000	484.4581	497.0241	102.5643
485.0000	483.9944	488.7644	100.9734
485.0000	483.5306	481.3886	99.5628
484.0000	483.0668	481.9558	99.7732
495.0000	482.6031	472.6311	97.9650
501.0000	482.1393	469.0713	97.3331
510.0000	481.6756	479.5886	99.5741
512.0000	481.2118	483.7328	100.5144
519.0000	480.7480	483.2000	100.5003
518.0000	480.2843	474.6193	98.8439

SOURCE.
BASED ON FOURIER ANALYSIS GIVEN IN THE TEXT

APPENDIX B

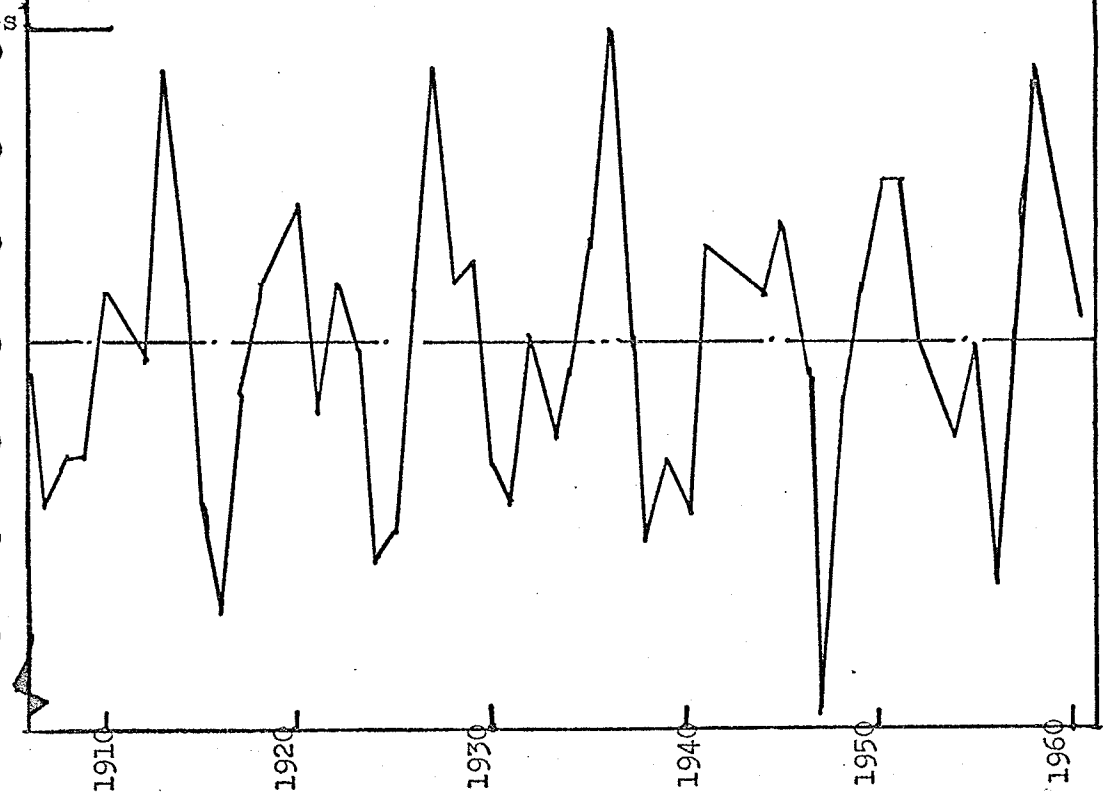
CANADA AND THE U.S. 1906-62.

Figure I. Canada exports, 1920-62.



CYCLICAL INDEXES OF CATTLE IMPORTS AND EXPORTS,

Figure II. U.S. Imports, 1906-60.



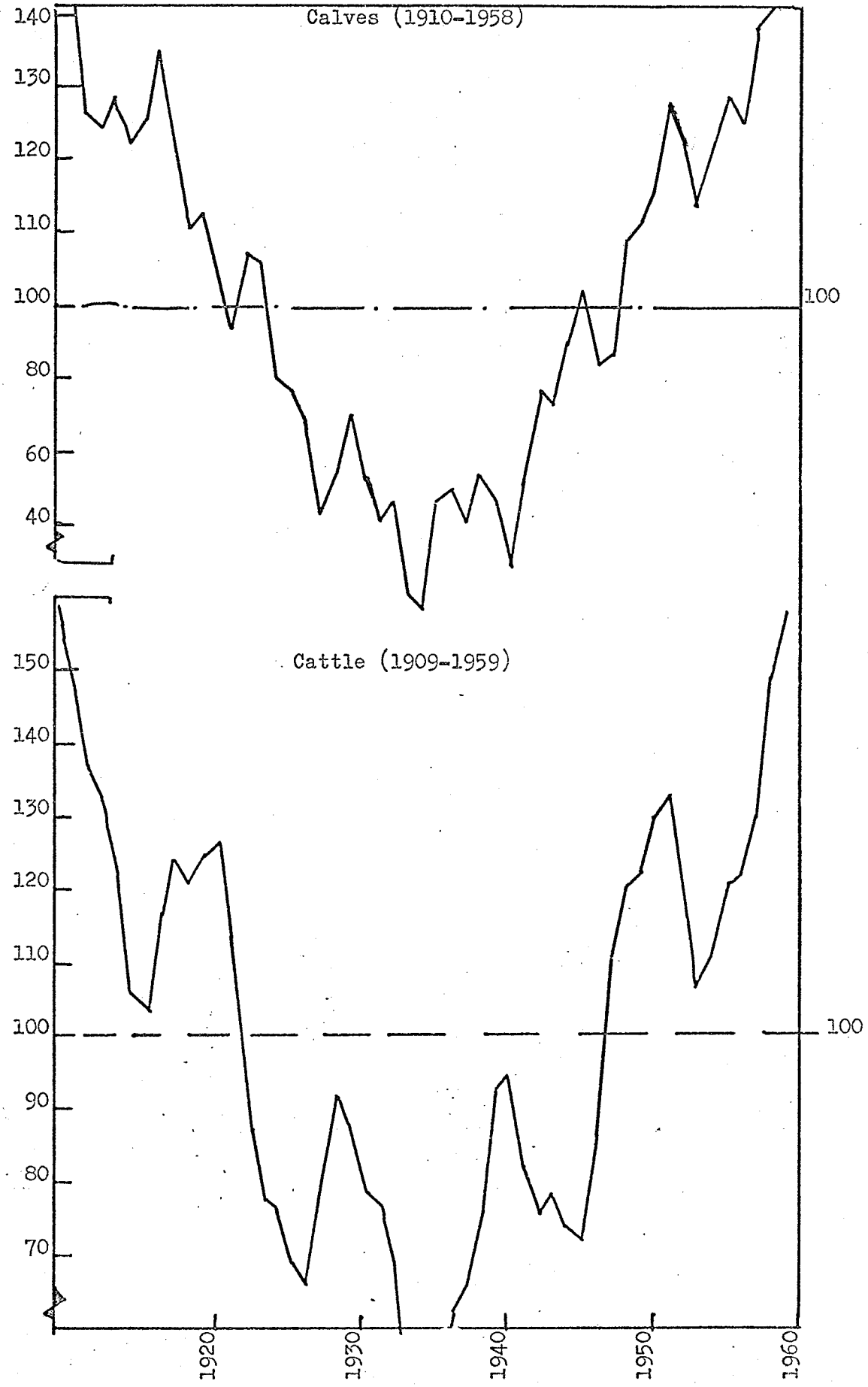


FIGURE III. CYCLICAL INDEXES OF AVERAGE PRICES RECEIVED BY FARMERS, U.S. 1909 -59.

Figure IV. Average Prices Received by Farmers for Calves, U.S., 1910-1958.

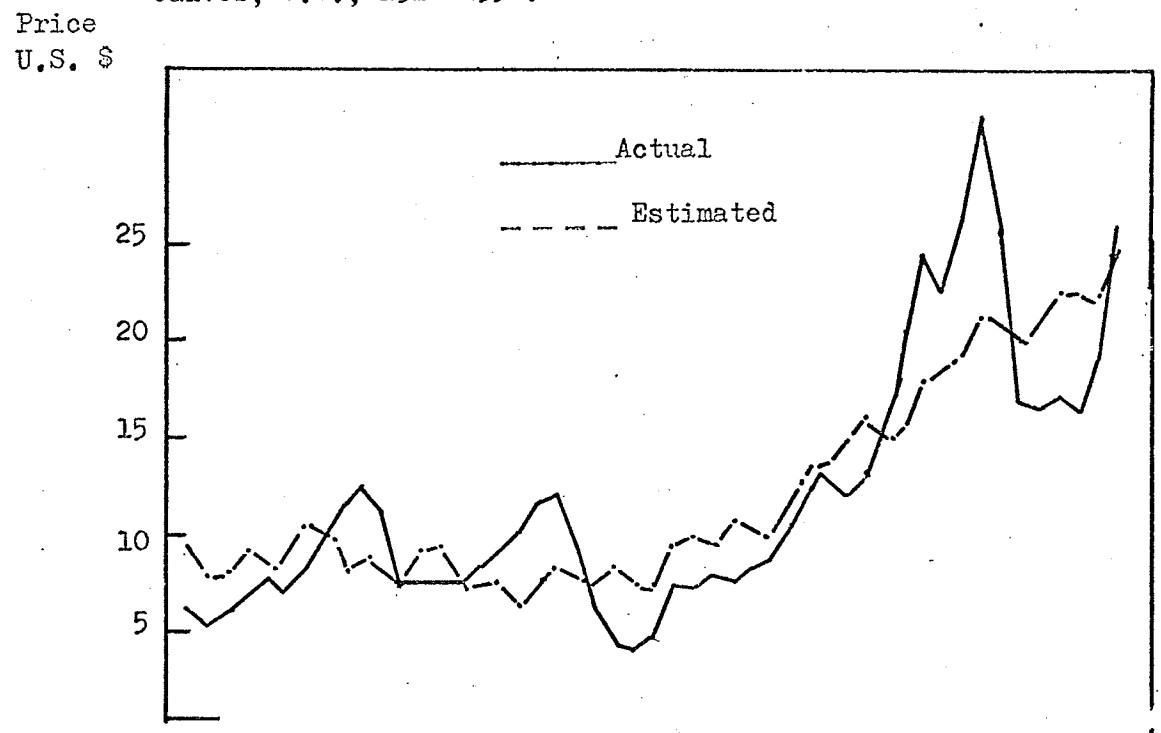


Figure V. Average Prices Received by Farmers for Calves, U.S., 1909-59.

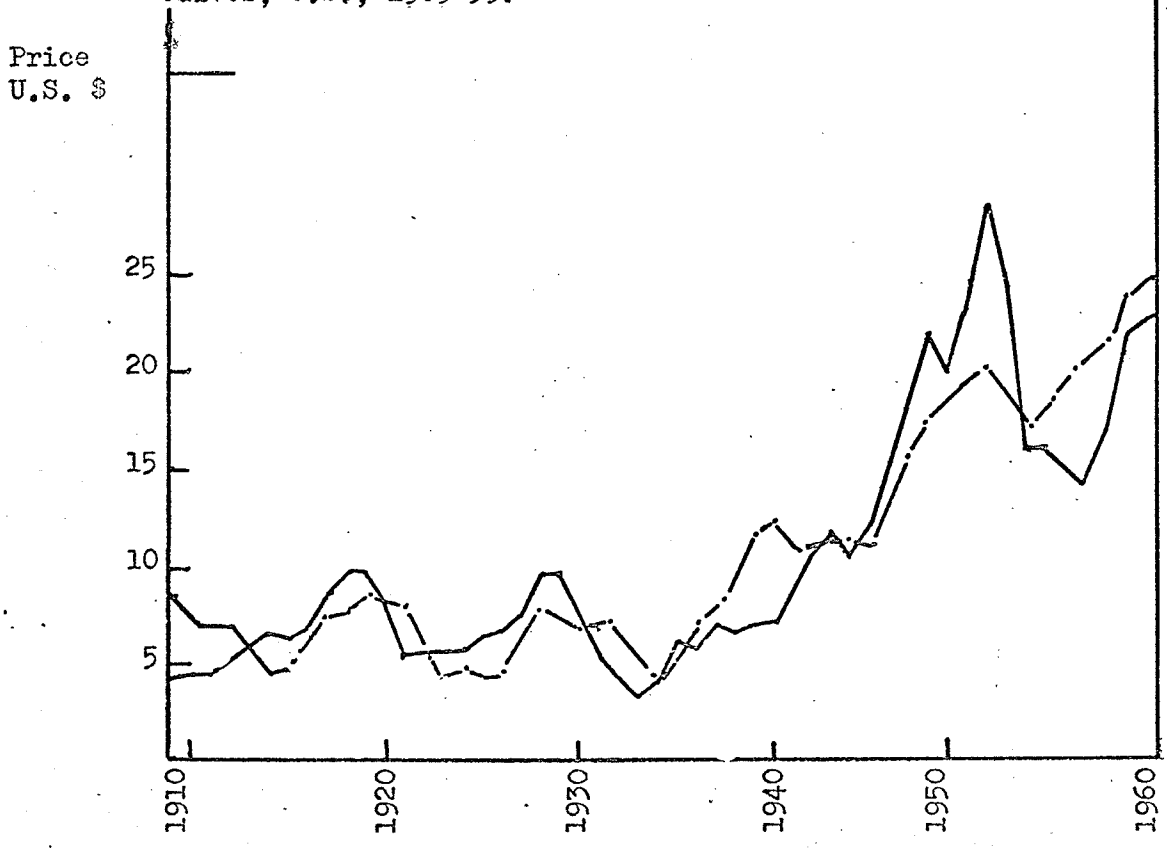


Figure VI. "Seasonal" Indexes of Beef Cattle Slaughter Canada and U.S., Based on Fourier Analysis, 1959-63.