A STUDY OF STEER-HEIFER PRICE DIFFERENTIALS

A Thesis

Presented to

The Faculty of the Graduate School

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Jan Harry J. M. Weijs

April, 1957

ACKNOWLEDGMENTS

The author wishes to express his appreciation for the guidance and encouragement received in the preparation of this thesis from Professor Arthur W. Wood, under whose supervision it was written. Special acknowledgment also goes to Professor Sol. Sinclair, Chairman of the Department of Agricultural Economics and Farm Management, and to Professor J. C. Gilson for many helpful suggestions. The efforts of Miss Sheila Shipley, who struggled through several drafts of this thesis, are greatly appreciated.

Acknowledgment is also due to the Manitoba Department of Agriculture and Immigration, whose financial assistance made this study possible.

A STUDY OF STEER-HEIFER PRICE DIFFERENTIALS

Jan Harry J. M. Weijs
University of Manitoba, 1957

In economic theory the steer-heifer price differential can be justified on the ground that it allows for a difference in form utility between steers and heifers. Form utility covers both the quality and quantity of a commodity. A steer-heifer price differential could, therefore, logically be based on differences in the quality and/or quantity of meat obtained from the two sexes of beef cattle.

The first section of this study examines the official market price reports to insure that heifer and steer prices used to calculate price differentials and ratios are accurate and comparable. It shows that the livestock marketing classification into live grades assures that steers and heifers within each live grade produce carcasses that will receive, on the average, the same official carcass grade. In a later section it is also shown that heifers and steers of the same carcass grade will generally produce retail meat cuts that are of equal quality as judged by consumers.

The prices of steers and heifers that are classified into the same live grade are, therefore, comparable with respect to quality. The only remaining reason for a differential between steer and heifer prices must then be a difference in the quantities of meat obtained from heifers and steers of the same grade.

The next three sections are devoted to an examination of the real

differences in meat yields insofar as these are known.

The first section describes differences in dressing percentage per hundredweight between steers and heifers. In the second the evidence for differences in by-product yields and values is examined. The last section considers the possibility of differences in retail cut-out value.

The next chapter presents an economic model that describes the extent and behavior of a differential for form over time and place in the perfect market. This model provides the standard by which to select the measurements used in presenting empirical findings.

A description of the actual steer-heifer price differential that follows gives a brief history of the differential for the different grades of cattle and for the five major public stockyards. The results in this section are compared with expected price differentials derived from the economic model.

The analysis of the price differential, necessitated by a lack of agreement between the actual and expected differential, suggests two sources of inefficiency and offers possible explanations.

Next the possible effects of the excessive price differential on resource allocation in the beef enterprise and on beef production generally are explored. Solutions to the problem are offered for consideration.

In the last chapter a summary of the findings is given. The aspects of the steer-heifer price differential that require further study are indicated.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Objectives of the Study

The ultimate objective of all marketing research should be an increase in the efficiency of marketing systems and methods. The measurement and the planning of improvements in efficiency require accurate knowledge of the actual performance of the market. They also require a well-defined model, or a concept of an ideal market, embodying optimum efficiency, with which the performance of the existing market can be compared. Only when these two fundamentals are well understood can a meaningful appraisal of existing methods be made and improvements developed and applied.

The first objective of this study is to develop a model for price differentials with respect to form. The model is an application to livestock marketing of the theory of the perfect market with respect to form and place. An attempt will be made to include all known rational factors influencing the steer-heifer price differential. This part of the study will include the assembly and critical examination of results from previous studies which touched on some aspects of steer-heifer price differentials, or on factors influencing them. An attempt will be made to co-ordinate and relate these separate findings to the specific problem involved in this study.

The next objective of this study is to examine the accuracy of the

available marketing statistics, and to ascertain which techniques should be applied to marketing data to assure the most accurate and useful measures of the real steer-heifer price differential. This is a most important part of the study. If price differentials are calculated from prices contained in the official market reports, the implicit assumption is made that price differentials calculated from weighted prices (these being the only type of averages used in these statistics) will be an accurate reflection of the real differentials observed in raw marketing data. It is important to make this distinction between price data and price statistics. Too frequently this distinction seems to be overlooked, particularly in the field of price differentials.

Following this logical sequence, the next part of the study will contain a brief description of the steer-heifer price differential found in the market, using the best available measures. The purpose of this part of the study is to get an indication of the extent and the characteristics of this differential over time and place for the various grades of animals.

When these facts are presented, an appraisal of the degree of efficiency involved in this part of the pricing mechanism is possible. By comparing the expected differential as derived from the model, with the actual differential calculated from marketing statistics, it is possible to measure the degree of inefficiency. Next an attempt will be made to identify the sections of the meat market responsible for this inefficiency.

Brief reference will be made to the possible effects of this pricing

inefficiency on the beef enterprise.

The last section will deal with needed additional studies, and suggested solutions to the problem.

Importance of the Problem

The selection of a problem for economic research may often be justified on several grounds. The first one, in terms of importance, is usually lack of knowledge regarding economic phenomena which appear to indicate an imperfection in the efficient functioning of some part of the economy. It is usually only after a study is completed that this factor can be appraised with any degree of accuracy. In order to solve a "problem" it is necessary that the actual situation, as well as the ideal situation, is clearly known. The divergence between the two situations will be an indication of the extent of the problem. In the case of the steer-heifer price differential, it is, therefore, first of all necessary to establish how much the differential really is, as compared to what it appears to be. Secondly, it is necessary to discover and evaluate the important factors influencing this differential.

Only when all these factors are known is it possible to determine whether a problem or imperfection exists. The size of the differential by itself does not indicate the extent of the problem. A large differential may be accounted for by sound reasons, and need not be predominantly due to imperfections. If the first is the case a study can be ended at that point. When large imperfections are found to account for a significant part of the differential, it may be desirable to proceed

with the study in order to determine whether improvements could be made to bring the actual differential closer in line with the justified differential.

The economic importance of the steer-heifer price differential can be indicated in several ways. The simplest measure is the relative number of heifers marketed. The number of heifers can be expressed as a percentage of the number of steers of all weights sold for slaughter at stockyards (and after 1940, also direct to packers). Between the years 1931 and 1954, annual heifer marketings were between 35.4 per cent (1953) and 91.0 per cent (1937). The average for this period was 48.9 per cent of steer marketings; thus, on the average for every two steers sold for slaughter, one heifer was sold. In absolute figures the total numbers of heifers marketed annually in Canada during the last nine years ranged between 209,686 in 1952 and 322,775 in 1946.

It is significant to note that the proportion of heifers marketed has increased appreciably over the years. Better production methods may have gradually enabled farmers to market a larger proportion of the heifer calves. In order to secure the same rate of growth of the cattle herd, fewer heifers need to be retained on the farm at present as compared to earlier years. This fact may have influenced heifer marketings considerably. It is conceivable that both quantity and quality of heifers sold are affected by this trend. If, in earlier years, a large proportion of the heifers were sold as unfinished two-year olds whenever need arose to balance herd size with severe reductions in feed supply, this fact might justify a price discount. In recent years this factor would be of lesser

importance, since many heifer calves are, from the start, destined for the market as yearlings.

A monetary indication of the importance of the discount of heifers under steers is given by calculating the amount by which all heifers are discounted. A crude estimate of this discount for the year 1955 for all heifers sold for slaughter at public stockyards and sold direct to packers amounts to slightly over five million dollars. The calculation was as follows:

Grade	Number of heifers	Average price differential ($ per cwt.)
Choice	25,666	2.19
Good	78,030	2.15
Medium	113,593	2.07
Common	74,210	1.54
Total	291,499	1.97

At an assumed weight of 900 pounds per heifer the value of the discount on all heifers would be $5,160,546.

The average differential is calculated by weighting the differential for each grade by the proportions falling in each grade at the Toronto, Winnipeg, Calgary, and Edmonton public markets. These markets handle about 80 per cent of all cattle sold at all public markets.

The total discount for 1955 may not be representative of the average discount over the years. The total discount is influenced by the price differential for each grade and the total quantity of heifers of each grade marketed. Both factors vary considerably over the years. This

lack of stability in the discount may, by itself, form a sufficient reason for studying the steer-heifer price differential.

Farmers' interest in the steer-heifer price differential was shown at the Saskatchewan Marketing Board hearings.[1] The Marketing Service of the Canada Department of Agriculture has shown interest in the steer-heifer price spread and has recently started retail cut-out studies in several Canadian cities. The Meat Packers' Council has recently published an article in its bi-monthly paper, in which suggested reasons for the price differential are presented.[2] Its research department is presently conducting further studies in this field.

All these facts indicate that a study of price differentials for form is warranted. It is important to ascertain the factors that influence this discount in order to appraise the efficiency with which this aspect of pricing operates.

Scope of the Study

In economic theory, the steer-heifer price differential can be justified on the ground that it allows for a difference in form utility between steers and heifers. Form utility covers both the quality and quantity of a commodity. A steer-heifer price difference could, therefore, logically be based on differences in the quality and/or quantity of meat

---

[1] Proceedings at Public Hearings under the Natural Products Marketing Act concerning A Proposed Livestock Marketing Plan, Regina, April 7, 1955, Number 10-C, pp. 35-6, 55.

[2] Meat Packers' Council of Canada, A Letter on Canadian Livestock Products, Toronto, May-June, 1956.

obtained from the two sexes of beef cattle.

In order to make a meaningful analysis, it is necessary to establish first whether a real difference in form utility exists between steers and heifers. It is also important that the heifer and steer prices used to calculate price differentials and price ratios are accurate and comparable.

The first section of the study, therefore, examines the official market reports from which the prices used in this study are taken. It shows that the livestock marketing classification into live grades assures that steers and heifers within each grade produce carcasses that will receive the same official carcass grades. In a later section, it is also shown that heifers and steers of the same carcass grade will generally produce retail meat cuts that are of equal quality as judged by consumers.

The prices of steers and heifers that are classified into the same live grade are, therefore, comparable with respect to quality. The only remaining reason for a differential between steer and heifer prices must then be a difference in the quantities of meat obtained from heifers and steers of the same grade.

The next three sections are devoted to an examination of the real differences in meat yields insofar as these are known. The results are then used in conjunction with an economic model that describes the extent and behavior of the price differential over time and place in a perfect market.

The description of the actual price differential, following a section devoted to some methodological considerations, gives a brief history of the price differential which can then be compared with the

expected differential contained in the model.

The analysis of the price differential, necessitated by a lack of agreement between the actual and expected differential, suggests two sources of disagreement and offers possible explanations.

Next, the possible effects of the excessive price differential on resource allocation in the beef enterprise and on beef production generally are explored. Solutions to the problem are offered for consideration.

In the last chapter, a summary of the findings is given. The aspects of the steer-heifer price differential that require more study are indicated.

CHAPTER II

ANALYSIS OF DIFFERENCE IN FORM OF HEIFERS AND STEERS

Accuracy of Livestock Marketing Classification

The livestock marketing statistics issued in periodical reports by the Marketing Service of the Federal Department of Agriculture have frequently been criticized. Particularly, the classification of cattle sold at markets, into live grades, has received much attention.

In the market reports of the Marketing Service, steers are reported under eight classifications. Steers are first divided into two weight classes: those under 1,000 pounds and those over 1,000 pounds. In each of these two classes steers are reported in four grades; namely, choice, good, medium, and common. Heifers are reported in the same four grades, but no weight division is used. The local branches of the Marketing Service are accused of "statistically grading" by dividing the range of prices paid for all animals falling within one class, into arbitrary or predetermined proportions. One critic described it: " . . . cattle sold at public markets are classified into the various trading categories of "choice", "good", "commercial", etc., mainly on a comparative price basis, with no hard and fast specification".[1]

---

[1] H. K. Leckie, "Price Support Operations in the Canadian Livestock Industry," Canadian Journal of Agricultural Economics, Vol. I, No. 2, 1953, p. 18.

Such criticism does not do full justice to the marketing reports. There are some indications that classification into live grades is not purely arbitrary, and may fit the classification by carcass rather well.

The first of these indications is the occurrence of gaps in the daily price range for a particular class of cattle. At some markets, occasionally no price is quoted for one or two grades of a class of cattle. If "statistical grading" was practised, this could never happen.

Only infrequently is there a normal distribution of prices from the low to the high for each class of cattle. More often, prices cluster into several fairly distinct groups, and remain this way for days, or even weeks. If these groups do not represent the real qualities as shown by carcass grades and weights, it is only due to the inability of packer buyers to judge cattle grade and yield on the hoof. For individual animals, the buyer estimates are frequently inaccurate, but when total sales are considered, average prices will roughly represent the true value of each classification.

This fact is frankly admitted by the packers: "The bulk of the commercial cattle, in Canada and United States, has always been sold on a live basis. But in reality, packers and butchers buy beef cattle on the basis of their value as dressed meat and by-products. Because the buyers, through long experience, know fairly well the out-turn of the live animal and have every-day practice in judging relative live and dressed equivalents, they have been able to make fairly accurate estimates of the value of various classes of live cattle. Even with this experience, however, their purchases are based on the value of the average of a number of animals and

of various classes rather than the actual out-turn of a particular animal."[2]

For some days, the range of prices for each live grade, as calculated by the Marketing Service, overlaps. If the breakdown of the price range was purely arbitrary, this could never happen.

These facts lead to the conclusion that live classification is not solely a matter of "statistically grading". The market reporter at a public market spends a considerable part of the day on the trading grounds, discussing prices and quality offered with both buyers and sellers. He reports to the office the range of prices at which various qualities of animals are being sold that day. The next day, the prices on the sales slips are fitted into these ranges for each grade and a weighted average price for each live grade is calculated. Unusual cases are also indicated by the market reporter, and account for the fact that price ranges overlap occasionally.

It is not suggested that this procedure will always arrive at the same classification of animals as determined by carcass grading. Price ranges are based on buyer estimates of quality and yield, and are apt to be somewhat inaccurate. When a day's sales are considered, the average error will not be as large, since both grade and yield errors for a large number of animals cancel out somewhat in the absence of a consistent bias.

---

[2] Meat Packers' Council Bulletin, November, 1955, as quoted in a speech, "Rail Grading of Livestock and Associated Problems," presented by Roy Grant, Assistant General Manager, Maritime Co-operator Services Ltd., at Maritime Convention, A. I. C., in Fredericton, August 8-10, 1955.

The method employed by the Marketing Service can possibly introduce new errors. The proportion falling into the live classifications may not coincide with the results of carcass grading. This is partly due to the pricing inefficiency displayed by the buyers in the market and partly to new errors introduced by the method of classifying live animals. It is virtually impossible to single out one of these errors. Comparison of live classifications and carcass grades for longer periods of time do not show a great deal of error. For a shorter time period, the error, due to both factors, may be considerably more significant. The importance of this error depends on the purpose for which these statistics are used.

For price differential studies in which various qualities of animals are compared over time and place, or with carcasses of corresponding qualities, the errors introduced may be significant. Average prices of particular live classes of beef animals, as calculated by the Marketing Service, based indirectly on the buyers' judgement of quality and yield, may not represent the real carcass grade and yield, as determined after slaughter.

There does not appear to be much evidence, then, that the procedure followed by the Marketing Service in classifying animals into live grades will introduce serious new errors. Most of the inaccuracies in the classification could rather be blamed on the inability or bias shown by buyers in estimating grades and yields.[3]

---

[3]Several studies are concerned with appraising the accuracy with which buyers estimate grades and yields of live animals. Among these are: C. D. Phillips, and T. L. Pearson, Accuracy of Present Marketing Method in

The error introduced by the procedure adopted by the Marketing Service can be expected to be larger for daily and weekly prices, than for monthly and yearly prices, since in the shorter time periods, the quantities sold are much smaller. But this error will again be reduced by the fact that during these time periods of a day, or even a week, prices offered by packer buyers often do not change very much.

The persistent criticism of the accuracy of live grading by some branches of the meat trade takes on less significance when the critics use the statistics, so much depreciated, to defend or explain their market conduct: "Anyone who follows closely the official market reports from week to week and season to season, readily observes that there are definite price differentials for livestock of the same classification between different markets . . . . . differentials between various grades and classes of livestock may fluctuate on the same market. Two main factors determine what the trade can pay for one market classification over another."[4]

It appears, therefore, that Marketing Service price statistics give a reasonably accurate breakdown of average prices paid for the various

---

Pricing Veal Calves, Bulletin 610, Lexington Kentucky Agricultural Experiment Station, University of Kentucky, March, 1954.
The National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Ottawa, Dept. of Agriculture, March, 1942.
E. H. Jebe, and E. S. Clifton, Estimating Yields and Grades of Slaughter Steers and Heifers, Journal Paper No. J-2857, Iowa Agricultural Experiment Station, Ames, Iowa.

[4]Meat Packers' Council of Canada, A Letter on Canadian Livestock Products, Toronto, October, 1955, p. 4.

qualities of livestock, as estimated by the trade. This assumption will be made during this study of steer-heifer price differentials. It is important to realize that in a study of price differentials, major emphasis is placed on the relationship between prices, rather than on the absolute prices. Even though average prices quoted in official marketing statistics are not entirely accurate, they are quite adequate as long as the degree and direction of the inaccuracies are the same for the heifer and steer prices used to calculate price differentials and price ratios.

Comparison of Dressing Percentage of Heifers and Steers

The dressing percentage or yield of an animal is the carcass weight as a percentage of live weight. The difference between live and carcass weight is made up of by-products and waste. The by-products usually contribute less than 15 per cent to the total revenue that a processor realizes from a beef animal. Consequently, the higher the carcass yield of an animal is, the higher will be the price a processor is willing to pay per live hundredweight. If heifers on the average yield less than steers, a price differential allowing for this difference in yield would be justified. It is, therefore, necessary to know the real difference in dressing percentage of steers and heifers.

Many results of yield tests that are reported in publications dealing with some aspect of livestock marketing are of limited scientific value. Results that at first appear to be conclusive prove, on closer examination, to be ambiguous and, not infrequently, deceptive. The yield of a beef animal is influenced by many factors. A comparison of the

dressing percentage of steers and heifers should show the influence of the sex of the animal on the carcass yield. This requires that other factors that also influence yield must be held constant, or, if this is impossible, an allowance should be made for their influence on the sample. This rule seems obvious, but too often it is not observed by people who are too closely connected with livestock marketing to be ignorant of the major factors influencing dressing percentages. Frequently, it is not indicated how the dressing percentages are calculated. Nor is the size of the sample and the degree of variation always stated. Omissions of this nature make it difficult to compare and consolidate results from different studies. For these reasons, it is necessary to give a brief survey of the many factors that are known to influence dressing percentages. Only this approach will clear up the confusion and explain the apparently contradicting results found in many studies of carcass yields.

Factors influencing dressing percentages can conveniently be broken down into those that are technical and those that are biological. Technical differences in yield are important when results from two or more different tests are compared. It is important to assure that live weight and carcass weight are measured in the same way; otherwise, an apparently real difference in yield may be simply a technical difference.

Live weight of cattle can be taken weight off car (w. o. c.) at destination or free on board (f. o. b.) at shipping point. Several studies have been made of the relation between the dressing percentage and the distance shipped, amount of feeding and watering in transit, and lengths of waiting period at yards. Generally, cattle shipped a considerable

distance without feed or water will have a higher carcass yield when based on w. o. c. weight than when calculated on the f. o. b. weight. The amount of feeding and watering in transit and at stockyards will influence the dressing percentage for the same reason.

Equally important is the carcass weight used. The degree of defatting will influence the yield considerably. During the second World War, regulations required the removal of excess fat at specified places on the carcass. These regulations have been rescinded, but there is an increasing tendency to defat carcasses on the killing floor, although this is not yet standard procedure. The importance of defatting is indicated by the fact that the difference in yield may amount to 2 per cent. The defatted yield for 2,590 steers and heifers with an average live weight of 1,002 pounds was 52.8 per cent. Had the defatting fat not been removed, the yield would have been 54.8 per cent.[5]

Carcasses can be weighed on the killing floor or after they have been in the cooler. Cold or chilled weight will be less than killing floor or warm carcass weight due to shrinkage. The difference has been estimated at approximately 2 per cent.[6]

All these factors have to be known and should be specified when results of tests are given, in order to insure that in comparing results

---

[5] H. J. Maybee, Meat Carcass Grading in Canada, Livestock Division, Marketing Service, Canada Dept. of Agriculture, Publication 960, 1950, p. 64.

[6] Ibid., p. 62.

from several studies, only real differences in dressing percentage are considered.

Biological factors affecting the yield of an animal appear to be many and varied. This is indicated by the tremendous variation of the dressing percentage for all cattle from a low of just over 40 per cent to a high of over 70 per cent. It is, however, possible to cross-classify animals in such a way that the range of variation in yield is reduced considerably for a single category.

One of the best known factors is the direct relation between dressing percentage and carcass grade. The higher the grade, the higher is the average yield. This relation is associated with the fact that conformation and finish are two factors determining the grade. Lack of conformation and finish will usually result in a lower yield, as well as a lower grade. The relation between grade and yield is well illustrated in Table I.

TABLE I

RELATION BETWEEN CARCASS GRADE AND DRESSING PERCENTAGES OF STEERS AND HEIFERS*

Carcass Grade	Steers		Heifers	
	No.	Dressing per cent	No.	Dressing per cent
A_1	178	60.47	40	58.25
A^1	1139	58.23	305	56.30
B	664	56.31	261	55.13
C	89	55.33	54	52.52
D	6	53.34	15	51.75

*Source: National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, p. 5.

The relationship holds for steers, as well as for heifers. The high grading animals are the best yielders. It must, however, be pointed out that the relation is true only for the average yield. Individual animals within a grade may deviate considerably from the mean. The extent of this variation for both steers and heifers grading A is shown in Table II.

TABLE II

DISTRIBUTION OF DRESSING PERCENTAGES
OF GOOD STEERS AND HEIFERS*

Range of dressing percentage	Steers Per cent within range	Heifers Per cent within range
Class containing the mean[a/]	13.49	10.33
Three classes about the mean	45.14	42.34
Five " " "	66.30	62.68
Seven " " "	80.76	80.01
Nine " " "	90.55	91.35
Eleven " " "	95.22	96.01
Number of animals	1134	300
Mean dressing percentage	57.7	56.4

*Source: National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, p. 20.

[a/] One class interval is equal to 1.00 dressing percentage.

Only slightly more than 10 per cent of the animals fell within the class containing the mean dressing percentages of the groups. A range of seven classes (the mean class plus and minus three classes) was necessary

to contain 80 per cent of the animals. The dressing percentage for steers ranged from 49 to 71; a variation of 22 percentage points. Heifers' dressing percentages ranged from 43 to 76; a variation of 33 points.

The presence of such a high degree of variation causes an average relationship to be of little practical value. The average relationship applies only to a small proportion of all animals. It is also important to keep this variation in mind when results of yield studies are based on very small samples. The chances are very small that the averages for such samples give a fair approximation of the real differences between them.

Besides the variation with carcass grade, the yield is related to the live weight of the animal. Normally, the heavier the animal, the higher the dressing percentage will be. The relationship is most pronounced if the sample is restricted to one carcass grade. This is indicated in Table III, which shows the relation between yield and live weight for both steers and heifers.

The relation between live weight and yield is direct. The heavier the animal, the higher will be the yield, and this relationship is the same for steers and heifers. The results in this table may clear up much of the confusion. It can be seen that when animals are classified by grade and weight class, the yield of heifers and steers is virtually the same.

TABLE III

RELATION BETWEEN YIELD AND LIVE WEIGHT FOR VARIOUS GRADES OF STEERS AND HEIFERS*

Carcass weight range	Number steers	Average live weight	Yield[a]	Number heifers	Average live weight	Yield[a]
	Grading A			Grading A		
300-400	156	691	55.2	137	680	55.1
400-500	1637	816	56.3	345	795	56.1
500-600	1496	935	57.6	86	908	57.8
600 up	344	1095	59.3	—	—	—
	Grading B			Grading B		
300-400	188	695	54.1	130	681	54.2
400-500	617	809	55.1	118	797	54.8
500-600	143	962	56.0	5	951	55.4
600 up	20	1142	56.3	—	—	—
	Grading C			Grading C		
300-400	198	690	53.0	54	658	52.8
400-500	238	807	54.6	15	802	54.9
500-600	28	945	55.3	2	801	55.2
600 up	3	1095	61.6	—	—	—

*Source: Manitoba calf clubs, Fat Stock Shows and Sales, 1951-56, Marketing Service, Dept. of Agriculture, Winnipeg, Manitoba.

[a] Yield was calculated from live weight off truck (w. o. t.) and warm carcass weight defatted.

In order to determine whether a difference in yield can be attributed to the sex of an animal, steers and heifers of identical grade and weight have to be used. This fact has been overlooked or disregarded in practically all previous studies of yield differences between steers and heifers.

In many of the studies, only one grade for both sexes was used, but in none was the average live weight approximately the same for both sexes. In order to get an idea of the type of error made by disregarding differences in average live weight, a weighted average yield was calculated for all steers and for all heifers grading A. The weighted average yield for steers was 57.21 per cent, while heifers averaged only 56.16 per cent, a difference in average yield of 1.05 per cent. But nobody familiar with the relationship between yield and weight of an animal would ascribe this difference in yield to the sex of the animal. The true explanation for this difference is the fact that average weight of steers was 886 pounds, as compared to 785 pounds for heifers, a difference of 101 pounds.

In other words, when steers and heifers of the same grade and live weight are compared, the average yield is not significantly different. At this point, it is necessary to emphasize again that Table III represents an average relationship; average live weight and average yield are used. It is true that by taking heifers and steers of the same grade and weight range, variation around the mean yield is somewhat reduced. In order to determine the range of yield values for animals of the same live weight, a frequency distribution of the dressed weight of 880 pound steers producing A grade carcasses was made.

TABLE IV

DISTRIBUTION OF CARCASS YIELDS OF 880 POUND GRADE A STEERS*

Carcass weight range	Frequency	Carcass weight midvalue	Midvalue in terms of dressing per cent[a/]
450-459	2	455	51.7
460-469	4	465	52.8
470-479	11	475	54.0
480-489	23	485	55.1
490-499	29	495	56.2
500-509	26	505	57.4
510-519	22	515	58.5
520-529	11	525	59.7
530-539	6	535	60.8
540-549	3	545	61.9

*Source: Manitoba calf clubs, Fat Stock Shows and Sales, 1951-56, Marketing Service, Dept. of Agriculture, Winnipeg, Manitoba.

[a/] Live weight, w. o. t.; carcass weight, warm, defatted.

The data shown in Table IV, when plotted, followed a normal distribution. The mean carcass weight was 500.0 pounds, with a standard deviation of 18.64 pounds. In terms of dressing percentage, the mean was 56.8, and one standard deviation was 2.1 percentage points. Approximately two thirds of the yields from the 880 pound steers were within plus or minus 2.1 dressing percentages of the mean. A range of 8.5 per cent around the mean contained approximately 95 per cent of the individual yields.

It is difficult to account for all of this variation. Virtually all animals were shipped by truck to the shows, but the distance travelled was probably in no case the same. Not all animals were fed and watered

before weighing, while others stayed overnight before being weighed. But these factors would not necessarily result in a virtually normal distribution of yields. A large part of the variation may be due to feeding and hereditary factors, as well as to other individual "normal" differences. It was casually observed that for animals raised on the same farm (as indicated by the name of the owner), the variation in yield was much less.

The variation shown in this sample of A steers of 880 pounds will roughly represent the typical variation around the true mean of animals of given weight and grade being normally sold at the public markets. This will be especially true for the top three carcass grades. For lower grades, variation in the yield of animals of a given weight around their "typical" yield may be much larger, since there is less uniformity among the lower grade cattle. For the same reason, the variation for heifers may be somewhat larger than that for steers of the same grade and weight.

The calculation from Table III showed that practically all the difference in average yield between all weights of steers and heifers within a given grade is due to the difference in the average live weight of the two sexes. When steers and heifers of equal grade and live weight were compared, the average yield was identical.

This result emphasizes the error involved in the custom of attributing a difference in average yield to such factors as accidental or deliberate breeding of heifers, when, in reality, the difference in live weight is the correct explanatory factor. Most heifers are marketed when they are approximately 12 to 15 months old, and at this age there is little

likelihood of pregnancy. Moreover, the effects of pregnancy on quality and quantity of carcass are by no means all detrimental.[7]

The average weight of heifers offered for sale at public markets is probably 125-175 pounds lower than that of steers under 1,000 pounds. Female calves grow a bit slower and are ready for market at a lower weight. In one study, 1,255 of the 1,531 steers under 1,000 pounds fell in the 801-1,000 pound weight range, while of the 768 heifers, only 232 weighed between 801-1,000, but 500 ranged from 501-800 pounds.[8] The same situation prevailed in the Manitoba calf club data, which also includes a reasonable number of farm-fed cattle besides those from club members.

In Table III, the average increase in dressing percentage with an increase in live weight of 100 pounds is approximately 1 per cent for all three grades and for both steers and heifers. If the average weight of the common run of heifers is 125-175 pounds lower than that of steers, the average dressing percentage of heifers will be at the most 2 per cent below that of steers of comparable grade. The average price differential should be just large enough to allow for this average difference in yield of 2 percentage points, other things being the same. Due to the large variation around the normal yield, which was shown in Table IV, the actual difference in yield of a particular lot of steers and heifers may vary

---

[7] M. E. Ensminger, Animal Science, Illinois Interstate Printers and Publishers, 1950.

[8] National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, pp. 16-17.

considerably and with it, the price differential. If the cattle buyer is only interested in the average yield, this variation will be somewhat reduced. To the extent that a buyer misjudges the yield, the price differential based on this error will not represent the true difference in yield.

Comparison of By-Product Yield of Heifers and Steers

The amount and the value of by-products is another factor determining the price processors can pay for live animals.

The by-products and waste products make up the difference between live weight and carcass weight. Except for the stomach and intestinal contents, all products can be sold. The returns for by-products vary considerably between individual animals, as well as over time.

The by-products of a beef animal can be classified into:[9]

Hide

Fats (edible) - killing fat, defatting fat

Edible Offal - liver, heart, tongue, tail, sweetbreads, and kidneys

Processed Meats - headmeat, cheekmeat, lipmeat, weasand meat, brawn, and tripe

Inedible Offal - casings, bones, tankage, and substances used for pharmaceuticals.

---

[9]Adapted from: Industrial and Development Council of Meat Packers, A Letter on Canadian Livestock Products, Toronto, April-May, 1952, p. 3, and from tests by Meat Board, Dept. of Agriculture, Ottawa, 1945.

This classification indicates the wide range and large number of by-products that can be produced from beef animals. The fact that by-product returns vary considerably between animals makes it necessary to investigate the possibility of an appreciable and consistent difference in the quantity or quality of by-products derived from steers and heifers. If such a difference exists, it would affect the steer-heifer price differential.

There are no studies available that deal with, or even make mention of the relative quality of steer and heifer by-products. It will, therefore, be assumed that, if a real difference in quality does exist, it has no influence on the price differential. This assumption is supported by findings from studies conducted in British Columbia in 1942. It was found that, at that time, the packers in Vancouver were receiving the same value per pound for the by-products of each grade of animal.[10]

Table V shows the quantity of by-products for both sexes per hundredweight of live animal. It appears that the total weight of by-products per 100 pounds live weight is greater for heifers than for steers. The same relationship is true when sub-totals and individual by-products are compared. This apparently logical conclusion may, however, be partly deceptive. It is to be noted that the average live weight of steers in the test was 1,076 pounds, while heifers weighed only 888 pounds, a difference of

---

[10]National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, p. 8.

TABLE V

YIELD OF BY-PRODUCTS FROM STEERS AND HEIFERS*

(Pounds per 100 pounds live weight)

By-Product	Good and Choice Steers		Good and Choice Heifers	
Hides		6.050		6.104
Fat		4.349		4.729
Killing	2.444		2.556	
Defatting	1.905		2.173	
Edible Offal		2.040		2.223
Heart	.353		.360	
Liver	.967		1.047	
Tail	.130		.146	
Kidneys	.195		.191	
Tongue	.395		.479	
Processed Meats		2.188		2.447
Head Meats	.046		.056	
Cheek "	.349		.422	
Lip "	.093		.112	
Brains	.070		.084	
Breads	.023		.028	
Weasands	.046		.056	
Tripe	1.561		1.689	
Total		14.627		15.503

*Source: Tests by Meat Board, Dept. of Agriculture, Ottawa, 1945.

nearly 200 pounds.

Before drawing a conclusion, it is necessary to know how by-product quantities are affected when live weight of the animals is changed. Table VI shows this relationship for the more important by-products.

TABLE VI

VARIATION IN QUANTITY OF BY-PRODUCTS WITH LIVE WEIGHT OF CATTLE*

(Pounds per 100 pounds live weight)

Live Weight Mid-value	Hide	Heart	Liver	Tongue	Headmeats	Total
550	7.09	.40	.95	.38	.51	9.33
650	7.08	.40	.95	.38	.51	9.32
750	7.07	.40	.95	.39	.51	9.32
850	6.82	.40	.95	.39	.51	9.07
950	6.84	.40	.95	.39	.49	9.07
1,050	6.57	.40	.95	.39	.50	8.81
1,150	6.61	.40	.95	.39	.50	8.85

*Adapted from: National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, p. 9.

While total by-products per hundredweight tend to decrease as live weight increases, this is mostly due to the preponderance of the hide quantity which expresses this tendency most strongly. Heart and liver constitute a constant proportion of live weight. Head meats show the same relationship as hides, although less pronounced. For tongues, the relationship is reversed; its proportion of live weight increases slightly when the animal gains weight. If hides are excluded, the average relationship will be an approximately constant proportion of by-products to live weight.

With these relationships in mind, Table V can be interpreted much more fully and conclusions drawn from it will have more general application. If the relation between live weight and the quantity of by-products, disregarding hides, is one of virtually constant proportion, the difference

in quantity of by-products per hundredweight for steers and heifers in Table V cannot be attributed to the difference in weight, except in the case of hides. The reason for the difference must be associated with the sex of the animal.

If the results of Meat Board tests are accepted, Good and Choice heifers will, on the average, produce more by-products than steers of this quality. This relation is true for total by-products, as well as for the individual by-products contained in the sub-groups of fat, edible offal, and processed meats.

The effect of this difference in by-product yield on the steer-heifer price differential will depend again on the average prices for by-products, especially on the prices of those by-products of which heifers contain a larger quantity per hundredweight than steers. Regardless of the relative prices of by-products, heifers should receive a premium over steers, other things being equal, on the basis of their higher by-product quantity per hundredweight. The extent of this premium will depend on the prices of individual by-products, and will vary with changes in the value of by-products.

It is dangerous to draw conclusions from Table VI, for although the approximate number of animals studied is specified, no measure of variance is given. If the range or standard deviation had been included, the results and implications could be stated with much more accuracy and confidence. Such measures could also be used in appraising results from other studies. The extent of the variations should be considered in determining the minimum size of the sample, in order that the significance

of the average difference in by-product quantities of steers and heifers can be tested statistically. That this is of real importance is shown in Table VII, where results of another study in by-product yields are adapted to make them comparable to those contained in the preceding two tables.

TABLE VII

YIELD OF BY-PRODUCTS FOR STEERS AND HEIFERS*

(Pounds per hundredweight, except as otherwise specified)

By-Product quantities and total value	Good Heavy Steers Avg. live weight 1250 lbs.	Good Butcher Steers Avg. live weight 1025 lbs.	Good Heifers Avg. live weight 900 lbs.
Hides, cured	5.16	5.32	5.00
Edible fats reduced to tallow	4.08	3.90	3.72
Heart	.32	.34	.33
Liver	.84	.98	.97
Tail	.10	.12	.14
Tongue	.32	.34	.36
Head and Cheekmeat	.40	.44	.42
Lipmeat	.08	.10	.11
Brains	.04	.05	.06
Breads	.04	.05	.06
Weasands	.04	.05	.06
Tripe	1.44	1.56	1.58
Total lbs. per cwt.	12.86	13.25	12.81
Total value per cwt.	$1.72	$1.80	$1.76

*Adapted from: Industrial and Development Council of Meat Packers, A Letter on Canadian Livestock Products, Toronto, April-May, 1946.

The results in Table VII do not agree with those shown in Table VI. In the latter, it was shown that the sum of the by-products remained a constant proportion of live weight, although there was a tendency for

some individual by-products to vary more or less than proportionally. For hides, this variation was more distinct. This characteristic of hides, combined with their large absolute quantity, compared to that of other by-products, made the total yield of by-products proportionately smaller when live weight increased. The data on yield variations in Table VI was originally contained in a yield card made up by Swift and Company, of Chicago. The results were based on a study of "thousands of animals".[11]

The calculations in Table VII appear to contradict the conclusions drawn from Table VI, that by-product yields, other than hides, tend to remain a constant proportion of live weight when the latter is changed. It was concluded that the consistently higher by-product yield per hundredweight for heifers in Table V had to be attributed to the sex, rather than to the difference in average weight.

The results in Table VII do not support these conclusions. The difference in by-product yield of Good Heavy Steers and Good Butcher Steers suggests that by-product yield varies inversely with weight, since both classes of steers are of virtually the same quality. The average by-product yield of good heifers was lower than that of both weight classes of steers. These results are the exact opposite of those in Table V and Table VI.

A close comparison of the yields for individual by-products in all three studies reveals considerable variation. This may be due to differences

---

[11] National Advisory Beef Committee, The Practicability of Selling Cattle by Carcass Grade and Weight, Dept. of Agriculture, Ottawa, March, 1942, p. 8.

in killing technique, in measurement, or in definition. Another possible reason for this discrepancy could be found in sampling variations. This possibility is emphasized by the fact that, in the study from which Table VI was derived, neither the number of animals, nor their quality and sex was indicated, although it was suggested that the number involved was large. The study from which Table VII was taken did not specify the total number of animals, or the proportion falling within each of the three classes.

In order to get an indication of the value of by-products, the individual quantities in the previous tables were multiplied by the corresponding ceiling prices for Toronto that were in effect during World War II.[12] The total value of by-products for the various classes of animals is shown in Table VIII.

TABLE VIII

YIELD AND VALUE OF BY-PRODUCTS FOR SEVERAL CLASSES AND GRADES OF STEERS AND HEIFERS*

Class and Grade of animal	Average live weight (lbs.)	Yield of by-products[a] (lbs. per cwt.)	Value of by-products[a] ($ per cwt.)
Good and Choice heifers	888	15.50	1.94
Good heifers[b]	900	12.81	1.76
Good Butcher steers[b]	1,025	13.25	1.80
Good and Choice steers	1,076	14.63	1.84
Good Heavy steers[b]	1,250	12.86	1.72

*Source: Tests by Meat Board, Dept. of Agriculture, Ottawa, 1945, and Industrial and Development Council of Meat Packers, A Letter on Canadian Livestock Products, Toronto, April-May, 1946.

[a] Total yield and value do not include casings, bones, and tankage.

[b] Yields and values for these three classes may not be fully comparable,

From the variation in by-product yields and values shown in Table VIII, it is difficult to draw any definite conclusions, especially since the groups are not on a strictly comparable basis.

The importance of the value of by-products can easily be underestimated. When prices of the more important by-products, like hides, fat, and some fancy meats are favorable, the revenue of these products will cover all cost of killing and processing livestock at the packing plants. Edible and inedible by-products can account for 6 to 20 per cent of the total value of the beef animal, the large variation being due to the severe fluctuations in the prices of many by-products. The recent trend of by-product values has been downward, due to the severe competition from new substitutes, while new uses for by-products have not been developed fast enough to maintain the demand.

From the available information, as shown in Table VIII, it is impossible to arrive at the real difference in by-product yield and value between steers and heifers. More and better-planned studies are needed before this matter can be clarified.

With respect to particular by-products, the available information is not much more satisfactory. The difference in the proportion of killing and defatting fat for both sexes has often been used to "explain" steer-heifer price differentials. But the results in Tables V and VII, as well

---

since for these animals, the cured-hide weight was taken, and the weight of edible fats was reduced to tallow weight.

[12] Industrial and Development Council of Meat Packers, A Letter on Canadian Livestock Products, Toronto, April-May, 1946.

as those from other studies concerned with by-product yields, are far too contradictory. Lack of standardization in dressing animals would undoubtedly contribute to this high degree of variation in results obtained in the various studies. Disregard of statistical techniques in setting up tests and in presenting results does not help matters.

For the remainder of this study, it will be assumed that the real difference in yield and value of by-products between steers and heifers is negligible, and does not enter into the determination of the steer-heifer price differential. This assumption is supported by trading practices. "For practical accounting purposes in making settlement to the producer, the value of the by-products are averaged for the different carcass grades and taken into account in the price offered for carcasses of any particular grade."[13] This statement suggests the existence of a real average difference in the yield of by-products for each grade, but variation due to the sex of the animal is not implied. The assumption that the difference in by-product yield from steers and heifers is negligible is also suggested by the results of studies where findings for both sexes are pooled, rather than shown separately. In one such study, 2,590 steers and heifers were about equally divided between the Choice, Good, and Commercial live grades.[14]

---

[13] Proceedings at Public Hearings under the Natural Products Marketing Act concerning A Proposed Livestock Marketing Plan, Regina, April 7, 1955, Number 10-C, p. 43. (Submission by Meat Packers Council)

[14] H. J. Maybee, Meat Carcass Grading in Canada, Livestock Division, Marketing Service, Canada Dept. of Agriculture, Publication 960, 1950, p. 64.

No indication was given that by-product yield differed significantly by grade or sex. The number of animals studied seems large enough to exhibit a real difference, if it exists.

For all these reasons, the assumption seems warranted that the difference in value of by-products from steers and heifers is not significant enough to be considered in determining the steer-heifer price differential.

Comparison of Retail Cut-out of Heifers and Steers

Another factor that could logically be partially responsible for the steer-heifer price differential is the relative retail value of carcasses from steers and heifers of the same quality. In this connection, it is important to distinguish between grade and quality. A great deal of confusion in this area is probably due to ambiguous use of these two terms.

Although quality is a major determinant of the grade of a carcass, it is not the only one. Conformation, fleshing, and finish will influence the carcass grade also. Quality in meats refers more specifically to the nutritive value and the palatability. Although nutritive value can be measured most accurately, since it is based on objective criteria like protein, vitamin, and calorie content, it is of relatively small practical importance. Meat buyers, and especially consumers, appear to be more concerned with factors like color, texture, and degree of marbling as indicators of palatability. These observable characteristics are presumably good indicators of tenderness, quantity, and quality of juice and fat, and the

desirability and intensity of flavor and aroma, all of which determine the palatability of meat.

Quality in this sense of the word is a distinct factor determining a grade of meat, and should, therefore, be separated from the other factors. Conformation, which indicates the proportion of meat to bone, is thus not related to quality, but is a predominantly quantitative measure. It indicates the amount, and not the quality of meat that can be sold from a given carcass. Fleshing signifies the proportion of lean to fat, and it can vary within rather broad limits without affecting the quality of the meat. The proportion of lean to fat is, therefore, predominantly a quantitative factor in the determination of the grade.

Finish refers to the thickness, smoothness, and the distribution of the fat covering on the outside of the carcass. The desirable degree of finish varies directly with the weight of the carcass. This factor appears to be more closely associated with quality. Adequate finish and marbling are indicators of palatability to the meat buyers and as such, are not independent of quality as defined previously. Under-finish may, therefore, reduce the quality of a carcass. Over-finish will not have the same effect, since such carcasses can usually be trimmed of excess fat and ribbed, without affecting the quality. An exception may be made for extreme cases of over-finish and patchiness, which will affect meat quality detrimentally. But patchiness will usually result in a lower carcass grade, and is, therefore, of no importance as long as animals of the same carcass grade are compared.

The quality of meat, as indicated by color, texture, and degree of marbling, depends largely on the feeding and management of the animals prior to slaughtering, and on the techniques of handling carcasses and retail cuts. Feeding and management practices will show the effects of age, weight, and diet on quality. Sometimes sex is included as another factor influencing quality, although this suggestion is never supported by results of quality tests. If the practical definition of quality, as stated previously, is used, many confusing and deceptive arguments will be eliminated.

One excuse for including sex as a determinant of quality may well be the fact that old, weighty heifers and cows usually produce meat of distinctly inferior quality. But this lack of quality could more logically be attributed to the age, weight, and diet of the animals, rather than to the sex. Steers raised under the same conditions would probably not produce meat of better quality.

In some cases, the reason for including sex must be attributed to the ambiguous connotations given to the word quality by the various groups that are concerned with meat.

F. B. Morrison, in 1936, referred to six studies showing that there was no appreciable difference due to sex in the yield and retail value of the carcass, or in the color, tenderness, and palatability of the meat from young heifers that were properly finished.[15] These results were more

---

[15] F. B. Morrison, Feeds and Feeding, Morrison Publishing Company, Ithaca, New York, 1936, p. 648.

recently confirmed by Ensminger, who stated that: "Carefully controlled experiments have now shown conclusively that, when heifers are marketed at the proper weight and degree of finish, sex makes no appreciable difference in the dressing percentage, in the retail value of the carcass, or in the color, tenderness, and palatability of the meat."[16]

It is important to note that "proper weight and degree of finish" will apply more stringently to differences in dressing percentage and retail cut-out than to quality. It is reasonable to conclude that heifer meat and steer meat, of carcasses grading the same, will be of identical quality in terms of color, texture, and finish. This conclusion does not preclude the existence of rather wide differences in conformation and fleshing between steer and heifer carcasses of the same grade, but it means that within the limits imposed by grade specifications, differences in conformation, fleshing, and finish will not affect the relative quality and must, therefore, be considered as quantitative differences.

In practice, consumers are not able to identify the sex of beef as displayed in the retail store or when cooked; nor is there evidence that they specify, implicitly or explicitly, the sex of meat bought. For these reasons, differences in quality of steer and heifer meat cannot be considered as a valid reason for a steer-heifer price differential.

Since the quality of the meat for one grade of steer and heifer

---

[16] M. E. Ensminger, Animal Science, Illinois Interstate Printers and Publishers, 1950, p. 474.

carcasses is virtually the same to the consumer, the only logical reason for a price differential at the wholesale level must be a difference in the quantity and value of retail cuts obtained from both types of carcasses.

Consumers are not interested in buying carcasses. They want the various kinds and qualities of meat cuts that are contained in the carcass. The retailer's function is to divide the carcass into the kinds and sizes of meat cuts that consumers are willing to buy. The value that consumers attach to the product will determine the price they are willing to pay for a given amount and quality of meat.

To assess the value at retail of a particular carcass, it is thus necessary to total the product of quantity times price for the individual retail cuts. Some cuts, like steaks and roasts, which make up only a relatively small proportion, usually account for the major part of total value, while portions like flank, plate, brisket, and brisket point add little to the total value of the carcass, although they make up a considerable proportion of the carcass. Products like fat, bones, and trimming, which may account for 15 to 20 per cent of the carcass, usually have to be sold at nominal prices.

These facts bring out clearly that, in comparing carcasses of equal quality, at least two factors have to be considered in determining the retail value. It is not enough to know the difference in the proportion of meat to bone and of lean to fat in the carcasses. Since the prices of the individual retail cuts are usually different, it is necessary to know, in addition, the relative proportion of those cuts that can be obtained from the carcasses. The larger the proportion of the high-priced cuts,

and the lower the proportion of the low-priced cuts and waste material, the more valuable a carcass will be to a retailer.

If heifer carcasses normally have a slightly lower proportion of meat to bone, and lean to fat, and particularly if this deficiency is more pronounced in the loins and rounds, which produce the higher priced beef cuts, one would expect heifer carcasses to be discounted under steer carcasses of the same quality and weight range. Trade literature abounds with statements to this effect, but in no cases are these assertions substantiated with results from retail cut-out tests.

One source states that: "It is generally accepted in the wholesale and retail beef trade that, after the yearling or baby beef stage, the loins and ribs of heifers do not carry the same thickness of beef covering as steers of comparable weight and quality; their hips and rounds are not usually as full as those of comparable steers; after a similar period of feeding, the better quality of heifers usually carry considerably more surface fat cover than steers, which must often be trimmed off before retail sale."[17]

Statements of this kind may be misleading. It must not be forgotten that conformation and finish are taken into account in establishing the grade of a carcass. Within a grade and weight class, the difference in conformation and finish between steer and heifer carcasses will not be

---

[17]Proceedings at Public Hearings under the Natural Products Marketing Act concerning A Proposed Livestock Marketing Plan, Regina, April 7, 1955, Number 10-C, pp. 35-6.

very large. This is particularly true of the degree of finish. Over-finish, especially patchiness, will result in a lower carcass grade unless the carcass is trimmed of the excess fat before the final grade is decided upon.

Moreover, the deficiency in the thickness of loin and rounds may be partly compensated for by the lighter bone in heifers. The fact that heifers usually produce lighter carcasses than steers may again make up somewhat for the lack of conformation, since lighter carcasses often bring more per pound than heavy carcasses, even though both are in the same grade classification.

In recent years, a few studies have been started to determine the cut-out of steer and heifer carcasses of various grades. Since these studies are being conducted on a small scale, final results will not be available for some time. An examination of some preliminary results may, however, throw some light on the relative retail cut-out of steers and heifers. In one study, where the proportion of some wholesale cuts were compared, the results applying to our problem up to date are as follows:[18]

Steers grading	Number tested	Avg. weight of carcass	Per cent in Hind	Hip	Loins and Rib
B	27	555	48.3	25.1	28.0
C	9	506	48.6	25.5	27.7
Heifers grading					
B	1	544	50.0	25.8	29.6
C	1	502	50.0	27.2	27.5

[18]Preliminary results of a study being conducted by the Animal Husbandry Department, Ontario Agricultural College, Guelph, Ontario.

The results of this test, which is perhaps the only study of this nature including both steer and heifer carcasses, certainly do not substantiate the conclusion that heifers produce a lower proportion of the more valuable wholesale cuts. Especially, the number of heifers tested is too small to draw any definite conclusions. The high value obtained for both heifers in the tabulation suggests that the difference in cut-out may not be very significant; the alternative explanation is that a large variation exists within each grade of carcasses.

The preliminary results of another study, which is concerned with the relative proportion of retail cuts that can be obtained from steer and heifer carcasses grading A, are:[19]

	Steers[a]		Heifers		Steers[a]	
Number	3		2		6[b]	
			Per cent of carcass			
Hind Quarter	48.0		47.9		48.0	
Sirloin Tip	3.79		4.16		4.23	
Sirloin Butt	5.30		5.27		4.39	
Short Loin	7.82		7.11		6.33	
Rump	5.09		5.35		5.79	
Round	6.21		6.07		7.46	
Total of five cuts		28.21		27.96		28.20
Front Quarter	52.0		52.1		52.0	
Rib	5.50		5.13		6.26	
Total of six cuts		33.71		33.09		34.46

[a] The two groups of steers were tested at different stores.

[b] Contains one steer grading B.

---

[19] Preliminary results of a study being conducted at two meat retail stores in Vancouver.

This tabulation shows the proportion of the most important retail cuts. Both groups of steer carcasses have a somewhat larger percentage of the five valuable hindquarter cuts and the one front cut than the heifer carcasses. For individual cuts, however, the variation between the two groups of steer carcasses is very significant. Here again, the number tested is too small to allow accurate comparisons. More important is the fact that the average weight of the carcasses for each group is not included. It is quite possible that here, as in the case of differences in dressing percentage, a large part of the variation in cut-out is associated with variations in the average carcass weight. In any case, the information that is available on this subject is not sufficient to allow general conclusions about the relative retail cut-out of steers and heifers.

The unwillingness or neglect on the part of meat processors and retailers to substantiate their qualitative statements concerning differences in retail cut-out of heifer and steer carcasses with results of accurately conducted and presented tests makes efficiency studies of this aspect of livestock marketing very difficult. For lack of accurate information, inferior measures have to be used.

An approximation of the real difference in retail cut-out can be obtained when heifer and steer carcass prices are compared. A differential or ratio calculated from these prices will contain the difference in value resulting from a difference in retail cut-out yield. Since this differential varies considerably over time, while the real difference in retail cut-out value is practically constant, particularly in the short run, the actual differential is not an accurate measure. It is reasonable to assume

that the differential will never be smaller than that necessary to allow for the real difference in retail cut-out, for otherwise it would be unprofitable to buy heifer rather than steer carcasses. On this assumption, the lowest price differential occurring in the market may be a reasonably accurate estimate of the difference in the retail cut-out value. This method, when applied in a later section, shows that the importance of the difference in retail cut-out may not be nearly as important as is often suggested.

Summary of Differences in Form of Heifers and Steers

Chapter II of the steer-heifer price differential study was concerned with an analysis of the rational factors that bring about a difference in value of the two sexes. To make the comparison meaningful, animals producing the same quality of beef, as judged by consumers, were considered.

At the retail level a differential would be justified if heifer carcasses produced a lower proportion of saleable meats and/or if heifer carcasses contained a lower proportion of the more valuable meat cuts. This argument is often advanced in trade literature, although it is never substantiated with results of retail cut-out tests. It is, therefore, impossible to know whether a retail differential is justified on these grounds. In case there is a real difference in cut-out value, it should be reflected in the form of a steer-heifer carcass price differential.

Another possible reason for the existence of a differential would be a difference in the value of by-products. It was shown that if a

differential was called for, it would be in favor of heifers. Although there was a basis for this differential in some studies, this relationship was not clearly brought out, and was contradicted by other studies. The difference in by-product yields and values was, moreover, very insignificant and of no practical importance. It will, therefore, be assumed for the remainder of this study that a price differential cannot reasonably be based on a difference in by-product value between steers and heifers of the same quality.

The only remaining reason for a differential between steer and heifer prices is a difference in the yield or dressing percentage. It was shown that heifers and steers of the same grade and weight class did not differ significantly in yield. However, since the average weight of heifers marketed within each grade is normally lower than that of steers, and since, on the average, yield varies directly with live weight, there is a justification for a price differential. In the normally encountered weight range, yield increased approximately 1 percentage point for every 100 pounds increase in live weight in the case of steers and heifers grading A or B. If the average run of heifers within each grade weighs approximately 150 pounds less than steers of comparable grades, a price differential that allows for a 1.5 per cent difference in yield will be justified.

The difference in yield, together with the difference in the retail cut-out are, according to this analysis, the only rational justifications for a price differential. In the following section of the study, a model

is constructed that incorporates the information contained in this discussion. Due to lack of complete information, some estimations will have to be made that will approximate the real difference in yield.

CHAPTER III

THEORY AND METHODOLOGY

Theoretical Framework of Steer-Heifer Price Differential Study

A study of the steer-heifer price differential covers only a small segment of the much more inclusive problem of pricing efficiency, which has caused much discussion. The term "efficiency" implies the existence of a standard or ideal with which existing pricing practices and institutions can be compared.

Theory of the perfect market

The need for a standard has been stated by many economists concerned with evaluating efficiency in marketing agricultural products. "A marketing firm, function, or system cannot be judged as efficient or economical in any absolute sense, but only relative to alternatives or to some standard. Studies may be designed to show how the existing marketing methods could be improved, i. e., made more efficient and less costly. To be most useful, however, marketing research should be orientated with reference to some concept of an ideal or perfect market."[1]

This ideal can be found in the theory of the perfect market, which contains three tests of pricing efficiency, developed from the classical division of utility into space, time, and form utility. Geoffrey S. Shepherd,

---

[1] R. J. Bressler Jr., "Agricultural Marketing Research," Journal of Farm Economics, Vol. 31, No. 1, Part 2, February, 1949, p. 54.

one of the foremost promoters of this concept, developed and applied it to the marketing of agricultural products. He defines the perfect market with respect to price discovery as one that would result in " . . . a price that would be uniform (plus or minus shipping costs) over a market area at any one time, and (plus or minus storage costs) over a period of time at any one market . . . [and] a uniform price for a commodity . . . plus or minus appropriate price differentials for different classes and grades within that commodity."[2]

The assumptions underlying this theory are that all buyers and sellers have perfect knowledge of supply, demand, and price, and act rationally upon that knowledge. Moreover, perfect competition should prevail in the market. The inclusion of perfect competition as a prerequisite has evoked much criticism concerning the value of this concept of the perfect market. It would not only make such a standard extremely unrealistic, but even undesirable.

Whatever truth there may be in these criticisms, the perfect market concept, though perhaps far from ideal, has not been seriously challenged by another standard of reference. Moreover, the possible disadvantages of the theory of the perfect market are less serious in the area of pricing efficiency with which this study deals. Approximate perfection with respect to form might well be expected to hold under conditions of imperfect com-

---

[2]F. L. Thomsen, R. J. Foote, Agricultural Prices, McGraw-Hill Book Company Inc., 1952, p. 128, citing Geoffrey Shepherd, A Framework of Marketing Theory, Dept. of Economics and Sociology, Iowa State College, Ames, Iowa, 1938, p. 20 (mimeographed).

petition, even though prices were not uniform in respect to time and place.

The perfect market with respect to form

According to the definition of the perfect market with respect to form, there will be a uniform price in a particular market for a commodity after allowance is made for real differences in quality and quantity. In a previous section, it was shown that steer and heifer carcasses of the same grade will be perfect substitutes with respect to quality as defined in this study. Consumers will not show a quality preference for meat obtained from steer carcasses as compared to meat from heifer carcasses of the same carcass grade.

It was also shown that the classification of livestock sold at public markets into the various live grades is a reasonably accurate reflection of the carcass grade classification. It is true that many individual animals are misjudged, but on the average the relationship will hold. Moreover, it is reasonable to assume that the amount of variation around the average relationship is the same for both sexes of animals.

Under these assumptions, steers and heifers classified in any particular live grade will produce carcasses of a corresponding carcass grade, whose quality will be the same to the consumer. Since the quality of the meat is the same, the only justification for a price differential will be a difference in the quantity of meat produced from heifers as compared to steers. In the perfect market, steers and heifers within one grade classification will not differ in price by more than the value of this real difference in quantity. The previous section showed that the difference

amounted to an average difference in yield of 1.5 per cent and an unknown difference in retail cut-out value. To simplify matters, all real quantity differences will in this section be expressed in terms of dressing percentages.

It is now possible to give a brief description of what would be expected to happen in the perfect market with respect to the steer-heifer price differential. The following discussion will be concerned with one grade of cattle, but, of course, the same relationship will hold for all grades.

In the perfect market, then, at given conditions of supply of cattle classified as Good and demand for corresponding (B) carcasses, reflecting consumer demand for B quality meat, buyers and sellers will arrive at such a price for Good cattle that the difference in price between steers and heifers will be just enough, and not more than enough, to allow for the difference in value resulting from the real difference in quantity. An example will clarify this situation. Suppose supply and demand conditions are such that a price of $20 per hundredweight for Good steers results. If Good steers dress out 50 per cent (in terms of retail cuts) and Good heifers only 45 per cent, heifers will sell for $\frac{45}{50}$ times $20 or $18 per hundredweight. Had the steer price been $10, heifers would bring $\frac{45}{50}$ times $10 or $9. As long as the heifer yield is 90 per cent of the steer yield, the price of heifers will be 90 per cent of the steer price, no matter how much the latter varies.

It is reasonable to assume that the difference in yield and value

actually stays constant over time, especially in the short run. But even in the long run, this relationship will not vary greatly, unless a distinct trend is present. Since the difference in yield between steers and heifers grading B is virtually constant over time, the heifer price will be a constant percentage of the steer price. As long as the yield difference is 10 per cent, the absolute price differential for heifers at the various price levels for Good cattle will vary such that the heifer price will remain 90 per cent of the steer price at all times.

The proportion of steers and heifers offered for sale is, of course, of no importance in determining the price of either sex of cattle. At a given consumer demand for B quality beef, the total supply of Good cattle will be the deciding factor in establishing the price level for this grade of cattle. The heifer price will be 10 per cent less than the steer price to allow for the difference in yield, regardless of the relative quantities of steers and heifers marketed. If the price differential tended to become larger than 10 per cent, it would be more profitable for cattle buyers to buy heifers as compared to steers, since heifers are perfect substitutes with respect to quality and differ from steers within a grade only by the amount of meat produced. This condition would cause an upward pressure on the heifer price and a downward pressure on the steer price, until the heifer price was again 90 per cent of the steer price.

In the perfect market, then, within each grade the heifer price will be a constant percentage of the steer price, regardless of the variation in the price level of the particular grade of cattle, and independent of the relative proportion of steers and heifers sold.

It is now possible to drop some of the assumptions of the theory of the perfect market to bring the model more in line with actual marketing situations and conditions which are often far from perfect. Some of the imperfections will affect the price of both steers and heifers to the same degree and should, therefore, not distort the heifer-steer price ratio. In this category fall errors in judging the true grade and yield of cattle, as well as errors introduced by classifying animals into live grades on the basis of price paid.

More serious are errors caused by the fact that the number of steers and heifers sold within a grade may not always be large enough to represent the average real value. But all these and similar imperfections will only cause a random fluctuation around the expected heifer-steer price ratio. They will not cause a persistent deviation from the expected ratio over a large marketing period, but will largely cancel out.

The perfect market with respect to form and place

The existence of a steer-heifer price differential has some interesting effects on the inter-market movement of cattle. In order to simplify matters, only two markets will be considered. It will be assumed that the relationship is that of a surplus-producing area (Winnipeg) to a deficit-producing area (Toronto). Moreover, total transfer costs per hundredweight will be taken to be the same for both steers and heifers, as well as for steer and heifer carcasses and meat cuts. These assumptions appear to be substantially realistic.

Under these conditions in the perfect market, the Winnipeg price of

steers will be equal to the Toronto price, after allowance is made for transfer costs. The same relationship will hold for heifers in both markets. Thus, when transfer charges between Toronto and Winnipeg are $1 per hundredweight, and the Toronto steer price is $20 per hundredweight, steers in Winnipeg will sell for $19. Assuming the difference in yield of heifers compared to steers to be the same at 10 per cent in both markets, the Toronto heifer price will be 90 per cent of $20, or $18 per hundredweight, and the Winnipeg heifer price 90 per cent of $19, or $17.10 per hundredweight.

Since the ratio of steer to heifer price will be equal in both markets, and since the price level of a given grade of cattle is normally unequal at surplus and deficit markets, the absolute market differential for steers will always be larger than that for heifers. In the example, the steer prices in the two markets differed by $1 per hundredweight, while the difference in heifer prices was only $.90 per hundredweight. Under such conditions, only steers will be shipped between markets. This is to be expected, since transportation charges are based on live weight. When steers yield 50 per cent meat as compared to 45 per cent for heifers, a steer contains 10 per cent more meat per hundredweight of live weight than a heifer, and at the same transfer charge per hundredweight it will, therefore, be 10 per cent cheaper to transfer meat in the form of live steers than of live heifers.

If part of the difference in yield is in the form of a difference in retail cut-out, it will also be more profitable to transfer steer carcasses than heifer carcasses for the reason indicated above. When steer carcasses

yield 5 per cent more saleable retail cuts than heifer carcasses of comparable quality, shipping meat in the form of steer carcasses will be 5 per cent cheaper.

This analysis brings out clearly the impact of a difference in yield on price relationships at one market and also between markets. The existence of this yield difference in products that are perfect substitutes with respect to quality as judged by consumers should result in the transfer of the higher yielding animals only. The relationship between freight charges for live animals and for fresh meats will determine in what form meat can be sent most economically. In this analysis, it was concluded that under perfect conditions, only steers and/or steer carcasses would be shipped from a surplus to a deficit area.

However, it must not be forgotten that, in this analysis, the difference in yield refers to the average run of steers and heifers of a given grade or quality. The difference in yield results from the fact that heifers on the average are marketed at a lower weight than steers, while it was shown that yield varied directly with live weight. It is, therefore, always advantageous to transfer the heavier cattle, since in that case more meat is moved per hundredweight of live weight. This will apply to steers, as well as to heifers. If the same relationship between weight and yield exists at the retail cut-out level, shipment of heavier carcasses will be preferred. Under these two conditions, some heifers and heifer carcasses that are heavier than average might be shipped just as profitably as the average run of steers. If female cattle tend to produce carcasses that typically have a lower yield of retail cuts, independent of

the variation with weight, it will always be more profitable to transfer steer carcasses. All in all, relatively few heifers and heifer carcasses would be expected to be transferred between the two markets.

Marketing Data and Marketing Statistics

In this section the usefulness and accuracy of the available market price statistics as measures in price differential studies will be discussed. This matter is of considerable importance. Good results can hardly be expected when poor measures are used. When the accuracy of the statistics used is not known, the results of a study are really of no great practical significance, since the true results are not known.

To get at the core of the problem it is necessary to bring out the distinction between marketing data and marketing statistics. In livestock marketing, the original data consist of the prices paid for individual animals or lots of animals of a particular grade and weight at a given market and time. Of course, marketing information is seldom available in this raw form. Practically all livestock marketing data are summarized into statistics of daily, weekly, monthly, and yearly weighted average prices and total quantities sold. Such treatment of data is for many practical purposes very desirable and will often increase its usefulness. But there is nothing inherent in procedures like weighting prices by the quantities sold that makes the resulting average prices accurate measures or tools for all purposes. Statistical treatment of original marketing price data for descriptive and analytical purposes depends on the theory or model used to explain or predict market price behavior. The statistics used

should be consistent with sound, theoretical explanations of actual marketing relationships.

Theoretical requirements of statistical measures

According to the theory of the perfect market at any level of supply of a given grade of cattle, and of the demand for the quality of meat obtained from these cattle, heifers will be discounted compared to steers to allow for the real difference in quantity of meat obtained per hundredweight. Since the quality of meat derived from both sexes of cattle is identical in the consumers' eyes, it is only the relative quantity of meat per hundredweight that influences the steer-heifer price differential. The proportion of steers to heifers sold at a given condition of supply and demand will not affect the differential, since, after allowing for the difference in yield, steers and heifers within a grade are perfect substitutes.

A hypothetical example will demonstrate this point. Suppose that a market opens a particular day with a price level for Good beef cattle which results in a price for Good steers of $20 per hundredweight. If heifers yield, on the average, 10 per cent less than steers, Good heifers should sell at 90 per cent of the steer price, which is $18 per hundredweight. Around noon, buyers discover that their opening price level for Good cattle was too high. A new level is established at which Good steers will be sold for, say, $10. The heifer price will still be 90 per cent of the steer price at $9.

When at the end of the day weighted average prices are calculated for

Good steers and heifers sold, the ratio of these average prices should again be 90 per cent. This result will be obtained from weighted average prices only when the proportion of steers and heifers sold at the two price levels is the same. A simple example will clarify this point:

Steers		Heifers		
Quantity sold	Avg. price	Quantity sold	Avg. price	Price ratio
50	$10.00	20	$ 9.00	90.0
100	20.00	40	18.00	90.0
Weighted avg. price	16.667	Weighted avg. price	15.00	90.0

The proportion of steers and heifers sold at the two price levels is the same, and the average ratio calculated from the weighted average steer and heifer prices is accurate at 90 per cent.

If the proportion is different, the ratio of the weighted average heifer and steer prices will be a biased estimate of the real relationship. This is clearly brought out when in the previous example the quantity of steers sold at the two price levels is reversed:

Steers		Heifers		
Quantity sold	Avg. price	Quantity sold	Avg. price	Price ratio
100	$10.00	20	$ 9.00	90.0
50	20.00	40	18.00	90.0
Weighted avg. price	13.333	Weighted avg. price	15.00	112.5

The disproportion in the quantity of steers and heifers sold at the two price levels has made the ratio calculated from weighted average prices a biased estimate of the true average price ratio, which here, as in the previous example, is 90 per cent.

Normally, this type of error will not be very likely to occur within one day, since usually only one price level will prevail. Even when the price level does change during a day, weighted daily averages can be used in calculating relatively unbiased heifer-steer price ratios, since the proportion of steers and heifers sold at each price level will be approximately equal. Cattle at stockyards are sold at random all during the day; there is no tendency for one sex to be relatively more plentiful at some part of the day. Weighted daily average prices can, therefore, be expected to produce accurate price ratios, especially when total quantities of each sex marketed are sufficiently large to insure an approximately normal distribution of the variation in yield for both.

But except for the most recent years, such daily prices are not readily available. In a study covering a longer time period, weekly, monthly, or yearly prices have to be used, all of which are weighted averages. Since both price level and relative quantities of steers and heifers within one grade vary daily, seasonally, and cyclically, the use of weighted average prices will introduce a bias. The extent of this bias will depend on: (1) the extent of the variation in the relative quantity of steers and heifers; (2) the extent to which the price level varies; (3) the frequency with which the price level changes; and, (4) the extent to which errors cancel each other out.

Application to hypothetical data

It is clear from the number of factors involved that a test for bias is a complex and cumbersome procedure. The problem is complicated by the

lack of testing material, except for the most recent years. Daily average prices and quantities at the various public markets, which constitute the best testing material, are only available for the last two years. For the year 1955, ratios of daily prices of Good steers under 1,000 pounds, and Good heifers in Winnipeg were calculated. Under conditions of the perfect market, these ratios would remain constant, regardless of changes in relative quantities of steers and heifers sold and of changes in the price level. Calculating a monthly or yearly average ratio would be a very simple matter. Even if the daily ratios fluctuated, but in a random fashion around the true mean, a simple average of the daily ratios would give a good estimate of the monthly and the yearly ratios. These estimates could then be used to test the bias introduced by calculating ratios from weighted average monthly and yearly prices.

However, the matter is not nearly as simple as this. In reality, daily price ratios are not constant, but vary considerably from day to day with a rather distinct seasonal pattern. These variations cannot be due to errors of judgement in price discovery, for in such cases, the variation would be of a random nature. This imperfection can be more accurately termed an intentional "error" because of its non-random character. The seasonal pattern indicates that other factors besides relative yield of meat enter into the steer-heifer price differential. This fact makes an appraisal of the bias due to weighting even more important. Only then is it possible to distinguish and to measure the extent of both weighting bias and intentional discrimination.

A simple method of estimating the bias introduced by using weighted

average prices is to calculate a hypothetical daily heifer price by assuming that heifers sell at a constant discount from the actual steer price. If the discount is 10 per cent, the heifer-steer price ratio will be 90 per cent each day, and, therefore, the monthly ratio will also be 90 per cent. This percentage will be obtained when the ratio is calculated from the unweighted, or simple, average monthly steer and heifer prices. The difference between this ratio, 90 per cent, and the ratio calculated from weighted average monthly steer and heifer prices will constitute the bias introduced by using weighted average prices. The results of these calculations for 1955 Winnipeg daily prices of Good steers under 1,000 pounds are shown in Table IX.

TABLE IX

ESTIMATION OF THE BIAS CAUSED BY WEIGHTING IN THE CALCULATION OF MONTHLY HEIFER-STEER PRICE RATIOS FOR 1955*

Month	Monthly ratio calculated from: Simple avg. of daily prices	Monthly ratio calculated from: Weighted avg. of daily prices	Bias due to using weighted avg. prices
	(1)	(2)	(1) - (2)
January	90.0	89.6	+.4
February	90.0	90.0	.0
March	90.0	90.1	+.1
April	90.0	89.9	-.1
May	90.0	90.3	+.3
June	90.0	90.0	.0
July	90.0	89.7	-.3
August	90.0	90.2	+.2
September	90.0	90.0	.0
October	90.0	89.6	-.4
November	90.0	90.3	+.3
December	90.0	89.6	-.4
Average	90.0	90.2	+.2

*Actual steer prices as obtained from the files of the Marketing

From the results shown in this table, it appears that ratios calculated from weighted average prices do not introduce a very large error. The monthly ratios and the yearly ratio calculated from weighted average prices are surprisingly close to the expected 90 per cent ratio. It must not be overlooked, however, that these calculations apply to the year 1955 only. Previously, it was stated that the extent of the bias caused by using weighted prices depends on the variation in the relative quantities of steers and heifers marketed and on the extent of the variation in the price level. In 1955, the relative proportion of steers and heifers marketed each day or month did not vary much. More important was the fact that seasonal variation in the price level did not amount to more than $2.00 per hundredweight, whereas a variation of over $5.00 is not unusual.

In order to substantiate this argument, daily prices for some years previous to 1955 would be needed. These prices, however, are not readily available. To test for weighting bias in years previous to 1955, a less accurate but still useful measure can be employed. It is possible to evaluate the bias introduced by calculating yearly price ratios from weighted yearly prices. These are calculated by taking a weighted average of monthly prices, which will be assumed accurate. Again, a hypothetical heifer price will be calculated by assuming a 10 per cent discount. The yearly ratio, calculated by taking the simple average of monthly prices

---

Service, Winnipeg, are used, and heifers are assumed to sell at 90 per cent of steer prices. The differences between columns (1) and (2) are due solely to weighting. Prices are unweighted in the first column, and in the second column are weighted by the numbers of steers and heifers marketed each day.

is, therefore, 90 per cent and can be used to test the ratio based on the weighted average yearly prices. The results of these calculations are shown in Table X.

TABLE X

ESTIMATION OF THE BIAS CAUSED BY WEIGHTING IN THE CALCULATION OF ANNUAL HEIFER-STEER PRICE RATIOS, 1947-1954*

Year	Yearly ratio calculated from: Simple avg. of monthly prices	Yearly ratio calculated from: Weighted avg. of monthly prices	Bias due to using weighted avg. prices
1947	90.0	89.0	-1.0
1948	90.0	96.0	+6.0
1949	90.0	89.5	- .5
1950	90.0	90.4	+ .4
1951	90.0	90.6	+ .6
1952	90.0	88.5	-1.5
1953	90.0	89.6	- .4
1954	90.0	91.0	+1.0

*Heifer prices are hypothetical, being calculated at 90 per cent of the price of steers, which was obtained from Livestock and Animal Products Statistics, Dominion Bureau of Statistics, Ottawa, Vols. 1947-1954.

The bias shown in this table is far more serious. Especially for years like 1948 and 1952, when the price level varied more than normally, and for 1954, when the variation in the relative proportion of steers and heifers sold over the seasons was extraordinary, using weighted averages to calculate yearly price ratios will result in considerable inaccuracy. Table X shows only part of the weighting bias, since monthly weighted average prices are assumed unbiased. In fact, this is not often the case, as was shown in Table IX. It is reasonable to expect that the total bias

will be even greater, since monthly weighted average prices are most likely to be biased in years like 1947, 1948, 1952, and 1954.

Application to actual data

So far the weighting bias has been estimated on the assumption that the heifer-steer price ratio remains constant over time. In practice, however, this ratio varies seasonally. It is, therefore, necessary to give an indication of weighting bias in this more complicated case. This is not an easy matter. The type of test to be employed depends on what the price ratio is expected to measure.

If it is assumed that, after allowing for the real difference in yield, steers and heifers are perfect substitutes, it is useful to calculate the average discount per hundredweight of heifers sold. The fact that the heifer-steer price ratio varies over time is recognized but considered as an imperfection. An unbiased estimate of the average heifer discount can be obtained by taking the weighted average of the daily price ratio (assumed to be unbiased), using as weights the quantities of heifers sold.

If, on the other hand, the fact that the price ratio varies over time is taken to indicate that steer and heifer meat have quite independent demands and are, therefore, imperfect substitutes, another calculation must be employed. When steer and heifer meats have independent demands, the quantity of each sex of animal marketed is mainly important relative to the demand for each type of meat. The proportion of heifers to steers has only an indirect effect on their relative prices.

In this case the most useful, unbiased, average price ratio will

result when a simple average of the daily price ratios is taken. This measure is quite similar to the hog-beef price ratio; it estimates the average level of the daily heifer-steer price ratios.

An average of the two price ratios obtained by each of these methods may represent the more reasonable measure since, in practice, heifer and steer meat are very close substitutes, although a slight independence of demand perhaps exists. Whatever assumption or approach is used, neither will justify using ratios calculated from weighted average yearly prices. The bias resulting from using monthly weighted average prices in calculating monthly ratios is shown in Table XI. The ratios calculated by the two methods explained above are compared with the ratio calculated from weighted average monthly prices.

Regardless of which approach to the problem is taken, ratios calculated from weighted average monthly prices will give biased estimates. For most months, the bias, as measured against the two standards, is in the same direction, although the magnitude differs appreciably.

Significant is the fact that for both approaches, the error introduced by using weighted average prices to calculate ratios is most important in the fall months, when total cattle marketings are largest. The negative sign of the bias during these months also shows that the use of weighted prices makes price ratios appear excessively large. Over the rest of the year the bias is rather small and the yearly average is only very slightly biased.

TABLE XI

BIAS INTRODUCED BY CALCULATING HEIFER-STEER PRICE RATIOS FROM WEIGHTED AVERAGE MONTHLY PRICES, WINNIPEG, 1955*

Month	Monthly ratio calculated by taking: Weighted avg. of monthly prices	Simple avg. of daily price ratios	Avg. of daily price ratios weighted by heifers sold	Bias due to using: (1) instead of (2)	(1) instead of (3)
	(1)	(2)	(3)	(1) - (2)	(1) - (3)
Jan.	81.9	82.4	82.4	-.5	-.5
Feb.	85.4	85.8	85.6	-.4	-.2
March	88.3	88.0	88.2	+.3	+.1
April	87.3	87.7	87.6	-.4	-.3
May	88.6	88.9	88.9	-.3	-.3
June	89.8	89.6	89.8	+.2	—
July	83.8	84.2	84.1	-.4	-.3
Aug.	82.6	82.4	82.4	+.2	+.2
Sept.	81.6	82.4	82.7	-.8	-1.1
Oct.	84.2	85.3	85.1	-1.1	-.9
Nov.	85.6	85.8	84.9	-.2	+.7
Dec.	88.6	88.5	89.9	+.1	-1.3
Avg.	85.7	85.9	85.8	-.2	-.1

*Source: Daily steer and heifer prices and sales were obtained from files of the Marketing Service, Dept. of Agriculture, Winnipeg.

Again, these results apply only to 1955. To get an indication of the bias caused by using weighted average yearly prices in calculating yearly ratios, a comparison for the years 1947-1954 was made. The monthly weighted average prices, used to calculate the yearly averages and ratios, were assumed unbiased. The results in Table XII measure, therefore, only part of the real bias.

TABLE XII

BIAS INTRODUCED BY CALCULATING HEIFER-STEER PRICE RATIOS FROM WEIGHTED AVERAGE YEARLY PRICES, WINNIPEG, 1947-1954*

Year	Yearly ratio calculated by taking: Ratio of weighted avg. yearly prices	Simple avg. of monthly price ratios	Avg. monthly price ratios weighted by heifers sold	Bias due to using: (1) instead of (2)	(1) instead of (3)
	(1)	(2)	(3)	(1) - (2)	(1) - (3)
1947	88.3	90.3	89.2	-2.0	- .9
1948	93.0	88.6	87.6	+4.4	+5.4
1949	88.6	90.2	89.0	-1.6	- .4
1950	91.4	90.8	90.9	+ .6	+ .5
1951	92.2	91.8	91.7	+ .4	+ .5
1952	85.9	89.7	86.9	-3.8	-1.0
1953	86.6	87.6	86.8	-1.0	- .2
1954	81.4	81.4	80.6	---	+ .8

*Source: Prices and sales of Good steers under 1,000 pounds and Good heifers were obtained from Livestock and Animal Products Statistics, Dominion Bureau of Statistics, Ottawa, Vols. 1947-1954.

The results in this table do not leave any doubt that the bias introduced by using weighted average prices is larger than can reasonably be overlooked in a meaningful analysis of price differentials. Whichever approach to the problem is used, the bias is large enough to completely reverse the yearly variation for some years. The extent of the weighting bias should not be compared to the absolute value of the price ratio, but rather to the extent of the variation of the ratio over time. Generally this variation does not exceed 10 percentage points in any one market. A bias of 4 percentage points is, therefore, highly significant. This fact is shown in Table XII, and is particularly important when the weighting

bias for two consecutive years is in opposite directions.

To get a better measure of the direction of the bias, a rank correlation between the amount of bias and the level of the ratio calculated from weighted averages was calculated. When the "simple average of ratios" approach was chosen, a positive correlation of approximately .6 was found. Ratios from weighted average prices tended to over-estimate at a high level and to underestimate at a low level of the price ratio. For the alternative approach, where a ratio calculated by weighting by the heifer quantities was taken as the standard, no significant rank correlation was found between bias and level of ratio.

The extent of the weighting bias will not be the same in all markets. Changes in the price level and variations in the proportion of steers and heifers differ greatly between markets, and are typically larger in the western markets. It is reasonable to expect the weighting bias to behave correspondingly. Spot checks for the Toronto market supported this hypothesis; in all cases the weighting error was smaller for Toronto than for Winnipeg.

CHAPTER IV

DESCRIPTION AND ANALYSIS OF STEER-HEIFER PRICE DIFFERENTIAL

Descriptive Study of the Steer-Heifer Price Differential

Previously the possible logical reasons for a steer-heifer price differential were evaluated. On the basis of these findings a difference in yield was estimated. The theory of the perfect market was then applied to this aspect of pricing efficiency, taking yield differences into account, and conclusions were drawn about the steer-heifer price differential. It was shown that under given, reasonable assumptions the price differential would be constant over time and place and that, generally speaking, only steers and steer carcasses would be exported from a surplus to a deficit producing area.

In the last section some calculation procedures were examined. It was shown that a heifer-steer price ratio, the measure commonly used to indicate the price differential, is at best only a rough estimate. Especially in critical years the bias introduced by calculating ratios from the weighted average prices found in marketing statistics is highly significant. For this reason such a ratio cannot be expected to be of much value in analytical work, where accurate measures are essential. However, this ratio will still be useful in a descriptive study since, despite its biased results, it gives a fair approximation of the real relationship for normal years. It has the advantage that weighted average prices are readily available and that its calculation is less time-consuming

than that of other, more accurate measures. For these reasons, the ratio calculated from weighted average prices will be used for descriptive purposes.

The main purpose of this section is to get an indication of the general behavior of the steer-heifer price differential over time and between markets. It will then be possible to compare the actual ratios with those that would be expected in a perfect market. The difference between the actual and the expected will be a crude measure of the imperfection existing in the market.

In the current official market reports, steers are divided into two weight classes: under 1,000 pounds, and 1,000 pounds and over. These two classes, as well as all heifers, are classified into four live grades. Since a large proportion of heifers marketed weigh less than 1,000 pounds, all comparisons in this section are with steers under 1,000 pounds. For earlier years a comparable class of steers was selected for which a corresponding heifer price was available.

Even within this scope a comparison for all four grades would take up an excessive amount of time and space. This procedure was, therefore, limited to a few years. These comparisons provide enough information to show the similarities and differences in the steer-heifer price differentials for each grade. For most of this descriptive study, steers and heifers classified as Good were selected. It is the most important class in most markets, and prices are readily available in all markets. Furthermore, the numbers falling in this grade are likely to be large enough at all times to assure that average prices are representative.

It was also necessary to select representative markets, especially since the study covers a period of time in which new markets were established and existing markets varied in importance.

For part of the study, the markets chosen were Toronto, Winnipeg, Montreal, Calgary, and Edmonton. Cattle sales at these five stockyards for every year from 1935 to 1939 constituted at least 90 per cent of sales at all stockyards. The remaining 10 per cent were divided between four or five other markets. During the period 1947 to 1954, these markets handled at least 85 per cent of sales at all stockyards each year, while the remaining sales were divided between five or six other markets.

To reduce the amount of work and to simplify the situation for part of the study, the Toronto market was compared with the Winnipeg market, with Toronto representing a deficit producing area and Winnipeg representing the western Canadian surplus producing area.

Description of yearly price ratios

To show the behavior of the steer-heifer price differential over time and at different public markets, yearly price ratios at the five selected livestock markets were calculated for the years 1927 to 1955. The resulting ratios in Table XIII on page 71, calculated from yearly weighted average prices, are far from accurate, but are useful in indicating the general movement of the price ratios. More accurate yearly price ratios, calculated from monthly prices, are shown for the Toronto and Winnipeg markets in Figure 1 on page 73.

TABLE XIII

YEARLY HEIFER-STEER PRICE RATIOS AT FIVE PUBLIC MARKETS, 1927-1955*

Year	Toronto	Winnipeg	Montreal	Calgary	Edmonton
1927	100	91	94	87	76
1928	99	93	89	92	90
1929	100	92	91	92	89
1930[a]	96	85	92	92	83
1931	100	91	88	99	97
1932	97	89	79	89	88
1933	98	87	82	84	84
1934	98	83	74	79	85
1935	96	81	75	76	81
1936	99	84	83	78	83
1937	96	77	76	76	73
1938	97	88	82	86	84
1939	100	90	86	88	95
1940	100	91	84	98	95
1941	99	91	86	94	94
1942	98	92	90	95	94
1943	98	90	91	93	92
1944	98	90	88	91	90
1945	97	88	85	89	89
1946	98	88	89	91	89
1947	97	88	91	89	88
1948	100	93	97	94	92
1949	98	89	93	92	88
1950	98	91	94	97	90
1951	98	92	96	95	94
1952	98	86	87	94	91
1953	98	87	84	91	90
1954	89	81	80	87	85
1955	90	86	85	88	86

*Price ratios are calculated from weighted average yearly prices for Good heifers and Good steers under 1,000 pounds, as reported in Livestock and Animal Products Statistics, Dominion Bureau of Statistics, Ottawa, Vols. 1927-1955.

[a] Ratios for 1930 are not fully comparable, since the yearly prices for this year were calculated from prices for the last nine months of the year only.

Granted the inaccuracies that are due to the use of weighted average prices, Table XIII reveals much interesting information. Until 1954, the price ratio in Toronto never varied by more than four percentage points. Typically, heifers were sold at a discount of approximately two per cent. This behavior of the price ratio is in general agreement with that expected to prevail in a perfect market, according to the findings and conclusions of the preceding chapter of this study. In 1954, however, a severe, unprecedented drop in the relative price of heifers occurred in the Toronto market and continued throughout 1955. This occurrence is unique in the history of the Toronto price differential and is contrary to all expectations.

In Montreal and in the three western markets the situation is much different. In the price ratios for all four markets, extreme variations, somewhat cyclical in character, have occurred over the entire time period. The direction of this variation in the price ratio is generally the same for all markets, although the extent differs considerably between markets. The price ratio was high between the years 1927 and 1931. It then declined rapidly, reaching a low point in 1935 to 1937. By 1939 it had risen to 90, and it remained steady at about that level during the war and post-war years until 1951. It has since dropped almost to the level prevailing during the depression and shows some tendency to recover again in 1955.

A graphic summary of these changes is supplied by Figure 1, where the Toronto and Winnipeg price ratios are compared. The other western markets and the Montreal market were omitted, since they all followed a pattern generally similar to that of the Winnipeg ratio.

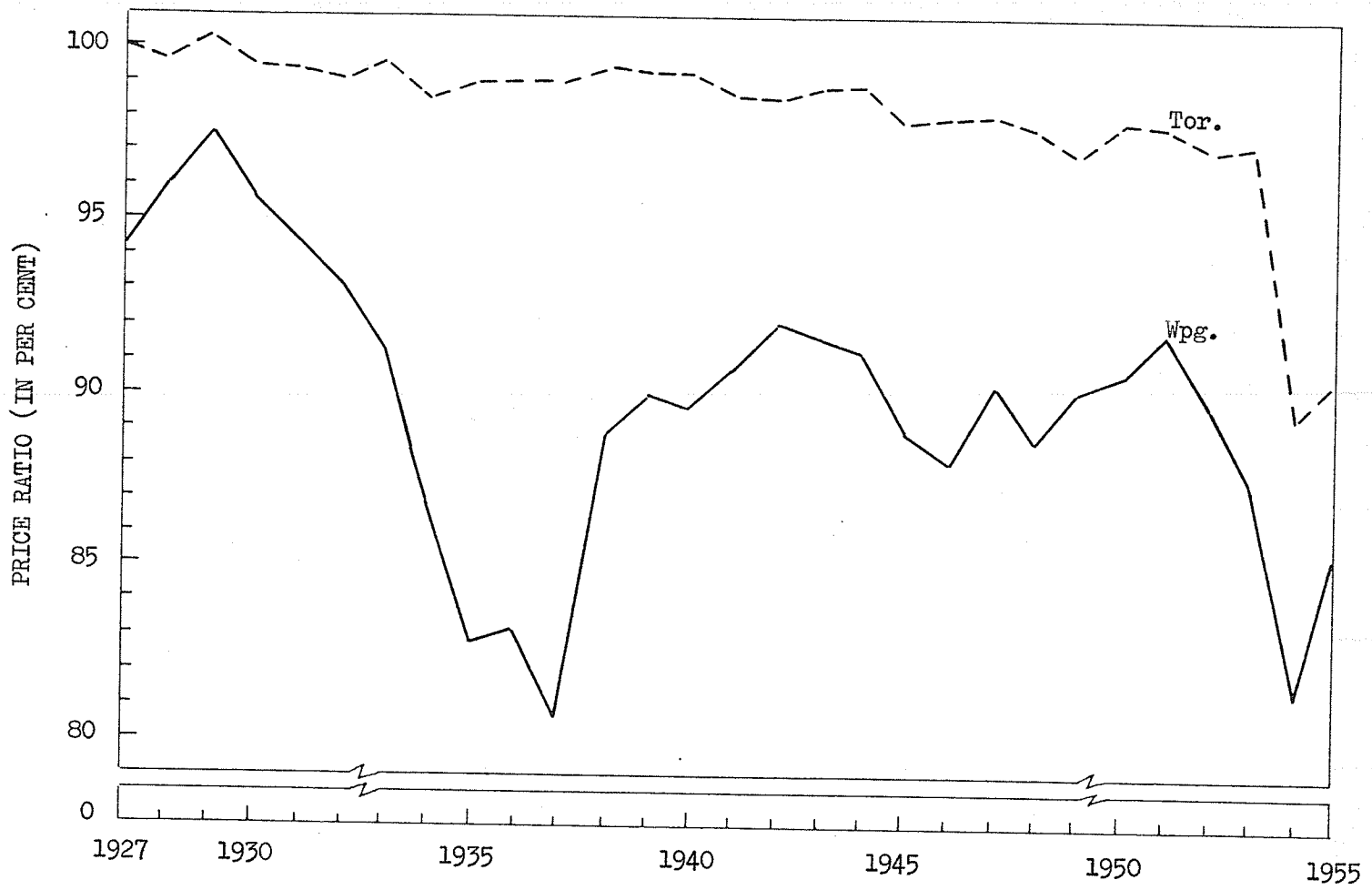

FIGURE 1

YEARLY HEIFER-STEER PRICE RATIOS IN TORONTO AND WINNIPEG, 1927-1955
(Calculated from monthly prices for Good steers under 1,000 pounds
and Good heifers, as reported in Livestock
and Animal Products Statistics)

Figure 1 illustrates the history of the price ratio as given in Table XIII and the subsequent two paragraphs. Apart from the constancy of the Toronto price ratio until 1954, a very gradual decrease in the ratio can be observed. This trend is far less noticeable in the Winnipeg series, which shows the presence of a cyclical variation in the price ratio that would have been even more distinct if wartime price regulations had not distorted the free market relationships.

Theoretically, the heifer-steer ratios should be the same in all markets. This relationship does not hold true in practice. The Toronto ratio is at all times above that of any other market. The western markets generally follow the pattern shown by Winnipeg, while the Montreal ratio tends to vary even more widely.

The situation is generally the same for other grades of cattle, as is shown in Table XIV. Ratios for Choice cattle are omitted. For several markets these ratios could not be calculated or were not strictly comparable, since for some months few or no Choice steers or heifers were offered for sale.

Table XIV shows clearly that the situation shown in Figure 1 is not restricted to Good cattle, but applies to all grades. The price ratios for Medium and Common cattle display the same relationships as those of Good cattle within and between markets, although there are some small differences in the degree of variation. When all three classes in Toronto are compared, it is seen that 1954 brought a significant change in all price ratios. The answer to the abrupt, unprecedented fall in the Toronto price ratio should, therefore, not be sought in one grade of heifers or

cattle, but rather in all grades.

TABLE XIV

YEARLY HEIFER-STEER PRICE RATIOS FOR GOOD, MEDIUM, AND COMMON CATTLE AT FIVE PUBLIC MARKETS, 1947-1955*

	Good					Medium					Common				
Year	Tor.	Wpg.	Mon.	Cal.	Edm.	Tor.	Wpg.	Mon.	Cal.	Edm.	Tor.	Wpg.	Mon.	Cal.	Edm.
1947	97	88	91	89	88	99	88	90	89	87	98	90	92	91	90
1948	100	93	97	94	92	99	94	87	98	85	98	93	81	94	87
1949	98	89	93	92	88	98	90	90	91	87	98	93	84	93	89
1950	98	91	94	97	90	101	93	92	100	93	100	93	87	101	94
1951	98	92	96	95	94	98	91	90	94	92	98	91	89	94	93
1952	98	86	87	94	91	97	86	89	92	89	100	89	89	95	96
1953	98	87	84	91	90	97	84	84	89	88	98	85	81	88	92
1954	89	81	80	87	85	90	78	78	85	84	92	82	77	84	82
1955	90	86	85	88	86	90	83	82	88	84	94	84	80	85	87

*Calculated from prices reported in Livestock and Animal Products Statistics, Dominion Bureau of Statistics, Ottawa, Vols. 1947-1955.

The data in this table also indicate that the price ratios of the different grades in each market very seldom get out of line relative to one another. This fact suggests that these grades of cattle are close substitutes for one another, and that analysis or arguments emphasizing significant independence of consumer demand for different grades or sexes of cattle are questionable.

Since the price ratios for the different grades at each market are of approximately equal magnitude, and since they vary together and even roughly to the same extent, it is quite justified to select one grade to represent all grades for the purpose of further analysis. When, therefore, in the following pages other aspects of the price ratio for Good cattle are discussed,

it is assumed that similar results will hold for all other grades of cattle, although the degree of closeness of a relationship may differ somewhat with grades.

Description of seasonal heifer-steer price ratios

The heifer-steer price ratio varies seasonally, as well as from year to year. Monthly ratios indicate the seasonal behavior of the price differential. Obviously, monthly and yearly price ratios are closely related. A consideration of the monthly ratios will, therefore, help to clarify the behavior of the yearly price ratios.

In order to bring out the relationship between the absolute level of the yearly ratio and the monthly ratios for the same year, for periods of high and low yearly price ratios at the Toronto and Winnipeg markets, monthly ratios were calculated, and are shown graphically in Figure 2 on page 77. For both time periods the solid lines indicate the average monthly price ratios for the years 1927 to 1929, and 1950 to 1951, when the yearly price ratio was high. Years with a low price ratio (1935 to 1937 and 1954 to 1955) are shown in broken lines.

When attention is concentrated on section A of Figure 2, it will be seen that for years of high price ratios, the monthly ratios at both markets fluctuated relatively little, although there was some tendency for the Winnipeg ratio to vary seasonally. When the yearly ratio was low, the situation did not change appreciably in Toronto. The variation in the level of the Toronto yearly ratio was not significant, after allowance was made for weighting bias. For both time periods Toronto monthly ratios did

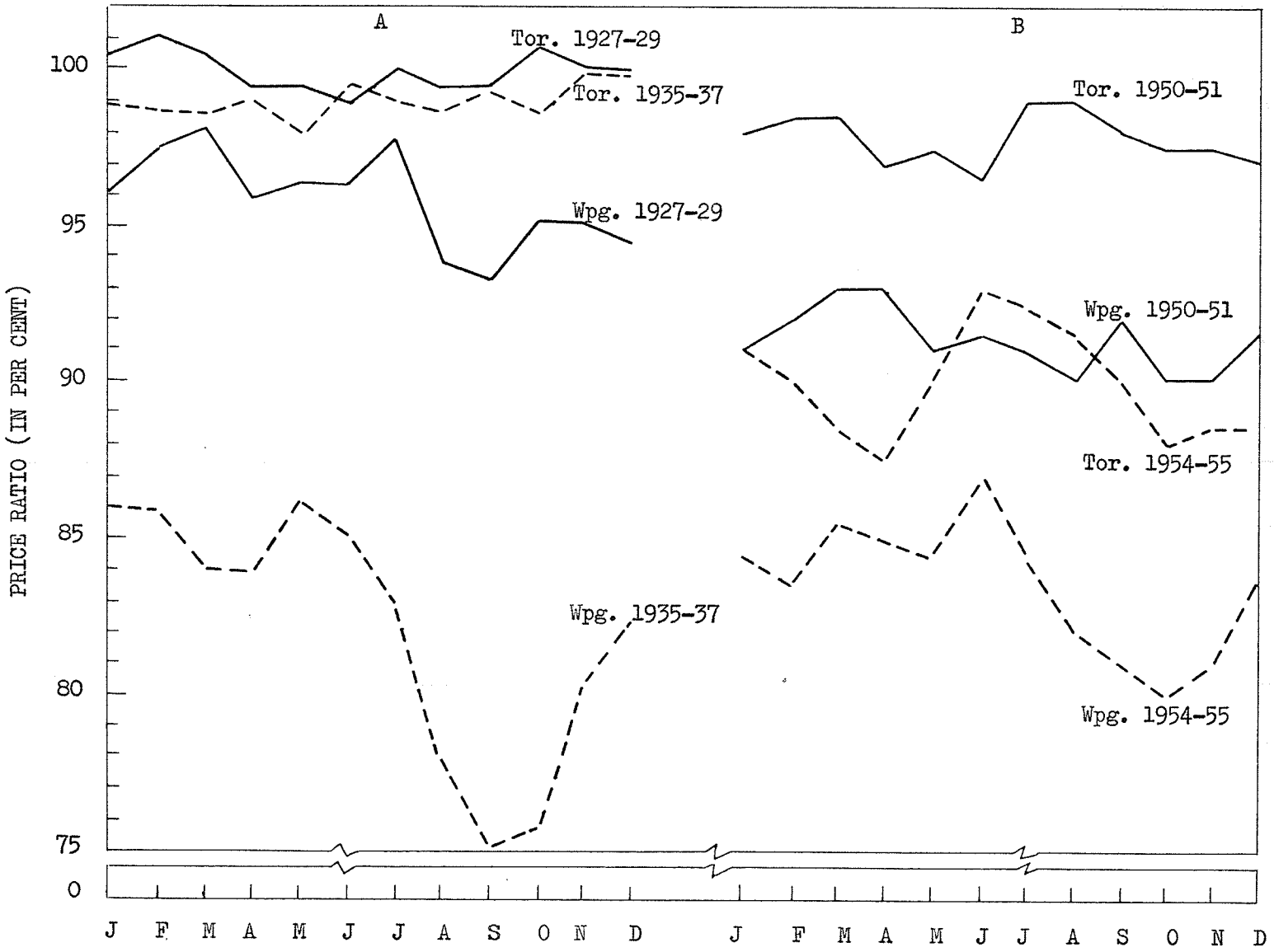

FIGURE 2

AVERAGE SEASONAL VARIATION OF HEIFER-STEER PRICE RATIO IN TORONTO AND WINNIPEG, 1927-29, 1935-37, 1950-51, AND 1954-55 (Source: See Figure 1, page 73)

not vary by more than two percentage points.

In Winnipeg the situation was much different. The high and the low average yearly ratios differed by approximately ten percentage points. The average monthly price ratios for these two periods differed considerably; although some seasonal variation in the average monthly price ratios could be observed in the 1927 to 1929 period, it was relatively insignificant compared to the seasonal variation for the years 1935 to 1937. Yet in both periods the monthly ratios followed a somewhat similar pattern. A more intensive study revealed that a variation in the monthly price ratios, generally corresponding to that shown for the years 1935 to 1937, was typical of all western markets during most of the period studied, and more recently also for the Toronto market, although considerable variation between markets and over years was observed. This monthly pattern can, therefore, be considered as a typical, average seasonal variation in the price ratio. The movement is very similar to the seasonal variation in the price of beef cattle. The ratio is normally highest in early summer and lowest in September and October.

Turning to more recent years, in section B a somewhat similar situation can be observed. For the years 1950 to 1951, when the price ratio was at a high level, the average monthly ratios for both markets did not show a distinct seasonal pattern. It can be noted that for these years the gap between the ratios in the two markets had widened slightly compared to the period 1927 to 1929. A more significant change occurred in the Toronto market during the low price ratio years of 1954 to 1955, when the average monthly price ratios showed a distinct, seasonal variation

at a level without precedent in this market. The pattern was very similar to that of the Winnipeg price ratio for the same period. Previous to 1954 the Toronto monthly price ratios for years of high and low yearly ratios did not vary significantly and did not follow a clear, seasonal pattern.

The approach used in Figure 2 provides some information about the seasonal variation of the price ratio for years when the level of this ratio was relatively constant at high or low levels. This method, however, is not satisfactory for years in which the level of the ratio is falling or rising, since these movements distort the seasonal variation. To derive a more accurate seasonal pattern of the price ratio in both the prewar and postwar periods in the Winnipeg market, the monthly ratios were expressed as percentages of the moving average and a seasonal index was calculated therefrom. This procedure corrects for trend and for cyclical variation in the price ratio. The data are shown in the Appendix, Table XV, and the results are presented graphically in Figure 3, on page 80.

For both time periods a pronounced seasonal variation is noticeable. In the prewar period the price ratio was high and relatively stable for the first three months of the year. It declined to a low point in August and recovered to its winter level by November. The seasonal movement was similar in the postwar period, but a substantial shift to the right had occurred. The lowest price ratio normally occurred in August during the prewar period. After the war October was the month with the lowest price ratio.

A study of the seasonal pattern for individual years showed a lack of uniformity in the seasonal movements for the different years included in

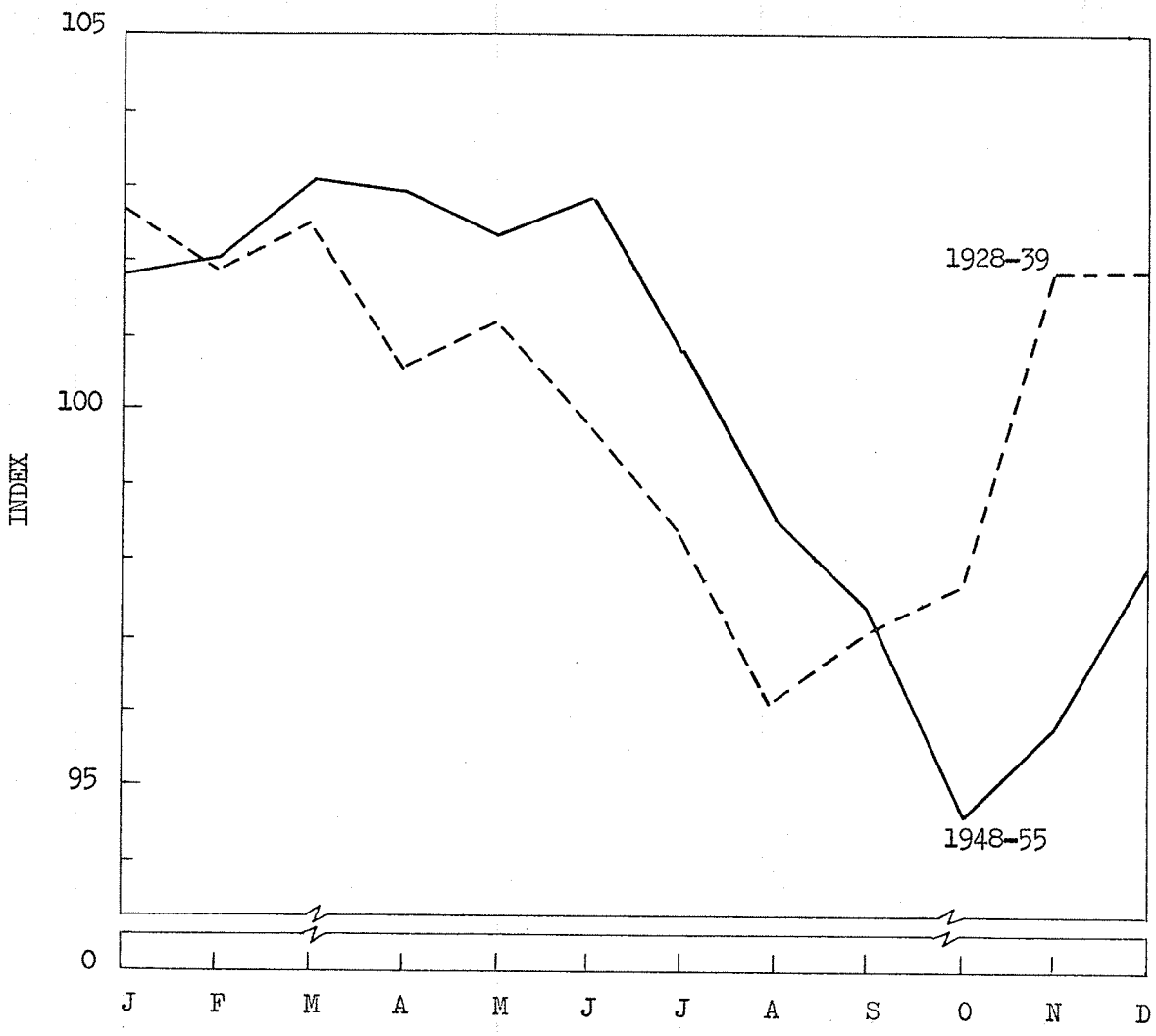

FIGURE 3

INDEX OF SEASONAL VARIATION OF HEIFER-STEER PRICE RATIO IN WINNIPEG, 1928-39, AND 1948-55 (Source: See Table XV, Appendix)

this analysis. Even after corrections were made for cyclical variations, the seasonal variation differed in extent with changing levels of the price ratio. For the years 1928 to 1930 and 1949 to 1951, the difference between the highest and the lowest value of the monthly price ratios each year ranged between 5 and 11 percentage points. When the level of the price ratio moved down, the range was from 15 to 21 percentage points in the 1932 to 1937 period and from 12 to 17 in the 1952 to 1955 period. These results are in accordance with the relationships observed in Figure 2; the seasonal variation is most pronounced in years when the level of the price ratio is declining or is at a low point.

Summary of descriptive study

In the theoretical discussion it was concluded that, in the perfect market, the price ratio would be constant over time and at the same level in all markets. This section of the study has shown that such behavior of the price ratio was actually true only in the prewar Toronto market. In all other markets and in the postwar Toronto market as well, the yearly and monthly ratios were found to vary considerably. The yearly ratios followed a somewhat cyclical pattern, similar to that shown by the price of beef. Seasonal variation was found to exist, the extent depending on the level of the price ratio. It was most pronounced in years of low price ratios in all markets. The price ratio was typically high in spring and low in fall.

Analytic Study of Steer-Heifer Price Differential

The description of the steer-heifer price differential in the previous section showed the disparity between the actual and the expected situation. According to the theory of the perfect market the price ratio should be constant over time and at the same level in all markets. The assumptions on which these conclusions were based are quite reasonable. In the first place it was assumed that consumers of meat do not differentiate between steer and heifer meat of the same grade with respect to quality, as judged by them. This is generally accepted as fact by those familiar with retail meat selling practices. The other assumption, that the average difference in quantity of meat obtained per hundredweight from steers and heifers of the same quality (which is the only logical basis for the differential) will not vary significantly over time or between markets, is equally reasonable. Since the actual price ratio does not conform with the expected price ratio, some imperfection must exist in the market.

If it is desirable that this imperfection be removed from the market, it will be necessary first to analyze the nature of the variation of the price ratio over time and between markets. Furthermore, it is necessary to know at what stage in the marketing process the imperfection arises. Packers may be blamed for imperfections in meat marketing that are caused by retailers and passed on by them in the form of prices offered to packers for beef carcasses and wholesale meat cuts. It is true that packers normally determine the price differential for heifers sold at stockyards,

but their decisions on the size of this differential may be the result of imperfections at the retail, rather than at the packing level. Only when this information is available is it possible to devise or suggest changes in the existing marketing situation to combat this type of pricing imperfection.

In the preceding section it was indicated that within the year a definite seasonal variation occurs. Figure 1, depicting the yearly price ratio for Winnipeg over the last thirty years, also suggests the presence of a cyclical variation in the price ratio. First, then, it is necessary to find the nature of this variation of the price ratio over time and to look for factors that reasonably explain this variation.

In a sense it is difficult to find a logical explanation for the existence of the varying price ratios since, according to the two assumptions, based on readily observable facts, such a variation is contrary to reason. Only very recently an attempt was made to explain the seasonal variation of the steer-heifer price differential in an article entitled "Why the Difference?".[1] In the analysis the price differential for animals classified as Good at the Toronto, Calgary, and Chicago markets was compared with the ratio of heifers to steers marketed. The charts showed a rather close positive correlation of the two variables. The differential was low in early summer, when the proportion of heifers to steers was low, and gradually rose in fall and winter with an increase in the heifer-steer quantity ratio. The use of the heifer-steer quantity

---

[1] Meat Packers Council of Canada, A Letter on Canadian Livestock Products, Toronto, May-June, 1956.

ratio as the explanatory variable implies a significant independence of demand for steer and heifer beef. This assumption is at variance with the arguments advanced in the present study, according to which heifer and steer beef are very close-substitutes.

The high co-variation loses significance when procedure is examined. The use of the absolute differential can hardly be defended except, perhaps, when a very short time period is used. Here, the monthly differential was averaged from monthly differentials for the years 1951 to 1955. During this period the price of cattle dropped by nearly 50 per cent, making absolute differentials of dubious value. In calculating the average differentials and quantity ratios, the influence of cyclical variations and trend on the seasonal variation of both factors was apparently also ignored. More important than these shortcomings is the fact that the heifer-steer quantity ratio fails to explain variation of the price ratio over the years. For the years 1947 to 1955, these two variables displayed a rather close direct relationship, while for the seasonals during that time period, the relationship was inverse. These mutually contradictory relationships make the heifer-steer quantity ratio of limited explanatory value.

Analysis of yearly heifer-steer price ratios

Far better results were obtained when total slaughtering was correlated with the price ratio. In order to show the yearly or cyclical variation, a moving average of the monthly price ratio and of total inspected slaughtering was calculated for the years 1948 to 1955. This

procedure eliminates the normal seasonal variation from the data. The results for the Winnipeg market are shown in Figure 4, on page 86.

The correlation coefficient for all years was relatively low at -.662, but was significant at the one per cent level. This rather low correlation was due to the lack of a definite relationship in 1948 and 1949. When these two years were omitted, a highly significant correlation of -.912 was obtained.

The logic of using inspected slaughtering as an explanatory variable is clear. It is a good measure of the supply of beef. Figure 4 shows that the supply of beef and the heifer-steer price ratio are inversely related. These results affirm statements by people familiar with the meat trade that the retail trade tends to discriminate against heifers when marketings are large. Naturally, in this analysis, the demand for beef is assumed constant, which is not normally the case when more than a few years are considered. When demand shifts only gradually, as it undoubtedly did during the period 1950 to 1955, inspected slaughter will still be a good approximation of the effect of changes in supply on the price ratio. When a longer time period is considered, allowance will have to be made for shifts in demand.

This factor also explains the relative lack of relationship for the years 1948 and 1949. These two years are abnormal, no matter what aspect of beef cattle marketing is studied, due to wartime price control regulations and wartime increases in purchasing power, which only became effective when regulations were rescinded in 1947. For these reasons a beef price, deflated so that it reflects supply relative to demand for beef, might give

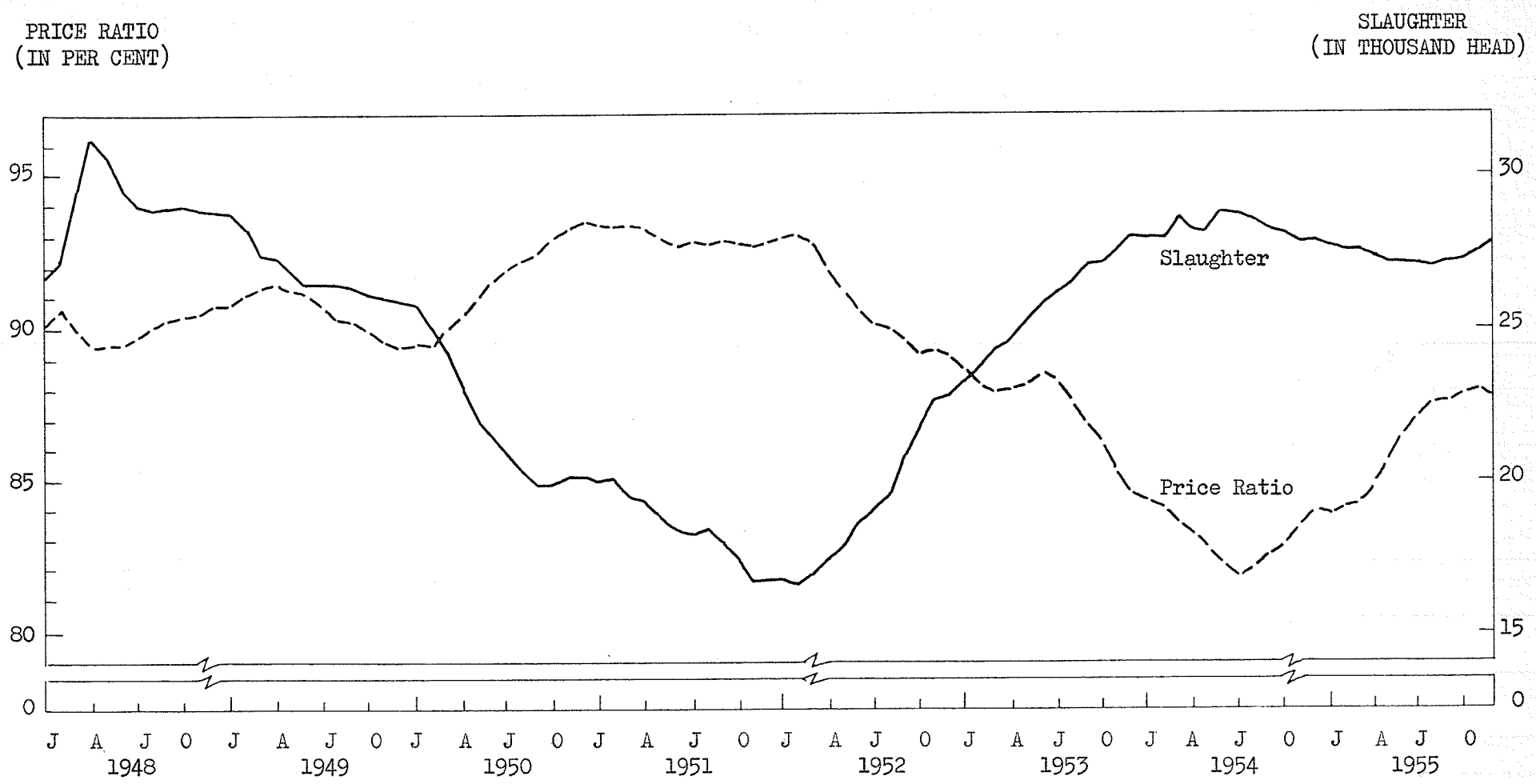

FIGURE 4

TWELVE-MONTHS MOVING AVERAGE OF HEIFER-STEER PRICE RATIO IN WINNIPEG AND OF INSPECTED SLAUGHTER OF CATTLE IN MANITOBA, 1948-1955 (Source: See Figure 1, page 73)

more accurate results, especially when longer periods are under consideration. However, this procedure has its shortcomings as well. High correlation would be expected when a price ratio is compared with the price level of beef, which invariably contains or is closely related to the prices from which the ratio is calculated. "All Heifers Marketed in Winnipeg", "All Heifers Marketed in Canada", and "Total Commercial Marketings in Canada" were used as possible explanatory variables, but none approached the explanatory value of "Inspected Slaughtering in Manitoba".

This measure proved to be equally successful in analyzing the Toronto price ratio, for which the same procedure was employed. The results are shown in Figure 5, on page 88. The correlation coefficient was -.911, and proved to be highly significant at the one per cent level. The covariation of price ratio and Ontario slaughter is as close as in Figure 4, where the situation in Manitoba is depicted. Figure 5 also provides a possible explanation for the unprecedented fall in the Toronto price ratio during 1954. The increase in Ontario slaughter since 1951 has been phenomenal and at the close of 1955 the rate of increase had not changed appreciably. This increased supply may have forced the Toronto price ratio into line with the ratio in other Canadian public markets.

Analysis of seasonal heifer-steer price ratios

The relationship between supply and the price ratio is also exhibited in the seasonal variation. The monthly ratio and slaughtering were expressed as percentages of their moving averages in order to remove trend

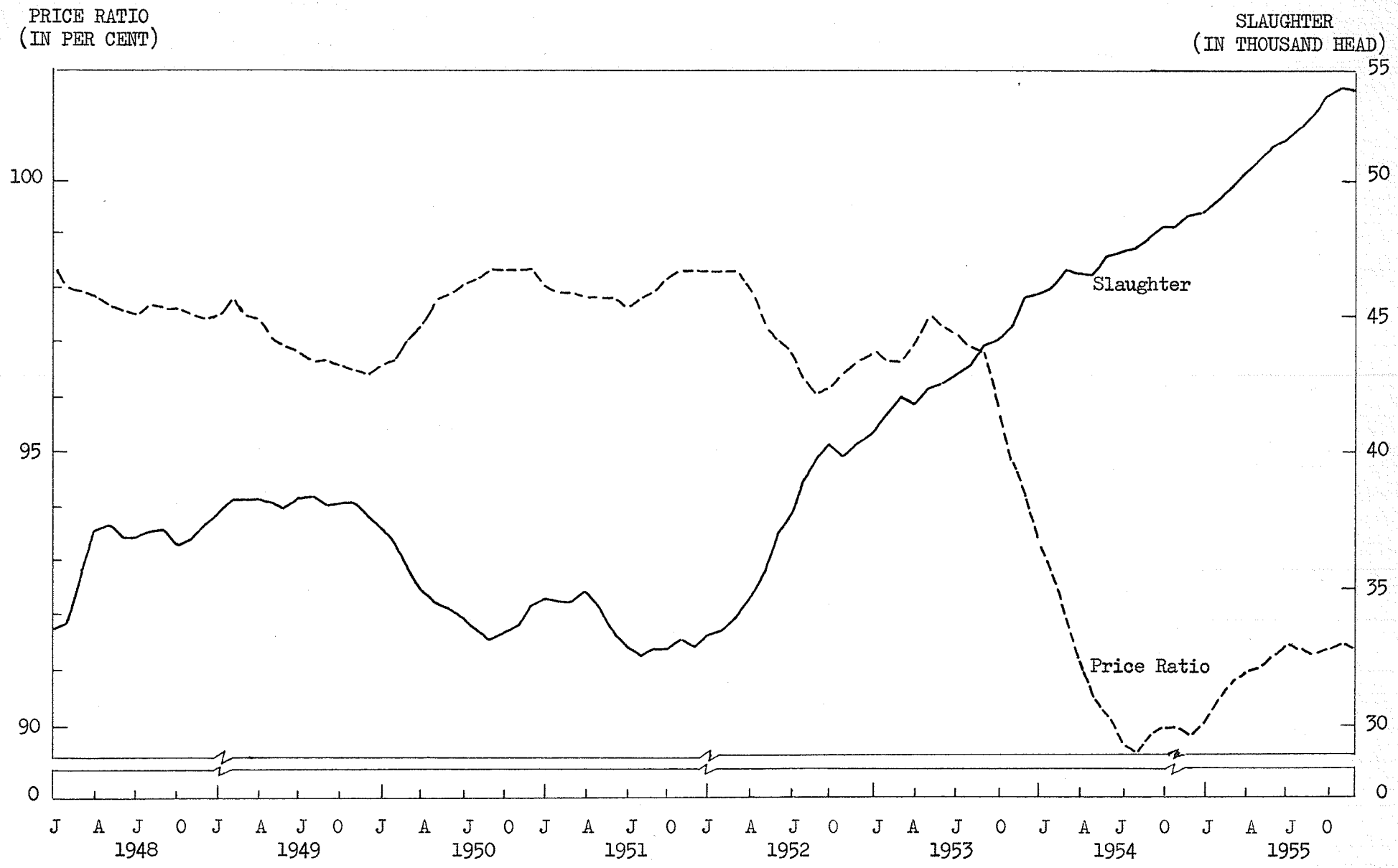

FIGURE 5

TWELVE-MONTHS MOVING AVERAGE OF HEIFER-STEER PRICE RATIO IN TORONTO AND OF INSPECTED SLAUGHTER OF CATTLE IN ONTARIO, 1948-1955 (Source: See Figure 1, page 73)

and cyclical variation. The results are shown in Figure 6, on page 90.

The two variables again show a high degree of correlation. The coefficient was very significant at -.921. The relationship is again inverse; when inspected slaughter is low, in the first part of the year, the price ratio is high; when slaughter is high, in the fall, the price ratio is low.

Interpretation of findings

Previously the high inter-relationship between various Canadian markets was demonstrated. The yearly price ratios were found to vary in all western markets in the same direction and approximately to the same degree. Inspected slaughter is also known to vary similarly in all Canadian public markets. It can, therefore, be taken safely that substantially the same relationship between the price ratio and inspected slaughter will prevail at all public markets in the postwar period. Since inspected plants process a very high proportion of all cattle sold for slaughter, inspected slaughter can reasonably represent the supply of meat.[2]

Figure 6, then, illustrates the inverse relation between the supply of beef and the heifer-steer price ratio. The procedure adopted in calculating the seasonals has removed the trend present in both series and has thus allowed for shifts in demand. This analysis seems to support the

---

[2] M. Rachlis, "The Structure and Operation of the Canadian Livestock Marketing System," Canadian Journal of Agricultural Economics, Vol. I, No. I, 1952, p. 48.

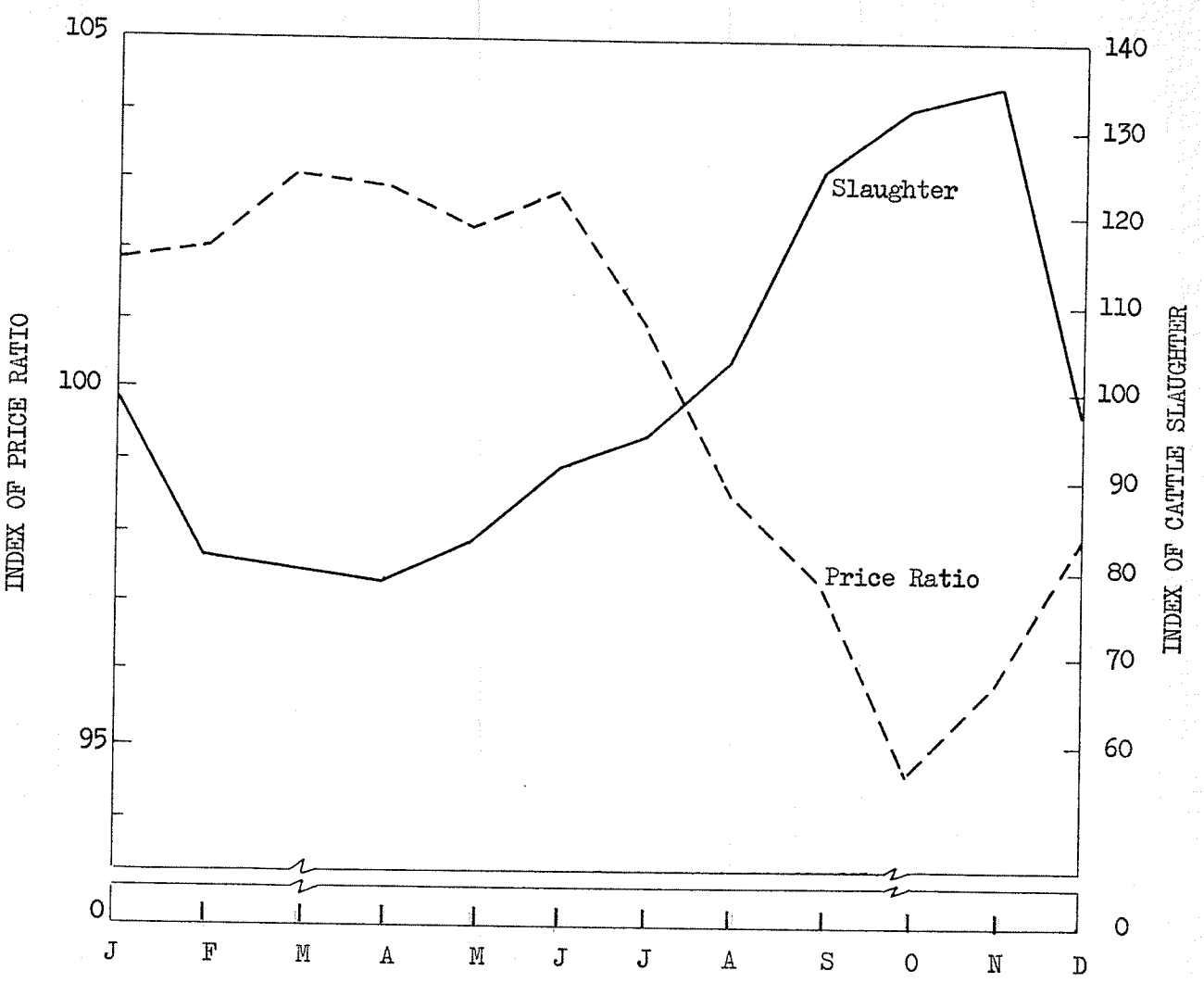

FIGURE 6

INDEX OF SEASONAL VARIATION OF HEIFER-STEER PRICE RATIO IN WINNIPEG AND OF INSPECTED SLAUGHTER OF CATTLE IN MANITOBA, 1948-1955
(Source: See Figure 1, page 73)

argument frequently put forward by the packers that retailers tend to discriminate against heifers when beef is in good supply. This tendency might be explained by the aversion on the part of retailers to adjustments in their selling prices with each change in their buying price. Retailers normally selling steer beef may react to a rise in the wholesale price by switching to heifer beef, since this may assure them the same margin of profits without requiring a change in their selling price. This action would have a tendency to decrease the demand for steer beef and increase that for heifer beef, and thus narrow the differential. Eventually, retailers might have to raise their selling prices, but even then, fewer and smaller price changes are necessary when heifers are bought, until the differential is just large enough to allow for the real difference in retail cut-out.

If this line of reasoning is correct, this action of retailers supplies a method to estimate the differential that is justified in a perfect market. The steer-heifer price differential will be closest to being just large enough to allow for a difference in yield in years when the supply of meat relative to the demand is smallest. Judging by the Toronto price ratio, this differential appeared to be not more than 2 per cent before the war, and perhaps 3 per cent in the postwar years. In Winnipeg the prewar minimum differential was 2.5 per cent, but in the post-war period, the smallest price differential, 8 per cent, differed too much from the Toronto minimum differential of 3 per cent to be a reasonable estimate of the justified price differential.

An attempt was made to find empirical evidence in support of the

argument that retailers tend to discriminate against heifers when the supply of beef is abundant. The weekly average live prices for Choice steers under 1,000 pounds and heifers at Winnipeg were converted into prices per hundredweight of carcass by multiplying them by the reciprocal of their respective dressing percentages. The values of the dressing percentage were obtained from Table III, on page 20. The average yield of 57.21 for the 3,537 steers grading A and a yield of 56.16 for the 568 heifers grading A were used. The resulting prices were used to calculate packers' buying price differentials in terms of hundredweight of carcass. The packers' selling prices were obtained from weekly price lists for the same period, and from them the packers' selling price differential between Red (A) steer and heifer carcasses were calculated.[3] The two differentials thus derived are shown in Figure 7, on page 93.

The significance of the packers' buying price differential is now clear. Since allowance is made for the difference in yield between steers and heifers, this price differential should be equal to the selling price differential, which in turn should only be large enough to allow for the difference in retail cut-out. If retailers tend to discriminate against heifer meat when steer meat of equal quality is in large supply, this would be reflected in the packers' selling price differential. Figure 7 actually shows that there is some movement in the packers' selling price differential, but no general pattern is apparent. The minimum differential of $.50

---

[3] Back issues of price lists were available for only one packer, and only for the period shown in Figure 7. Spot checks indicated that prices quoted by two other packers were generally the same.

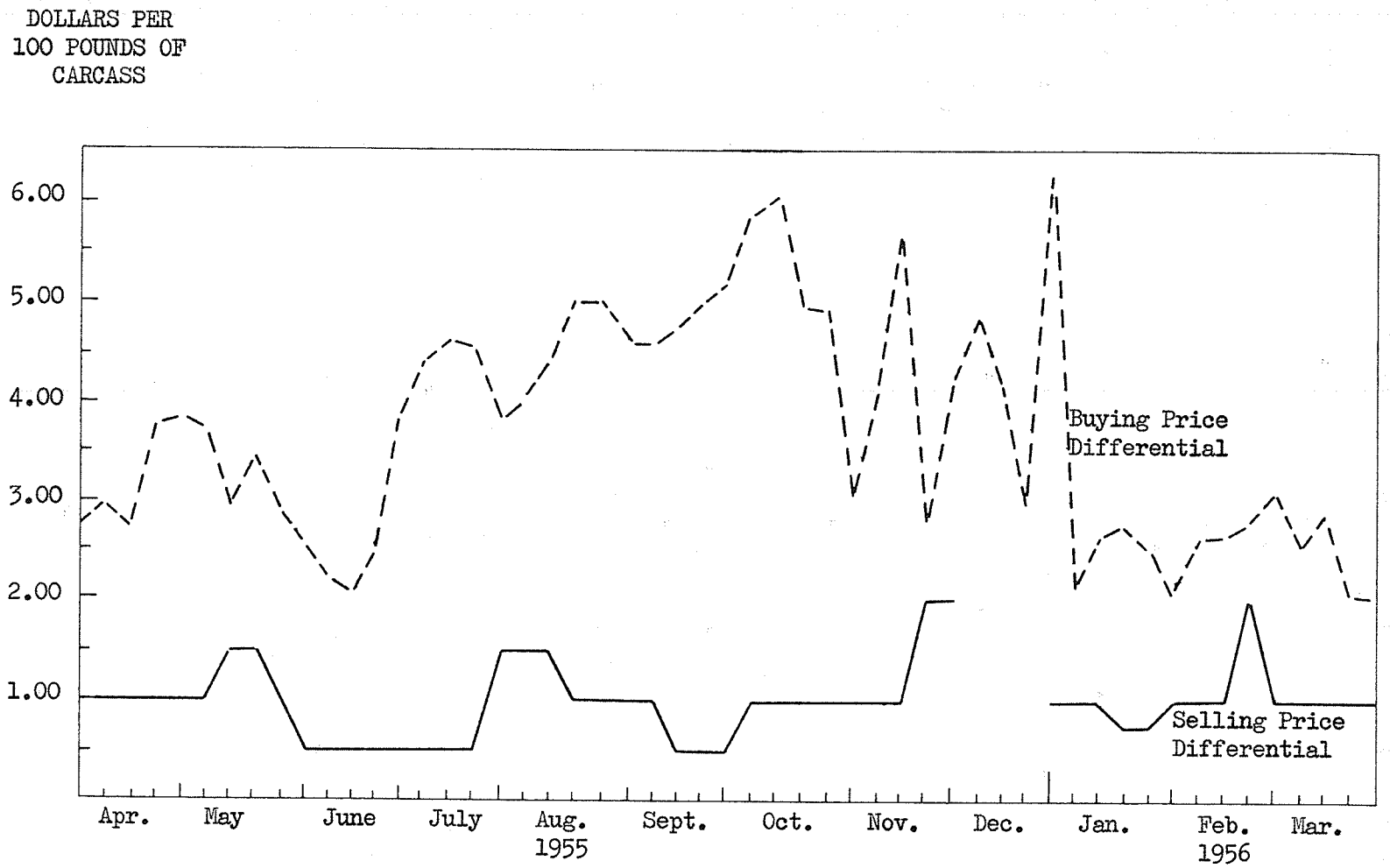

FIGURE 7

PACKER'S WEEKLY BUYING AND SELLING STEER-HEIFER CARCASS PRICE DIFFERENTIAL, WINNIPEG, APRIL 1955-MARCH 1956
(Source: Weekly buying price differentials calculated from weekly prices for Choice steers under 1,000 pounds and Choice heifers, as reported in Livestock and Meat Trade Report, converted to carcass basis as shown on page 92; weekly selling price differentials calculated from weekly prices for Red C., 450/up steer and Red heifer carcasses, as quoted by one packer in Winnipeg)

per hundredweight was probably enough to allow for the real difference in retail cut-out between steers and heifers grading A. Any differential above this value would, therefore, constitute an imperfection.

Larger values of the differential in more recent years may be related to changes in retail meat marketing organization. Since the war the number of meat retailers has decreased considerably, while the average size of the remaining retail establishments has increased. The increasing dominance of chain stores in the retail meat business may have created conditions of monopolistic competition, particularly when centralized purchasing is practised. To increase efficiency in their buying and processing operations, a uniform product, readily available in the desired quantities, is of considerable advantage. These considerations may lead them to buy steer carcasses even when the differential is occasionally so large that heifer carcasses would be much more profitable. In interviews and letters in which this matter was discussed, several cases were cited of large meat retailers that had recently switched to the sale of steer meat only, while previously, both steer and heifer meat was sold. In this respect it is significant that the Purchasing Office of Defence Production, perhaps one of the larger buyers of beef in Canada, revised beef specifications in July, 1953, so that since that time military contracts have specified steer beef only.[4] Such action will undoubtedly have a reaction on the packers' selling price differential, especially if several large beef retailers subscribe to this policy. Further investigations may show

---

[4]R. K. Bennett, Chief, Livestock Marketing, Marketing Service, Dept. of Agriculture, Ottawa, in a letter to the author, September, 1956.

that the low price ratio in the western markets, relative to that prevailing in Toronto, is also partly due to the practice on the part of large-scale meat retailers of buying steer carcasses only. These practices result in different demands for steer and heifer carcasses and, therefore, will tend to result in price differentials larger than warranted by the difference in meat yields. However, more research needs to be done before any definite conclusions can be reached; virtually no information concerning this aspect of livestock marketing is available.

Granted that there is imperfection at the retail level in the perfect market, the packers' buying price differential per hundredweight of carcass should still be equal to his selling price differential. Figure 7 shows that this is not the case. In 1955 the discrepancy was seldom below $1.00 per hundredweight of carcass and for several months was higher than $4.00.

It may be argued that the prices contained in the weekly price lists are not the actual selling prices, but are merely used as a basis for bargaining. The price lists, however, contain an order form with columns for quantity, product, and price, so that anybody willing to buy can send in his order based on information contained in the price lists. There is evidently no room for bargaining by mail order. Until evidence to the contrary is produced, it is reasonable to assume that the prices quoted are rough approximations of the actual selling prices. This conclusion is supported by the fact that during the period covered in this analysis, the average wholesale prices for Commercial quality steer and Utility grade cow carcasses in Winnipeg as reported in publications of

This analysis shows a steer-heifer price differential that is much larger than necessary to allow for the differences in yield and retail cut-out, which were the only theoretically justifiable reasons for a differential for form. Differences in yield and retail cut-out are also the reasons invariably used by packers to justify existing price differentials, although their claims are never substantiated with accurate and meaningful empirical evidence.

The part of the differential that is not accounted for could possibly be explained by factors that have been overlooked in this analysis. However, since within the scope of this analysis, based on reasonable assumptions, it has to be explained by differences in form, this suggestion appears very unlikely. If packers operated under conditions of perfect or nearly perfect competition, part of the differential could possibly be attributed to inefficient operation of the competitive market, although this would fail to explain many aspects of the steer-heifer price differential clarified previously. A more plausible hypothesis can be based on the assumption that the livestock processing industry operates under conditions of oligopsony with a competitive fringe. Particularly the western Canadian markets are typified by the presence of relatively few, large-scale, cattle processors who dominate the market. On theoretical grounds these departures from competitive conditions provide an opportunity for processors to profit by a policy of price discrimination.[5]

---

[5]For a discussion of this matter see "Marketing Canadian Livestock," Canadian Journal of Agricultural Economics, Vol. I, No. I, 1952, pp. 47-87.

This suggestion makes the high correlation between the supply of meat and the price differential more intelligible. The policy of a few beef buyers to depress the price of one class of cattle with respect to other classes in excess of the real difference in value between the classes of cattle would be least effective when the supply of cattle is low relative to the demand. In this situation even a small number of small-scale processors would be able, by their bids for cattle, to acquire so large a proportion of the supply that the oligopsonists would not be able to buy a sufficient number of cattle to keep their plants running at reasonable costs and to supply sufficient meat to the portion of the retail trade which they normally serve.

When the supply of cattle is large, the influence of small-scale processors on the price of cattle or on a given class of cattle would be less significant. Their influence is at all times determined by their total processing capacity relative to the supply of cattle. A large supply would enable a few large-scale packers, within limits, to state the price at which they are willing to buy, even after the demand of the small-scale processors is satisfied. This policy could also be applied to other classes of cattle and even to grades of cattle. By means of it oligopsonists could hedge against adverse price changes and insure a more consistent, positive margin of profit.

This explanation is, of course, highly tentative; it has been suggested since it fits the facts better than any other explanation advanced. It provides a possible explanation for the high correlation between the supply of cattle and the steer-heifer price differential, as well as for the difference in the levels of the price ratio that existed between

western Canadian markets and the Toronto market. In Western Canada a very large proportion of the supply of cattle is sold to a few large-scale packers. The fact that Western Canada is also a surplus producing area assures that the influence of small processors on the cattle price is small at all times. Statistics of the beef processing industry also reveal that the number of small-scale beef processors relative to total processing capacity was largest in the Toronto market.[6] This situation may have accounted for the difference in the level of the price ratio between the Western and the Toronto markets.

Few people familiar with the meat trade will doubt that processors are in a strong bargaining position. In prewar years their situation may have been even more powerful. In both their buying and selling operations they were typically dealing with many small operators. If the situation on the buying side has not changed greatly, this cannot be said of the selling side. Postwar meat retail organization is vastly different from that prevailing before the war. Retail meat buying has been concentrated into the hands of country-wide chain stores, with central purchasing offices. Sales to large institutions and government purchasing have also increased. The packers are gradually losing their strong selling position the more meat retailing is conducted by fewer, larger organizations.

It is hardly necessary to point out that these interpretations can only be substantiated when an intensive study of market and retail conditions is made. Such treatment is outside the scope of this study.

---

[6] Slaughtering and Meat Packing Industries, Dominion Bureau of Statistics, Ottawa, Vols. 1936-1954.

The effect of this reorganization of the meat retail trade on the steer-heifer carcass price differential also needs to be investigated. Some possible effects were brought out previously in this chapter.

CHAPTER V

SUMMARY AND CONCLUSIONS

Effect of Excessive Price Differential and Suggested Solutions

A study of the steer-heifer price differential will not be complete unless mention is made of the effect of an excessive differential on resource allocation. In a free economy the prices of commodities serve as regulators of economic activity; the relationships between prices should express the relative value of the commodities to the consumers. If prices are kept out of line with respect to one another, inefficient resource use may result.

In the beef industry this type of inefficiency is very important. When cattle are sold on the basis of estimated carcass weight and grade, prices are normally based on average results. This procedure discriminates against producers of high quality and high yielding cattle and favors producers offering cattle of low quality and yield for sale. The function of price, as regulator of production, by determining the relative profitability of high and low quality production, is, therefore, distorted.

Similar effects can be expected when the steer-heifer price differential becomes larger than necessary to allow for real differences in the quantity of meat obtained from them. The production of heifers is made relatively less profitable and, therefore, the producers' risk is increased. The proportion of heifers to steers born at any one farm and in any one year is seldom equal. The higher the proportion of heifers, the

narrower will be the operating margin, assuming that the cost of production per live hundredweight is the same for both sexes. There is, moreover, no incentive to produce high quality heifers, especially since the differential is often lowest on the poor quality cattle.

Beef producers have little scope for adjustment, since they are not able to stop producing heifers. The excessive differential may induce them to raise a low quality of heifers or to sell heifers as calves or baby beef, since at that age, heifers are normally not discounted. This practice may be socially inefficient, since it is generally less costly to obtain, say, 500 pounds of beef carcass from one heifer than from two heifer calves raised from the same cow, each producing 250 pounds of beef carcass.

The effect on feeder price differentials is equally serious. If the same discount per hundredweight held for feeders and finished animals, heifers would be much less profitable than steers. This is due to the fact that the difference in buying value, at the low weight, is more than offset by the difference in selling value. If steers and heifers were bought at 300 pounds and sold as finished animals at 900 pounds, and if steers were bought at $16.00 per hundredweight and sold at $20.00, with heifers at $17.00, the heifer feeders would have to be bought at $7.00 to make both sexes equally profitable. The selling differential of $3.00 per hundredweight requires a buying difference of $9.00 per hundredweight. The initial advantage of heifer feeders, expressed in the buying differential, applies to only 300 pounds, while the differential in the selling prices applies to the 600 pounds gained during the feeding period, as well

yield and grade that have not been verified.

If price differentials were held at proper levels, packers would be induced to sell heifers at their actual worth. Heifer carcasses that, due to retailer prejudices, cannot be sold fast enough, can frequently be sold in wholesale cuts at insignificant price differentials.

For all these reasons, organized action on the part of beef producers should have a good chance for success.

Summary of Findings and Suggestions for Further Study

This study of the steer-heifer price differential has, of necessity, been a rather extensive one, since a fairly comprehensive study of this aspect of livestock marketing has been attempted. Previous studies which touched on some aspects of steer-heifer price differentials or on factors influencing them have been assembled and critically examined. Available information on meat yields was used to estimate the approximate magnitude of a logical price differential based on the difference in the quantity and value of meat obtained per hundredweight live weight.

To make the comparison meaningful, animals producing the same quality of beef, as judged by consumers, were considered. It was concluded that heifers and steers of the same grade and weight class did not differ significantly in yield. However, since the average weight of heifers marketed within each grade is normally lower than that of steers, and since, on the average, yield varies directly with live weight, there is a justification for a price differential. In the case of steers and heifers grading A or B, a price differential that allows for one and one-half per cent

difference in yield was found to be justified.

No empirical evidence in the form of retail cut-out tests could be found to substantiate the argument often advanced in trade literature, that heifer carcasses produce a lower proportion of saleable meats or that heifer carcasses contain a lower proportion of the relatively more valuable meat cuts. In a later part of this study the minimum packers' selling price differential suggested a difference in retail cut-out value, but of much smaller size than had often been suggested.

The difference in yield, together with the difference in the retail cut-out, is, according to this analysis, the only economically rational justification for a price differential.

It was next necessary to develop a standard of efficiency with respect to the price differentials for form. For the purpose, the theory of the perfect market was applied to this study. In a "perfect" market, steers and heifers within one grade classification will not differ in price by more than the value of the real difference in quantity of meat obtained from each. As long as this difference remains unchanged, the heifer price will be a constant percentage of the steer price irrespective of the extent of variation in the general price level of beef. Since heifers and steers within each grade are perfect substitutes with respect to quality, as judged by consumers, the proportion of steers and heifers is of no importance in determining the differential.

The ratio of steer to heifer price will be equal in all markets, and since the price level of a given grade of cattle is normally unequal at the various markets, the absolute market differential for steers will

be larger than that for heifers. Under such conditions it will always be more profitable to ship steers rather than heifers. If part of the difference in value is in the form of a difference in retail cut-out, it will also be more profitable to transfer steer carcasses rather than heifer carcasses.

Before a description and analysis of the actual price differential could be carried out, some methodological problems were considered. The statistics used in calculating ratios should be consistent with sound theoretical explanations of the actual marketing relations. This consideration raised a question as to the validity of using weighted average prices in calculating price ratios, since, in theory, the relative quantities of steers and heifers will not affect the differential. The analysis that followed showed that ratios calculated from weighted average monthly and yearly steer and heifer prices actually introduced a bias, whichever approach to the problem was used. This bias could not be overlooked in a meaningful analysis of price differentials. To reduce the effect of bias in analysis, only ratios calculated from monthly average prices were used.

The descriptive study of the price ratio over time and between markets revealed that the price ratios for all grades of steers and heifers varied considerably over the years and over the seasons. Generally, similar variation was shown to exist in all major Canadian public markets, with the exception of the prewar Toronto market.

These variations in the seasonal and yearly price ratios at different levels in the five public markets contradict the theoretical conclusions,

according to which the price ratio would be constant over time and at the same level in all markets. Yearly ratios followed a somewhat cyclical pattern, while seasonal variation was most pronounced in years when the level of the price ratio was low.

The seasonal and yearly variation in the heifer-steer price ratios proved to be very closely associated with total slaughtering, a good measure of the supply of meat. Price ratios were highest when total slaughtering was low and conversely, the ratio was lowest when total slaughtering was high.

In order to determine where in the beef marketing process this form of pricing inefficiency occurred, the packers' buying price differential and selling price differential (both expressed in dollars per hundredweight of carcass) were examined. The packers' selling price differential, which should be fixed and large enough to allow for the difference in retail cut-out, was shown to vary over the season up to 300 per cent above the lowest level in a single year. If the lowest level was sufficient to allow for the difference in retail cut-out, the inefficiency at this point is significant. Since the packers' selling differential depends on retailer demands, an excessive differential at this point is due to retailer discrimination against heifer beef.

Besides this pricing inefficiency in the retail trade, a much larger discrepancy was found to exist at the packer level. Under perfect conditions the packers' buying price differential, measured in dollars per hundredweight of carcass (to allow for differences in the average dressing percentage between steers and heifers), would be equal to their selling

price differential. During the period under consideration, however, these price differentials were never equal, but varied over one year on the average by approximately $2.00, from a minimum of $.75 to a maximum of $5.10 per hundredweight of carcass.

It is extremely difficult to account for the inefficiency exposed in this analysis. There are indications that the answer lies in the economic organization of the meat processing and retailing industries, but far more research has to be devoted to these sections of the meat market before imperfections in steer-heifer price differentials can be completely understood and accounted for. The meat processing and retailing industries undoubtedly operate under conditions of imperfect competition, although the extent and the effects of this imperfection are largely unknown.

The possible effects of the excessive price differential on beef production is significant. The production of heifers is made relatively less profitable and, therefore, the producer's risk is increased. Beef producers have little scope for adjustments since they do not control the sex of the calves born from their cows. Adjustments can take the form of production of inferior quality animals or of selling heifers at an early age as veal calves or baby beef. These adjustments are probably socially less desirable, since it generally takes fewer resources to raise a heifer to 900 pounds than to raise two heifers to 450 pounds. This method will also pose other serious problems to the farmer and will increase his risks.

The feeder cattle enterprise is similarly affected. A given price differential for finished cattle will normally require a much larger differential in the price of feeder steers and heifers in order to make

both sexes equally profitable to a feeder. An excessive price differential has here an accentuated effect.

Offering solutions to the problem is dangerous, since the results in this study are tentative. Additional studies are needed to fill out the gaps of information throughout the last sections. Effective and enduring reforms might be obtained by increasing the bargaining power of the individual farmers through organized action. Reasonable price differentials can be set when the price of cattle is based on dressed weight and official grade, with subdivisions, if needed, to approximate the actual commercial value of each kind of carcass.

Many results and conclusions in this study are, of necessity, only tentative. The studies and price series on which these conclusions are based are not always accurate and are seldom complete. It is, however, possible on the basis of this study, to enumerate the type of information necessary in order that more definite conclusions can be drawn.

First, more information should be supplied concerning the real difference in yield, particularly in retail cut-out between steers and heifers of each grade and weight class. Fortunately, two studies now in progress will supply at least part of this need.

Next, studies should be conducted to discover the extent of the packers' selling price differential. Studies of packers' selling practices and retailers' buying practices should provide useful information. In this respect, studies of changes in the meat wholesale and retail marketing structure over the years may provide interesting information and substantiate qualitative discussions of the extent of imperfect

competition existing or developing in these markets.

An indication of the impact of an excessive price differential on the beef-feeding enterprise may be supplied by a study of the relative proportion of steers and heifers sold as feeders at various values of the price differential.

These studies should contribute to a better understanding of the steer-heifer price differential and of the ways in which improvements, if deemed necessary, can be brought about.

BIBLIOGRAPHY

Bressler, R. J. Jr. "Agricultural Marketing Research," Journal of Farm Economics, Vol. 31, No. 1, Part 2, 1949.

Department of Agriculture. Livestock Market Review. Vols. 1928-1955, Ottawa.

Dominion Bureau of Statistics. Livestock and Animal Products Statistics. Vols. 1928-1955. Ottawa: Queen's Printer.

_____. Slaughtering and Meat Packing Industries. Vols. 1936-1954. Ottawa: Queen's Printer.

Ensminger, M. E. Animal Science. Illinois Interstate Printers and Publishers, 1950.

Jebe, E. H. and E. S. Clifton. Estimating Yields and Grades of Slaughter Steers and Heifers. Journal Paper No. J-2837, Iowa Agricultural Experiment Station, Ames, Iowa, 1955.

Leckie, H. K. "Price Support Operations in the Canadian Livestock Industry," Canadian Journal of Agricultural Economics, Vol. 1, No. 2, 1953, p. 18.

Maybee, H. J. Meat Carcass Grading in Canada. Ottawa: Canada Department of Agriculture, Publication 960, 1950.

Meat Packers Council of Canada. A Letter on Canadian Livestock Products. Toronto.

Morrison, F. B. Feeds and Feeding. New York: Morrison Publishing Company, 1936.

National Advisory Beef Committee. The Practicability of Selling Cattle by Carcass Grade and Weight. Ottawa: Department of Agriculture, 1942.

Phillips, C. D. and T. L. Pearson. Accuracy of Present Marketing Methods in Pricing Veal Calves. Bulletin 610, Lexington Kentucky Agricultural Experiment Station, University of Kentucky, 1954.

Rachlis, M. "The Structure and Operation of the Canadian Livestock Marketing System," Canadian Journal of Agricultural Economics, Vol. 1, No. 1, 1952.

Saskatchewan Marketing Board. Proceedings at Public Hearings under the Natural Products Marketing Act, concerning A Proposed Livestock Marketing Plan. Regina, 1955.

Shepherd, G. "A Framework of Marketing Theory." Iowa: Department of Economics and Sociology, Iowa State College, 1938. (Mimeographed.)

Thomson, F. L. and R. J. Foote. Agricultural Prices. New York: McGraw-Hill Book Company Inc., 1952.

APPENDIX

TABLE XV

INDEX OF SEASONAL VARIATION IN THE WINNIPEG HEIFER-STEER PRICE RATIO, 1928-1939 and 1948-1955*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1928	99.5	99.4	103.0	103.2	103.8	99.8	101.6	97.5	93.0	97.9	102.9	102.8
1929	103.3	102.4	102.0	97.0	98.2	102.8	98.2	95.8	99.0	100.9	102.2	102.4
1930	101.8	99.8	104.2	98.3	96.4	94.5	98.1	102.4	104.8	101.7	97.2	100.9
1931	98.1	96.3	106.6	101.5	102.3	101.0	98.8	98.4	93.3	97.4	103.7	100.0
1932	101.4	101.6	104.5	100.6	101.0	98.8	97.0	92.4	95.2	99.5	107.6	105.8
1933	105.2	104.3	99.9	101.0	96.5	93.4	92.1	96.3	107.2	106.8	106.3	100.4
1934	104.5	99.9	93.9	99.3	97.0	99.0	98.3	95.6	98.0	95.5	108.4	108.9
1935	109.2	99.8	95.1	93.6	100.7	100.8	106.7	101.2	95.2	90.1	94.7	97.4
1936	97.0	107.5	106.6	105.9	105.9	104.8	101.6	91.4	90.8	94.0	100.5	100.8
1937	102.1	101.7	102.8	104.7	107.6	105.6	94.7	92.3	87.4	91.0	95.0	98.9
1938	104.7	107.5	108.1	102.8	105.0	97.5	95.8	97.2	99.8	97.8	99.4	99.9
1939	103.0	101.8	102.5	98.1	98.7	99.9	97.1	92.2	101.1	99.9	102.8	101.6
Index	102.6	101.9	102.5	100.6	101.2	99.8	98.3	96.1	97.1	97.7	101.8	101.7
1948	101.3	99.2	100.6	103.1	103.5	100.1	101.2	95.7	91.6	91.6	96.5	96.8
1949	102.9	104.5	102.3	102.2	102.5	102.3	99.6	99.2	94.7	94.1	95.0	96.0
1950	99.6	101.0	102.3	99.7	97.8	98.2	99.7	97.5	99.7	96.8	98.8	99.4
1951	99.7	100.6	101.3	102.6	100.1	100.1	96.8	97.3	98.6	96.9	95.1	96.6
1952	102.0	100.3	102.2	103.4	99.8	103.9	103.3	101.7	98.4	89.6	88.6	92.0
1953	100.6	102.7	104.0	102.3	104.5	104.0	98.5	97.3	98.4	93.4	96.6	100.2
1954	103.1	98.0	99.0	99.4	98.2	101.9	103.8	98.9	96.7	91.2	91.6	94.0
1955	97.6	101.5	104.9	102.8	103.4	103.8	96.1	94.3	93.2	95.8	97.3	100.9
Index	101.8	102.0	103.1	102.9	102.3	102.8	100.9	98.6	97.3	94.6	95.8	98.0

*Calculated from prices for Good steers under 1,000 pounds and Good heifers, as reported in Livestock and Animal Products Statistics, Dominion Bureau of Statistics, Ottawa, Vols. 1928-1955. Procedure adopted is outlined by F. L. Thomson and R. J. Foote, op. cit., p. 326.