AN ANALYSIS OF ERRORS IN ESTIMATING YIELD AND GRADE OF CATTLE SOLD ON A LIVE WEIGHT BASIS

A Thesis

Presented to

The Faculty of Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Richard Murray Alwyn Loyns

July, 1964

ACKNOWLEDGEMENTS

The author wishes to acknowledge the support and guidance of all those who assisted in making this project and report possible.

The author would like to express particular appreciation to Dr. A.W. Wood, under whose supervision this thesis was written. His advice, assistance and criticisms were invaluable. Appreciation is also directed toward Professor S.K. Sinha, who assisted by way of statistical consultation.

Acknowledgement must be given to those in the Livestock Industry, who freely gave their time and information. Mr. Ken Knowles, Manager of the Public Markets Limited was most helpful, as was the Staff of the Canadian Livestock Co-operative (Western) Limited. The two packing plants (anonymous by request for obvious business reasons) which co-operated in this study deserve special acknowledgement.

The forebearance of Mrs. Marilyn Morley, typist of the original and final drafts of this thesis, is gratefully acknowledged.

AN ANALYSIS OF ERRORS IN ESTIMATING YIELD AND GRADE OF CATTLE SOLD ON A LIVE WEIGHT BASIS

Richard Murray Alwyn Loyns
University of Manitoba, 1964

The livestock industry is an important segment of the Manitoba economy. Thousands of cattle are sold and slaughtered in the Winnipeg market area each year. Most of these animals are sold on a live weight basis, a method of sale by which the estimated value of an animal determines the price per pound paid to the seller. The evaluation process involves estimation of the yield and grade by an experienced buyer. The possibility exists of errors in estimating yield and grade which will affect the final estimate of total value.

This thesis is a report on the nature, frequency and magnitude of yield and grade estimation errors committed by the purchasers of animals for two St. Boniface packing firms. The data sampling was limited to a time period of less than one month, during which a total of 287 steers and 52 heifers were sampled. The sampling was limited to steers and heifers of the estimated grade classifications Canada Choice, Canada Good and Canada Standard.

The study attempted to determine the size of errors experienced by the packers under the assumption that the packers are concerned with only aggregative accuracy. An attempt was made to determine the frequency and magnitude of errors experienced by sellers of individual animals. The study also attempted to determine differences in errors made on steers and on heifers as well as error differences between sales made directly to the packing plants and sales through the Public Markets Limited.

The major assumptions necessary to the analysis were:

(1) the buyers assisting in the sample gathering were unaffected in their decision making by the recording of their decisions.

(2) the buyers grade estimates were attempts to identify the official carcass grade.

(3) the value of each beef carcass grade purchased was the average of the prices the buyers attempted to pay for those grades.

(4) the population of errors sampled were normally distributed.

The significant conclusions drawn from the study are as follows:

(1) maintenance of identity of individual animals through the slaughter process although time and labor consuming, is feasible at least on a research basis.

(2) individual yield, grade and price errors do not always cancel off so that the packer buyers may pay less than or more than their buying orders for their beef procurements. Evidence of over-payments as large as $0.96 per hundredweight live and underpayments as large as $0.89 per hundredweight live were found on packers purchases.

(3) individual yield, grade and price errors occurred which resulted in total pricing errors as large as $4.50 per hundredweight live. In all cases, over one-third of the animals were priced with an error of over $1.00 per hundredweight live.

(4) yield, and probably grade errors, are of such nature that producers of high valued animals are underpaid, and producers of low valued animals are overpaid.

(5) more study is required to detect conclusive differences between the ability of buyers to evaluate steers and heifers, and to

accurately evaluate animals purchased through direct and indirect channels.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

1. HISTORY

Founding of the Red River Settlement in the early nineteenth century resulted in the introduction of cattle into the area which is now known as the Prairie Provinces. Early slaughtering was done only for home consumption but later, animals were slaughtered by local butchers for the growing urban population. By 1870, an export trade for cattle had developed with the U.S. In the Prairie Provinces a few small packing plants were recorded as early as 1890 but their importance was not significant until about 1910.[1]

In the early stages of development, cattle were sold both direct to packing plants and through public stockyards. An Act passed by the Manitoba Government in 1911 incorporated the Public Markets Limited. This institution officially began operation on August 14, 1913.[2] The method of price negotiation adopted involved settlement on the basis of live price per pound by the private treaty method.

Development of truck transportation from the 1930's onward increased the proportion of truck deliveries at the expense of deliveries by railway transportation. Accompanying the increased importance of truck deliveries was the increased proportion of animals by-passing the

---

1 W.F. Chown, S.C. Hudson, J.N. Lewis, The Direct Marketing of Livestock, Marketing Service, Economics Division, Canada Department of Agriculture, November 1941, p.3.

2 Canada's Largest Public Market, Bulletin published by the Union Stockyards, St. Boniface, Manitoba, 1957.

public stockyards and being sold directly to the packers. Although these trends are not necessarily related, they have very closely parallelled one another.[3]

Recognition of the importance of beef grading was first made in 1928 when a report of the Joint Beef Committee was made public in Winnipeg.[4] This report recommended that the Department of Agriculture develop an official grading and branding system for beef. The reasons for these recommendations were: (1) to ensure beef consumers of quality, and (2) to provide incentive to producers to market better quality animals. In September, 1929, the service of beef grading became available to any establishments requesting it. The official grades adopted were "Choice" and "Good".[5] Rapid progress was made in the attempt to increase the numbers of animals officially graded. By May, 1942, the system was sufficiently developed that it became statutory that all beef to be branded was required to be first graded and stamped by an official grader at the point of slaughter.

The records available do not indicate how the transition to the present live sale method evolved. Since their inception, the packing plants and Public Markets Limited have negotiated on a live weight price determined by some form of visual appraisal of the animal prior to slaughter. At the time when packers purchased a large proportion of

---

3 Chown, et. al., The Direct Marketing of Livestock, p. 3.

4 H.J. Maybee, Beef and Veal Grading in Canada, Livestock Division Marketing Service, Canada Department of Agriculture, Ottawa, December, 1955, p. 3.

5 Ibid., p. 4.

their procurements from livestock drovers, the price the producer received was determined on a "per head" basis. These animals were, however, ultimately purchased by the packers on a "per pound" basis. The importance of drovers has decreased to the point where only a few producers still sell animals by this method. A recent development has been the apparent trend towards marketing slaughter animals on a rail grade[5a] basis.

2. THE PROBLEM

By far the largest proportion of slaughter cattle marketed are priced by a visual appraisal of the animal prior to slaughter. Live pricing involves the making of two important types of estimations by the buyer in the process of arriving at the final price offered. An estimate of the carcass grade of the animal determines the carcass price according to the offered carcass prices in that time period; estimation of yield determines the adjustment from carcass price to live price. The live price is negotiated on a per pound basis.

Appraisal of the animal is performed by an experienced packing plant buyer, but his estimates are based on subjective judgments rather than on objectively quantifiable characteristics. The buyer attempts to visualize the animal in its saleable carcass condition and to evaluate the carcass in terms of his buying orders. When he has decided upon the anticipated carcass grade, he must then convert the carcass price per pound to a live price per pound according to his estimate of the yield.

[5a] See page 15.

The grade of a carcass is determined entirely by the physical features of the actual carcass as perceived in accordance with the official grade standards by the government beef grader. There is no *a priori* relationship between the characteristics of the live animal and the resulting carcass grade. The buyer, depending on his experience, must appraise the live animal according to his estimation of the characteristics of the resulting carcass.

Similarly, yield is dependent on the total amount of loss in weight from the live to the carcass condition. Buyers, on the basis of their experience, are supposedly able to judge the amount of this loss and convert this estimate to a yield estimate which is then used to convert carcass price to live price.

Many factors contribute to the difficulty of estimating carcass grade. Since the estimation of grade is subjective rather than quantitative, the buyer himself is a source of error. Different buyers appraising the same animal under identical conditions may estimate the grade differently. Secondly, since official grade designations depend on such factors as age, conformity, meat color, and color of and relative distribution of fat, these factors must be detected by the buyer if the proper appraisal is to be made. The relationship of external and internal characteristics is not known with certainty. As a result, inability to detect internal characteristics or misinterpretation of the relationship between external and internal features may result in estimation errors. Thirdly, the resultant carcass grade is to a large extent a subjective decision. Skill in carcass grading is not always

uniform between qualified graders. Consequently, an additional source of error is possible from the buyer - grader relationship.

Similar to grade estimation is the problem of relating external characteristics of the animal to the amount of weight loss in the slaughter process. The weight loss is influenced mainly by: (1) amount of "fill" (water and feed), (2) viscera and body wastes, (3) necessary trim including fat and bruises, (4) hide and appendages. The amounts of these components relative to the carcass weight vary considerably from animal to animal. Ability to detect these differences may be difficult. Further, these subjective evaluations are generally made on the basis of a brief and sometimes distant assessment of the animal's phenotypic traits. Ability to estimate accurately the factors determining yield may be a function of proximity to the animal. Since price negotiation usually occurs rapidly and under conditions of considerable distraction, calculation errors in converting the carcass price per pound to the live price per pound are also a possibility.

Therefore, the live purchase process seems to be one of estimating the physical grade and yield of a live animal, then transforming these estimates into a price per pound of the live animal. The problem fundamental to this study is to measure and analyze the accuracy with which these estimates are accomplished, and further, to measure and analyze the effect of these estimates on the value and price transformations resulting therefrom.

3. IMPORTANCE OF THE PROBLEM

Common classifications of research usually include applied research as one type. In marketing, applied research is usually of the efficiency orientated nature. The method of efficiency orientated research is generally concerned with conceptualizing an abstract, ideal market, where, according to Alfred Marshall, "the same price is paid for the same thing at the same time in all parts of the market ..."[6] The deviations from the ideal market are measured and taken to be a measure of the relative efficiency of the existing system.

In this study, the ideal or perfect market was considered to be that in which there were no deviations between the grade and yield estimates placed on individual animals prior to slaughter and the true grade and yield known only after slaughter. In the absence of these deviations, the price paid for an animal would have been the price that animal was worth as an input factor to the production process of the packing plant unless other sources of variations existed. Such imperfections could result from calculation errors and/or premiums or discounts paid as a result of differences in bargaining power.

A study of the accuracy of pricing animals is important for several reasons. A recently published report[7] revealed varying degrees of dissatisfaction with the live sale of slaughter cattle. Live sale is

---

[6] Alfred Marshall, Principles of Economics, (London: MacMillan and Company Ltd., 1961) pp. 270-71.

[7] Livestock Marketing in Manitoba, Report of the Select Committee of the Legislative Assembly of Manitoba, February, 1964, p. 53, and Chapter 15 passim.

preferred because it provides greater freedom to bargain and an opportunity for the seller to reject or accept an offered price. On the other hand, rail payment is advantageous because of its precision in pricing. Since in the rail payment selling method no estimation of grade or yield is required, these sources of error are eliminated. Rail pricing is opposed because of the difficulties involved in identification of animals, the loss of freedom to reject a bid of total known magnitude, fear of large losses due to condemnations and the impossibility of simultaneous bidding in an auction ring of feeder and packer buyers.

Although the incidence of rail pricing has been increasing in recent years, a very small proportion of the slaughter animals sold in the Winnipeg market area are sold in this manner. In order to determine whether improvements in the existing marketing system are urgently needed, some quantitative knowledge must be available on the relative accuracies of rail pricing and live pricing. The problem of the practicability of rail pricing was analyzed in British Columbia in 1940-41.[8] A similar and more exhaustive study was done in Minnesota from 1946-48.[9] The results of these studies indicate that improvement in marketing efficiency from the standpoint of grade and yield estimation accuracy may be possible. However, since many technological and institutional changes have occurred since these studies were made and, since

---

8 The Practicability of Selling Cattle by Carcass Grade and Weight, The National Advisory Beef Committee, Ottawa, March, 1942.

9 A.A. Dowell, G. Engleman, E.F. Ferrin, P.A. Anderson, Marketing Slaughter Cattle by Carcass Weight and Grade, Technical Bulletin No. 181, University of Minnesota Agricultural Experimental Station, February, 1949.

they were carried out under conditions temporally and geographically different from the Manitoba situation, their reported findings may not be valid currently and locally.

Yield and grade components are important to pricing accuracy because of their importance in the price determination process. A relatively small physical error in the estimation of yield or grade may result in a relatively large price error per pound and a relatively large aggregate error when considered on the total animal basis. An error in the estimate by one grade could easily result in a ten dollar total price error on an animal. Similarly, a deviation of one percentage point between estimated and true yield could easily result in a total price error of five dollars per animal.[10] If these errors are committed simultaneously, a total price error of fifteen dollars means a relatively large loss to one bargainer and a large gain to the other. An error of this magnitude may exceed the total margin of profit available to either the producer or the processor from the animal.

Approximately four hundred thousand slaughter cattle are sold annually in the Winnipeg market area, (see Table I) and errors of the type studied could account for many thousands of dollars being redistributed among producers and packers. Assessment of these errors, if they do in fact exist, is important to both packers and producers in improving marketing efficiency as well as to assist policy makers in effecting a more efficient and equitable system if this were found to be desirable.

---

[10] These values are approximated from a live animal assumed to weigh one thousand pounds. The assumed carcass price is about $45.00 per hundredweight and a grade price differential of $2.00.

TABLE I

TOTAL CATTLE RECEIVED BY PUBLIC STOCKYARDS AND PLANTS IN MANITOBA 1959-63*

Year	1959	1960	1961	1962	1963
Received at Public Stockyards (Wpg.)	264,184	251,975	330,744	232,256	246,995
Received at Plants (Man.)	142,200	173,568	183,035	146,079	154,759
Total Manitoba	406,384	425,543	513,779	378,335	401,754
Total Canada	2,183,701	2,348,506	2,563,782	2,518,889	2,590,267

* Source: Livestock Market Review, Markets Information Section, Production and Marketing Branch, Department of Agriculture, Ottawa, Canada.

4. SCOPE AND LIMITATION OF THE STUDY

The scope of this study was confined to an analysis of yield and grade estimation errors on slaughter cattle sold in the Winnipeg market area. Price errors resulting from other sources of variation, though economically important if they existed, were outside the scope of the present study. Similarly, the relative costs of rail pricing and live pricing were not considered, nor were the relative desirabilities of the two methods of sale other than the comparison of accuracy. The carcass grade and true yield were incorporated only as a means of determining the deviation from the ideal.

Ideally, the results of this study would enable direct inference to the entire population of animals sold on a live weight basis in the Winnipeg market area. Due to sampling restrictions this type of broad generalization is impossible from the results of the present study.

The collection of necessary data involved a heavy input of research labor per animal included in the sample. The technique for sampling was unfamiliar to the industry and research personnel time was limited. As a result of these restrictions only two processing institutions were sampled, the period of time was limited to one month and the class of cattle restricted to steers and heifers of the three top grades.

The fact that only two of about fourteen packers were included need not be a serious limitation in itself. The number of animals purchased by these two processors make up a considerable portion of total animals processed in Winnipeg. However, the one packer was buying a particular class of steers and heifers for a particular market. As a result, only that particular class can be considered to have been sampled. The other processor purchased all kinds and classes of animals by all channels but this did not represent a random sample of all packers. For this reason, the study may be more justifiably considered as a case study of two processors rather than a study of the Manitoba meat processing industry.

The limitation of the time period studied could be serious. Considerable seasonal variation occurs in livestock marketings. Although absolute numbers of animals marketed display less variation, the structure of the classes and kinds of animals varies to a large degree. The month

sampled was characterized by heavy cow and feeder cattle deliveries and relatively light deliveries of the classes being sampled. In addition, a seasonal movement of grass-fed cattle was being received. The grades of these cattle may be penalized because of extreme yellowing of the external fat layers resulting from high carotene-pigment content. Judgment of the true grade on such animals is considered to be more difficult than on dry-fed cattle. Therefore, the errors normally involved in grade estimates may be overemphasized by statistics from data gathered from a population containing a higher than average proportion of grass-fed cattle.

The sample was also limited to steers and heifers estimated to produce carcasses grading Canada Choice (Red), Canada Good (Blue) and Canada Standard (Brown). Since estimated gradings were not all correct some carcasses of lower grades were included. The study carried out in Minnesota[11] showed small differences in the ability of buyers to estimate grade and yield on steers and heifers compared with these estimations on slaughter cows, the accuracy of estimation on steers and heifers being slightly greater than on cows.

Accuracy of pricing necessarily involves the inclusion of value of edible and inedible offal. This information was not available and therefore could not be included. The scope was limited to the carcass of the animal and the estimate of this carcass by the buyer at the point of sale.

---

[11] Ibid, p. 22

The limitations noted were a consequent of the limited time and resources available to accomplish a more comprehensive survey, and the refusal of one major packing firm to co-operate in the study. The effects of the limitations are to restrict the inferential base for generalization. However, valuable information was revealed and generalizations within the restrictions were made.

CHAPTER II

THE LIVE SALE OF SLAUGHTER ANIMALS

1. DEFINITION OF TERMS

Considerable terminology used in this thesis has special meaning when used in the context of livestock marketing. Some terms were used in order to simplify description and are unique to this report. Much of the terminology is defined when it appears in the report but it is appropriate to clarify some of the important and recurring terms at this point.

Grade - is defined as the quality designation attributed to the cold carcass of a beef animal. The grade is determined by an employee of the Canada Department of Agriculture, Livestock Division, in accordance with statutory beef grades.[1]

The official beef grades which were included in the study were:

(1) Canada Choice - denoted as "Red"

(2) Canada Good - denoted as "Blue"

(3) Canada Standard - denoted as "Brown"

(4) Official grades less than any of the above, denoted as "Ungraded".

Yield - is defined as the ratio of the weight of the carcass after chilling to the live animal weight at the time of sale. It is usually expressed in per centum.

In practice, the carcass is not reweighed after cooling and only the hot carcass weight at the time of slaughter is available. Due to

---

[1] See Appendix "A"

the shrinkage in the cooling process each packer deducts a standard percentage allowance from the hot carcass weight in order to estimate the cold carcass weight. The deduction is usually three per cent. The estimate of yield which the buyer makes is based on his estimate of the cold carcass weight.

Example of Calculation of Yield

Live animal weight	980 pounds
Hot carcass weight	575 pounds
Discount by 3% to obtain	
Estimate of cold carcass weight	557.75 pounds

$$\text{Yield} = \frac{\text{Cold Carcass Weight}}{\text{Live animal weight}} \times 100$$

$$= \frac{557.75}{980} \times 100$$

$$= 56.91\%$$

Carcass - is defined as the saleable portion of the slaughtered animal remaining after removal of the hide, appendages and all the internal organs (edible and inedible). The saleable carcass is usually divided longitudinally into two nearly symmetrical portions.

Slaughter Animal - is defined as a steer or heifer in a suitable physical condition for slaughter, processing and resale.

Live Sale - refers to the consummation of price negotiations on slaughter cattle prior to slaughter and prior to knowledge of the true carcass grade or weight. This method involves estimation of the carcass grade

from the physical features of the animal and conversion of the estimated carcass price to a live-weight price by an estimate of the yield.

Direct Sales - are defined in this study as those sales of livestock which occur at the location of the purchasing packing plant. It is to be noted that this definition is different from that used in current statistical reports. Such reports define as direct sales any sales to a packing plant other than through a Public Market.

Indirect Sales - are defined in this study as those sales which are consummated in the Public Markets Limited by the auction method of selling.

Rail Graded or Rail Priced - refers to the establishment of grade and/or price of a slaughter animal after the animal has been processed and is hanging in the cooler of the processing plant.

Winnipeg Market Area - is defined as the geographic area from which the Winnipeg and St. Boniface Packing Plants receive their supplies of slaughter animals. The area is composed primarily of Manitoba and Eastern Saskatchewan.

Error - within the context of this study is defined as any divergence of the buyers estimate of yield, or of grade, from the true yield, or grade as determined by the beef grader. The information obtained from the carcass was assumed to be accurate and final; a true measure of yield and grade.

2. LIVE SALE TRANSACTIONS

Live sale transactions as defined in the preceding section represent the largest proportion of slaughter cattle sales in the Winnipeg Market area. Accurate statistics were not available to determine the exact proportion but it has been estimated that about ninety per cent of all slaughter animals are sold by this method of pricing.[2]

The mechanics of the live-sale transaction involves the transformation of the carcass price into a live price by adjustment according to yield. The carcass price is determined by the estimated grade of the animal. The conversion to a live price is accomplished by the buyers estimate of the yield of the animal. The accuracy of the estimates depends primarily on the experience and competence of the buyer, and the degree to which true yield and grade can be estimated by a visual appraisal of the external characteristics.

The carcass price per pound which buyers employ is determined within the packing firm according to the estimated supplies of livestock required, and the price at which these can be sold to retail buyers. The prices are given to the buyer as his "buying-orders".

If, for example, the buying orders are: Red steers, $45.00 per hundredweight of carcass, Blue steers, $43.00 per hundredweight of carcass, and Brown steers, $41.00 per hundredweight of carcass, these prices are in effect, the maximum prices which a buyer may bid to secure these classes of steers.

---

[2] Mr. L. Hancock, District Supervisor, Livestock Division, Canada Department of Agriculture. Mr. Hancock estimated the proportion of rail graded animals to be from eight to ten per cent. It was also reported that this proportion is slowly increasing.

If a producer offers an animal, it is appraised by the buyer who mentally places an estimate of grade and yield on the animal, then converts the ordered price for that estimated grade to a live price according to his estimate of yield. This live price is then in effect the maximum price which the buyer can offer for that animal. Assuming that the animal in question is considered by the buyer to fulfill the requirements of the "Red" grade and to yield fifty-six per cent, he may offer $25.20 per hundredweight of live animal.[3] If, however, the animal were assumed to be estimated as a "Blue" carcass and the estimated yield to be fifty-six per cent, the maximum offer price would be $24.08 per hundredweight of live animal. Similarly, if the same animal estimated to provide a blue carcass were estimated to yield fifty-five per cent, the maximum offer price would be $23.65 per hundredweight of live animal.

Slaughter animals are not always sold in single animal units. It may seem advantageous to a seller to negotiate on the basis of a group of animals. If the animals so offered are of the same estimated carcass grade, the lot price will be determined by an estimate of the average yield of the group. If the lot is estimated to be heterogeneous in carcass grade, either the separate estimated grade will be priced or a weighted average price of the estimated grade will be used along with an estimated average yield factor. In either case, the mechanics of determining the price offered are similar and only the unit of sale has changed.

---

[3] Red Carcass Price $= P_c = \$45.00$
Estimated Yield $= Y_e = 56\%$
Live Price $P_l = P_c \times Y_e = \$45.00 \times 56\% = \$25.20$

The price orders which direct the livestock buyers include prices for all classes and grades of livestock. The quoted prices for steers and heifers are usually different, steers being at a premium over heifers. Prices often differ for different weight ranges of the same grade classifications. The premiums or discounts between grades of steers over heifers, and between weight ranges vary over time according to market conditions.

3. DIRECT AND INDIRECT SALES

Direct sales were defined in a preceding section as those sales which are consummated at the plants which make the purchase. This type of sale is often referred to as "Back-door deliveries."

Indirect sales were defined as those sales which are consummated by the auction method of selling at the Public Markets Limited. The relative importance of indirect sales has been diminishing as is evidenced by the following figures: In 1957, about sixty-six per cent of total cattle marketings were delivered to the public stockyards; in 1963 about 61 per cent were sold through the public stockyards.[4]

Animals sold directly to the packing plant by the producer or trucker are unloaded into temporary holding pens where they are evaluated and where the bargaining process occurs. Often the animals are weighed prior to the final price decision. Animals sold in this manner are available to the buyer for close examination of the physical characteristics which assist him in judging the internal characteristics. A buyer has the opportunity to walk around the animal, to poke or feel the critical

---

[4] Livestock Marketing Review, 1963

surfaces of the animal's body, and to watch its movement. These opportunities are thought to allow the buyer to better appraise the condition of finish, degree of fill and so possibly to increase his accuracy of estimate of yield and grade. In the case of a group of animals to be sold simultaneously, he may mingle among them, and develop a mentally ordered appraisal of the animals taken singly or as smaller, relatively homogenous groups.

Price negotiation in indirect sales is normally by the auction method and occurs in an auction ring attended by several buyers representing different interests. The seller is an experienced commission agent and an auctioneer serves as the moderator to maintain open opportunities for bidding and a uniform and rapid flow of sales. By this method, the buyer is seldom able to do more than visually assess the animal as it is brought into the auction ring, moved around for several seconds, then moved out, often before bidding has terminated and a price determined. The buyer is usually several feet from the animal and can only feel the animal momentarily if it passes his vantage point.

Animals sold in a group in the auction ring receive only slightly more time for the group than the time given for a single animal. Separation of lots into smaller groups are made only if the buyers or commission agent feel this necessary.

4. STATEMENT OF THE HYPOTHESES

The primary function of hypotheses is to direct and guide scientific inquiry to its conclusion. There are several areas from which hypotheses

may arise; two of these being: (1) from an analysis of the problematic situation and, (2) from a critical evaluation of practical experience.

The hypotheses which are defined below resulted from both sources. Their primary function was to guide the research in an orderly analysis of the type and the magnitude of error committed by livestock buyers in the live-purchase of slaughter animals.

It was hypothesized that, on the average, slaughter animals live-purchased by packing plants have grade and yield estimated correctly and, as a result of this accuracy animals are on the average accurately priced according to their grade and yield.

It was further hypothesized that even though the mean error of grade and yield may be zero, variation in the ability to estimate yield, grade and price accurately on individual animals results in errors in the evaluation of and hence, the payment for, individual animals.

It was hypothesized that errors resulting in sales direct to packing plants are not as great as from those sales negotiated through the indirect method, and consequently, that pricing accuracy is greater for direct sales than for indirect sales.

It was further hypothesized that grade and yield estimation is more accurate for the steer class than for the heifer class and as a result, pricing accuracy is greater for steers than for heifers.

It was hypothesized that evaluation errors are unfavorable to the producer of high quality animals and favorable to the producer of low quality animals.

It was further hypothesized that evaluation errors are unfavorable to the producers of high yielding animals and favorable to the producers of low yielding animals.

CHAPTER III

THEORY AND METHODOLOGY

1. ASSUMPTIONS

The analytical framework and statistical tests of hypotheses involved making certain assumptions. The empirical validity of conclusions drawn from analysis based on these assumptions depends on the logical consistency of the analysis as well as on the empirical validity of the assumptions. The assumptions listed and described below are only the major assumptions made in the study. Other minor assumptions are discussed as they become necessary to the analysis. Some of the limitations of the assumptions are discussed in this section but these limitations become more important in the last chapter in discussion of the findings and statement of conclusions.

An assumption necessary to the study was that the buyers involved in the sampling process were unaffected by the sampling. In order that a representative sample of the errors committed on live purchased animals from the two packing plants sampled be obtained, it was necessary to accurately receive and record the estimates which were used by the buyers in their price-making decisions. If the buyers attempted to improve their estimates or were caused to err more often due to the fact that their purchases were individually recorded, the errors recorded would not be representative of the normal situation. Quantification of bias from this source, if existent, was not possible so that the assumption was necessary.

The assumption seems justified for two reasons. The reasons for the sample taking were well known to the buyers. Their co-operation was voluntarily given and as far as is known no attempt was made to deviate from their usual practices. Furthermore, the buyer did not always know at the time of purchase which animals were to be included in the sample. The decision to select any particular animal was often made immediately after the sale. Therefore, any effect of the sampling procedure on the buyers is not expected to be serious.

Another important assumption required by the analysis was that buyers do in fact attempt to estimate the true carcass grade of an animal as defined in Chapter II. If some other quality designation system were practiced, grade estimation errors as defined in this study would not reflect the buyers ability to estimate the official grade. Although large errors could be recorded, this would measure only the difference between evaluation according to the buyers' system and evaluation by official carcass grades.

Since most packing firms supply the retail trade in terms of the government grade, it is reasonable to expect that this is the unit of estimate which is used. Furthermore, the buying orders received by the buyers in the packers sampled were in terms of the government grades. Finally, it was claimed by the buyers that their attempt was to assess the animal only in terms of their estimate of the government grade.

Conversion of yield and grade errors to price errors required the assumption that an average carcass grade price was the value of carcasses of that grade to the packer. The carcass grade price used was calculated

by averaging the carcass prices which buyers estimated they were paying for each grade of carcass. The average price for each grade provided a representative price level from which the value of grade errors and yield errors could be determined.

This assumption may be justified by the fact that since these prices were the actual prices which buyers estimated they were paying, an average of these would give an indication of the average value of the carcasses to the packer. The value of by-products is assumed to be reflected in the price the buyer is willing to bid for the animal.

Parametric type tests of hypotheses require that samples be drawn from known populations. The tests used in this study were of the parametric type so that the assumption of random samples from a normal distribution was required.

Although no special technique was used to ensure random sampling, no attempt was made to limit the estimation errors to any particular type or types. Since only steers and heifers of the estimated classes of Red, Blue and Brown were sampled, the sample collection was limited to those classifications. Within the classifications, animals were chosen as randomly as conditions permitted. In some cases, due to the limited numbers of animals available, all of the animals of that classification purchased at that time had to be included. This however, was a sampling limitation imposed by conditions and not by discriminative sampling.

The assumption of a normal distribution of errors is warranted primarily by the fact that biological phenomena were being sampled.

Although it was hypothesized that errors at either extreme of grade or yield would tend to occur consistently in one direction, this is not sufficient reason for violation of the normality assumption. Since there is no a priori reason for a greater number of high valued animals than low valued animals in those sampled, and since a random sample has been assumed, each directional error has equal probability of occurrence. For this reason the directional errors would not be expected to introduce skewness into the data. A preliminary test for correlation of yield and grade errors provided no evidence that these errors tended to occur together. Therefore, considering the error distribution in its entirety, the assumption of normality seems justified.

The last important assumption is concerned with the representativeness of the sample. In order to provide an inferential base for generalization it is necessary to assume that the sample was representative of the population from which it was drawn. It was mentioned earlier that the study was in effect, limited to a case study of the Red, Blue and Brown steers and heifers purchased by the direct and indirect methods by two packing plants in a one month period. The sample was drawn as randomly as possible for this purpose. Generalization to all animals live purchased in the Winnipeg market area is limited by lack of knowledge of the representativeness of the samples for that population.

2. SOURCE OF THE DATA

One of the reasons for undertaking this study was to investigate a relatively unapprized area. Information of the type required to accept

or reject the hypotheses, except for the first hypothesis, is unavailable in livestock slaughter records. Such information is potentially available only from the slaughter-processing plants. It is in the interest of the packers, if they are able to procure their required supplies of slaughter cattle in competition with other plants, only to ensure that their buyers protect the packing plant from losses on purchases in a given time period. This condition can be satisfied by aggregative accurate pricing. Individual variation is not an important consideration to the buyer or plant as long as the required animals are procured at a sufficiently attractive average price. Consequently, only aggregative statistics are available in the packing industry.[1]

Due to the availability of only aggregative statistics and the necessity of data on an individual animal basis it was necessary to obtain the data from its original source, beginning at the point of sale of the animal. In order to gather the data, co-operation from a packing plant or packing plants was required. Since it was desired to make a comparison between direct and indirect sales, the co-operation of the Public Markets Limited was also required. The necessary co-operation was solicited from the Public Markets Limited and from two packing plants in St. Boniface. One packer, called Packer A, is dependent on both direct and indirect purchases for its procurements; the other, called Packer B, purchases all its animals from the Public Markets.

---

[1] This information is not published but the results of each buyers purchases are available to him on a daily basis.

3. THE SAMPLING TECHNIQUE DESCRIBED

The data required for analysis of yield and grade involved maintenance of identity of each animal from the point of sale to the chilled carcass condition. In the mechanized slaughter process of a modern meat packing plant, this is a time consuming and difficult task, especially since this type of identification is not normally made. The method of identification chosen was a waterproofed, numbered tag which was attached to the live animal at the time of weighing. When the hide was removed the tag or the number from the tag was transferred to the carcass.

Samples were taken simultaneously from both direct and indirect sources. One member of the research team was at the packing plant to secure information from animals sold directly to the packing plant. Another member of the research team occupied a position in one of the auction rings in the Public Markets Limited and obtained steers and heifers from both packers simultaneously. The method of identifying and recording the data was the same in both locations and for both packers.

When the animals were weighed immediately after sale, they were identified by affixing one of the glued tags to its hide. The live weight, the live price per pound and the buyers estimate of grade and yield were recorded for each animal. The animals for each packer and in both locations were penned separately from other untagged purchases so that they would be slaughtered separately. The reason for the separate penning of the tagged animals was to minimize the inconvenience to the packing plant and to prevent unnecessary loss of tagged animals.

After slaughter, chilling and grading in the plant coolers, the information from the carcasses was matched with the information obtained at the time of purchase. The information obtained from the carcasses included the grade assigned to the carcass by the government grader and the hot carcass weight. The cold carcass weight was estimated from the hot carcass weight and the true yield calculated.

The selection of animals for the sample was done as randomly as conditions permitted. The only discrimination which was made was that animals estimated to provide carcasses of the Red, Blue or Brown classes were selected. Because of the limited numbers of animals of the required classes, the adoption of an elaborate sampling technique was not feasible. An important consideration was to obtain an adequate number in the sample to allow comprehensive analysis. If a larger staff had been available, and if marketings had been heavier, a more statistically orientated sampling technique could have been adopted.

The following table shows the sample sizes obtained between July 22 and August 18, 1963. In a few cases the sample size is too small for comprehensive analysis. Due to some loss of information and all information not being available on some animals, the sample numbers shown in the table were not available for all stages of analysis. Different sample sizes of the same classification will be noted for different purposes in the study indicating that the information on every animal in the original sample was not useful for all purposes.

TABLE 2

ORIGINAL SAMPLE SIZES

	Packer A		Packer B	
	Steers	Heifers	Steers	Heifers
Indirect purchases	79	25	109	11
Direct purchases	99	16	no purchases	no purchases
TOTAL	178	41	109	11

4. THEORETICAL ASPECTS OF THE TESTS OF HYPOTHESES

Whenever it is possible to do so, it is of greatest use to test the validity of hypotheses by statistical significance tests. Some hypotheses are not readily adaptable to quantitative significance tests and some, although quantitative, violate assumptions of the test. Often statistical significance tests may be made but the results of the tests are acceptable only within the limits of the validity of the required assumptions.

The attempt was made in this study to subject each hypothesis to a statistical significance test or at least to express the data in statistical form to facilitate drawing conclusions from the quantitative data. Some of the assumptions and their applicability have already been discussed. The applicability of the conclusions drawn from the study as a basis for generalization are discussed in the final chapter.

The first hypothesis, that on the average yield and grade are accurately estimated and consequently animals are priced according to their average grade and carcass weight, results from the industry confidence in the live-purchase method of livestock marketing. Intricate accounting and recording techniques allow the packing plant to record the daily performance of its livestock buyers. Consistent buyer errors will be corrected by one means or another. Errors resulting in overpayment will be rapidly corrected since this would result in unnecessary losses to the packing plant. In a competitive system, errors resulting in underpayments would ultimately be reflected in the inability of a buyer to procure his share of the livestock supplies.

One of the methods used to correct consistent pricing errors could be to alter the price of carcasses to compensate for the errors. This method would be undesirable for two reasons. It would require accurate knowledge of the type and exact magnitude of the errors of each buyer, and would require different price orders for different buyers. A much more effective way to correct the error would be to attempt to correct the basic error, i.e., the inaccuracy of assessment of yield and/or grade. By improving the ability to estimate these determinants of price, the price errors would tend to be eliminated.

The absence of yield or grade errors, on the average, does not ensure that mean price errors will be zero. Pricing errors may still occur since yield, grade and price are not independent of each other.

The value of a yield error depends on the price level at which that yield error occurs. The analysis of yield errors occurs under cir-

cumstances of different price levels, depending on the carcass grade of the animals. Although yield errors are measured in percentage points, the valuation errors are measured in dollars per hundredweight of live animal. The relationship between a yield error and the resulting price errors changes with changing carcass grade of the animals.

The value of a grade error depends upon the difference in price between the grades on which the error was committed. If price differentials between grades were equal, a given magnitude of grade error would have an associated magnitude of price error. The relationship would remain constant for an error of one grade occurring at any level of grade and if the mean grade error were zero, the mean price error due to grade would be zero. However, the grade price differentials are rarely, if ever, equal. As a result, the fact that the mean grade error is zero, does not necessarily imply that the mean price error is zero.

Since grade and yield errors may occur simultaneously on any animal, discrepancy from accurate mean pricing can result from both sources of error. Therefore it is concluded that even though yield and grade mean errors may be zero, mean total price error is not necessarily zero.

The second hypothesis is extremely important to this study. One criterion of an efficient marketing system is that the same price is paid for the same product in the same time period (see page 6). If grade and yield estimation errors result in pricing errors and therefore, maldistribution of livestock payments, the system does not meet this basic criterion of efficiency. Although other factors must be considered in

evaluating the live sale method of marketing livestock, this study was concerned only with the errors committed in estimating grade and yield.

Errors of the type studied are important to the seller of single animals or small groups of animals. If errors tend to cancel out in large groups, the packer is protected against large variations in prices paid for the same quality of animal. Since buyers are constantly informed of the results of their purchases, it is possible for them to correct consistent errors and to accomplish the buying objectives of the packing plant. The seller of large groups of animals will also be protected against large variation in pricing for identical animals. The variation experienced will, theoretically, diminish with the size of the group sold when the objective is aggregative accuracy.

The seller of individual animals is faced with expected gains or losses depending on the magnitude of the individual errors. If errors occur in both directions and so cancel off, although the buyers' record indicates accurate purchasing, some sellers have gained at the expense of other sellers. Some sellers will be overpaid and some underpaid. The fact that buyers are constantly informed of their purchases may have some effect on the amount of variation which results from the live-sale method but this type of information is not sufficient to ensure elimination of errors on individual animals.

If variation exists in the pricing of identical animals, this is in itself a type of inefficiency. But awareness of this inefficiency may develop other types of inefficiencies. Producers or buyers may be able to use the individual variation to their benefit. One example of

profitable use of the inefficiency is the feeding of animals prior to sale in an attempt to maximize animal weight while minimizing the physical effects of the feeding. Feed used for this purpose represents an economic waste since its nutritive value is not realized. Furthermore, if packers discover that they are paying for "fill" which is not accounted for by the yield estimate, attempts to offset these errors can be made in any one of three ways. The first is to attempt to correct the errors in yield estimation. If the incidence of "fill" is large, correction by this method is likely to result in a revision of the buyers estimating habits. The incidence of "fill" will appear to the buyer as an upward bias in his estimates. Hence to correct the fault, all estimates of yield may be discounted by some compensating amount. The second corrective procedure is to establish price levels which are discounted for the amount of "fill" which buyers are unable to detect. This method would require each buyer to adjust his prices to his own apparent bias. The third corrective method would be to combine the above two corrective measures. The result of any of the three methods would represent further economic inefficiency. The price of all animals would reflect a discount from the real value by a sufficient magnitude to compensate for the animals on which errors occurred due to "fill".

The third hypothesis, that pricing is more accurate by the direct method of selling than by the indirect method, results from an analysis of the two alternatives. Live-sale transactions by both back-door deliveries and the auction method were described in Chapter Two. The reason for

the hypothesized difference results from the proximity of the buyer to the animal and the speed with which the negotiations occur.

Several factors could have offsetting influence on the hypothesized results. Since purchases made in an auction ring occur more rapidly and at a greater distance from the buyer, greater skill would be required to purchase according to the buying orders. If this is in fact the case and if it is recognized by the packing plants, the more experienced buyers may be assigned to the auction rings. This would tend to offset the disadvantage of the greater distance from the animal and the rapidity of sales. Similarly, if competition forces rapid reassessment of the external features, the disadvantages of the auction method would be partly compensated by the greater degree of competition in the auction ring. Theoretically the auction method involves more competitive bidding than back door deliveries because of the participation of an experienced commission agent who performs the selling service, and the presence of other experienced buyers who may bid on the same animal.

The importance of these considerations is not known and would be extremely difficult to detect and measure. The specific problem studied in respect to direct and indirect deliveries is limited to a comparison of the errors resulting from purchase-sale transactions made in the two methods.

The fourth hypothesis concerning the difference in ability to estimate yield or grade on steers and heifers results from the apparent impression of buyers that the ability differs. These impressions have

some bases of justification.

Steers and heifers differ anatomically in the relative distribution of muscle and fat tissue. Steers tend to display heavier muscling in the loin and rump areas, whereas heifers tend to display heavier muscling in the front quarters. Heifers tend also to develop a greater amount of internal fat stratification which results in a lower grade than the external characteristics indicate.

An additional factor contributing to the greater difficulty in accurately pricing heifers is the condition of pregnancy. Early stages of pregnancy may not be detected from a rapid appraisal of the animals but if the condition is sufficiently advanced, it may significantly affect the yield. As a result, the yield of a pregnant heifer may be overestimated.

Finally, heifers are seldom selected and fed as fattening cattle. Often the heifers which are marketed are herd culls which have been force-fed to a saleable condition. This tends to develop heterogeniety in the animal units. As a result of this relative heterogeniety, buyers may experience difficulty in employing their past experience to assess any particular animal.

The validity of any or all these factors which may contribute to the greater difficulty in purchasing heifers than steers is not known and cannot be analyzed from the data collected for this study. They were, however, the factors which resulted in the formulation of the testable hypothesis.

For discussion purposes, the last two hypotheses may be considered jointly. Both hypotheses result from a consideration of animals which fall in the extremes of grade and yield. If buyers are interested only in individual errors cancelling out so that only average errors are zero, it is possible that errors will tend to increase as the extremes of yield and grade are approached. Since quality is measured in discrete measurements which have a relatively wide range, occurrence of the type of errors hypothesized is probably less frequent than the occurrence of yield errors. Although yield is a continuous measurement, the known range for top quality slaughter cattle is limited for the most part to between the extremes of fifty-three and sixty per cent. Since this approximate normal range is known, a buyer will prevent large errors from occurring on the average by restricting his estimates to the range of typical yields. But at the same time that the buyer protects himself against the large errors, his action would represent consistent over and underpayment to producers where animals fall outside the typical range. The producer of high quality and/or high yielding animals would be consistently underpaid. The producer of low quality and/or low yielding animals would be consistently overpaid. This type of marketing inefficiency would tend to discourage the marketing of animals in extremely good condition, and to encourage or at least not to discourage the marketing of animals in poor condition. Since high valued animals are underpaid according to their high quality and yield, the producer is not receiving a payment commensurate with their true value. Similarly, low valued animals are purchased at a price in excess of their true value so that there is insufficient discouragement to the production of poorer animals.

5. THE STATISTICAL TEST OF THE HYPOTHESES

The statistical test of the hypothesis that yield, grade and pricing errors cancel out theoretically involves the calculation of a Students 't' statistic under the Null Hypothesis that the population mean is zero: i.e., $H_o: \mu = 0$

The 't' statistic is calculated according to the formula:

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

where $\bar{x}$ = calculated sample mean

s = calculated sample standard deviation

n = sample size, degrees of freedom = $n - 1$

μ = population mean hypothesized equal to zero

The population was defined as the number of animals in each classification which were purchased by the packing plant in the time period July 22 to August 18, 1963. Since the population is finite, the test of significance theoretically involved a correction for finiteness. The correction factor is given by $\frac{N - n}{N}$, where N is the number of animals in the population, and n is the number of observations in the sample. Operationally, if the sample size is not greater than twenty per cent of the population size, this adjustment has little effect and so is not required. In no case was the sample size in excess of twenty per cent of the population size so that this adjustment was not made in any of the tests.

Since the second hypothesis involved the analysis and description of individual errors, direct use of statistical tests was not feasible.

Probability frequency tables were calculated to specify the theoretical probability, assuming the errors are normally distributed, of an error of given size occurring.[2] The recorded errors in yield, grade and price are displayed on the same tables.[3]

The probability frequency distributions were calculated by finding the area under the normal curve for an error of a specified magnitude. For the errors the means of which were not statistically different from zero, the mean of the population was assumed to be zero. For the errors the means of which were statistically different from zero, the mean of the population was assumed to be the mean of the sample. This assumption is justified since a sample mean is the best estimate of the population parameter μ.

The errors observed in the sample were tabulated as Recorded Frequencies. These were calculated by dividing the number of observations of a given magnitude of error by the total number of observations in the sample. In grouping the price errors for calculation of Recorded Frequency, an error of less than (plus or minus) ten cents was considered to be an error of zero. Yield errors were grouped to the nearest 0.5 and since grades are discrete measurements, grouping was an exact procedure.

The relative variability expected by the seller and the packer may be represented by the variance of the errors which each experienced. The best estimate of the true variance experienced by the seller is the variance of the observations calculated from the sample. The best estimate of the true variance experienced by the packer, if packers are only interested

---

[2] See tables 5, 6 and 7.

[3] See tables 5, 6 and 7.

in aggregate accuracy, is the variance of the mean of the sample. This value is defined statistically as the variance of the observations in the sample divided by the number of observations in the sample, i.e.: $s^2_{\bar{x}} = \frac{s^2}{n}$.[4] The square root of the variance of the mean is the standard error of estimate. It is easily seen that the expected variation for the seller is greater than the expected variation of the packer.

The statistical test of the hypothesis comparing the results of direct and indirect sales, and of comparing the results of steer and heifer sales was tested by the use of a Student's "t" test. The Null Hypothesis under test in each case was that the difference between the population means of each classification was zero, i.e.:

$$H_o: \quad \mu_i = \mu_j.$$

The "t" statistic is calculated according to the formula:

$$t = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\frac{s_i^2}{n_i} + \frac{s_j^2}{n_j}}}$$

with $n_i + n_j - 2$ degrees of freedom

where $\bar{x}_i$ = sample mean of the i^{th} classification,

$\bar{x}_j$ = sample mean of the j^{th} classification,

s_i^2, s_j^2 = sample variance of i^{th} and j^{th} classification,

n_i, n_j = sample size of the i^{th} and j^{th} classification.

In these tests as well as in the tests of the first hypothesis, the

---

[4] R.D.G. Steel and J.H. Torie, Principles and Procedures of Statistics, McGraw-Hill Book Company Inc., New York, Toronto, London, 1960, p.19.

rejection or acceptance of the Null Hypothesis about yield or grade does not ensure that the price error has the same result. Since both yield and grade errors affect the price errors, the two in combination may affect price in a manner differently from the effect of either treated separately. Furthermore, the existence of unequal price differentials between grades and different price levels allows the possibility of a net price error even if grade and yield errors cancel out.

The statistical significance test on the difference between means is an incomplete analysis upon which to base acceptance or rejection of either the third or fourth hypotheses. In effect, the significance test on the means is a test on differences in results of purchases by the packers of steers and of heifers, and of purchases direct and indirect. It provides information on the relative location of the distribution of errors experienced by the seller for each classification, but does not provide information about relative accuracy within each classification.

A comparison of relative accuracy was accomplished by calculation of a correlation coefficient in each case between the estimated evaluation and the actual evaluation. A correlation coefficient is a numerical measure of thedegree to which two variables move together. The square of the correlation coefficient is known as the Coefficient of Determination. The coefficient of determination measures the proportion of the variation in the dependent variable which is determined by the variance in the independent variable.[5]

---

[5] R.D.G. Steel and J.H. Torie, Principles and Procedures of Statistics, McGraw-Hill Book Company Inc., New York, Toronto, London, 1960, p. 187.

A test of significance on the difference between two correlation coefficients is in effect a test of the ability to estimate accurately in the classifications tested. The information obtained from the statistical comparison of means as well as the comparison of correlation coefficients provides adequate information upon which to reach conclusions for the third and fourth hypotheses.

The test of significance on the difference between correlation coefficients involves calculation of a "Z" statistic under the Null Hypothesis,

$$H_o: \quad \rho_i = \rho_j$$

where ρ_i and ρ_j are the Population Correlation coefficients.

Calculation of the Z statistic requires a logarithmic transformation and is represented mathematically by:

$$Z = \frac{z_i - z_j}{\sqrt{\frac{1}{n_i - 3} + \frac{1}{n_j - 3}}}$$

where $z_i, z_j = 0.5 \log_e \frac{1 + r}{1 - r}$

n_i, n_j = number of observations in the sample from which r_i and r_j are calculated.

A significant difference between the correlation coefficients indicates that a difference does exist in the amount of the variation in the dependent variable explained by variation in the independent variable.

If significance tests are done on means and correlation coefficients calculated from the i^{th} and j^{th} classifications, there are four possible

combinations of results. First, a non significant difference between the means of the i^{th} and j^{th} classifications may be associated with a non significant difference between the i^{th} and j^{th} correlation coefficients. This result would indicate that the mean errors as well as the ability to estimate accurately in the two classifications do not differ statistically. It could then be concluded that purchases and sales do not differ for the two classifications. Second, a non significant difference between means but a significant difference between correlation coefficients could be interpreted as similar mean errors but a difference in the ability to evaluate animals in the i^{th} and j^{th} classification. This result could also be interpreted as a non significant difference of purchases by the packer (considering only the packer's aggregative standpoint) but a difference in accuracy of pricing of animals sold by the producer. Third, a significant difference between means and a non significant difference between correlation coefficients indicates a difference in thelocation of the error distribution but no difference in the ability to estimate. Finally, if both comparisons were significant, a difference in both the mean errors and the ability to estimate would be indicated.

The remaining two hypotheses were not easily adaptable to statistical analysis and test. Complete analysis would require calculation of the first non-central moment and the second, third and fourth central moments. These values are more commonly known as the mean, variance, skewness and kurtosis. A precise description of this type would then allow accurate assessment of the data in terms of the

hypotheses. Since this exhaustive statistical treatment was found impossible for the number of classifications and number of observations available, a less definitive statistical treatment was adopted. One method of quantification was possible by assuming that the estimated and actual observations were normally distributed. If data are normally distributed it is known that 68.27 per cent of the observations fall within one standard deviation of either side of the mean, 95.45 per cent fall within two standard deviations, and 99.73 per cent fall within three standard deviations of the mean.[6] Since both the mean and standard deviation of the estimated and actual distributions of priced data[7] were available for all classes, the comparison of the two theoretical distributions of prices could be made. The hypotheses would be supported if the range of the distribution of the actual (Normal) prices fall without the range of the distribution of the estimated (Attempted) prices. Another method of providing evidence for the sixth hypothesis was used. The same method was not useful for treatment of grade because of the small number of grade classifications. From the transformed price data (described in the next section) means of the extremes of the true yields of both the Attempted and Normal prices were calculated. It was decided to select the top and bottom twenty per cent of the true yields as representative of the extremes of true yield. The differences between the means of the Attempted and Normal prices were then subjected to statistical significance tests. If the mean of the Normal price were greater and less respectively than the mean of the

---

[6] B. Ostle, Statistics in Research, The Iowa State College Press, Ames, Iowa, p. 23.

[7] These terms are defined in the next section.

Attempted price at the upper and lower extremes, significance would indicate that a true difference existed and hence the hypothesis would be supported. If no evidence of a difference was found, this could be considered as rejection of the hypothesis.

6. ANALYSIS OF YIELD AND GRADE ERRORS BY CONVERSION INTO PRICING ERRORS

An economic analysis of any problem is rarely concerned with only the physical aspects of the problem. Expression of any phenomena in monetary terms is usually necessary for complete economic analysis. Transformation of yield and grade errors into monetary terms proved to be one of the most difficult aspects of the present study.

It was necessary to express yield and grade errors as priced[8] errors for several reasons. Due to the nature of yield and grade errors, quantification in their own units of measurement allowed no comparisons of their relative importance and therefore, had limited economic significance. If for example, it were found that the expected value of grade errors was 0.5 and that the expected value of yield errors was 1.0 for any given class of animals, only comparison of that grade error with grade errors from other classifications could be made; and similarly only comparisons with other yield errors could be made. The information does not give a directly comparable set of values for the two kinds of error within any class. It cannot be concluded that from this information yield errors are larger or more important than grade errors since

---

[8] "Priced error" or "priced data" refer to the yield and grade errors expressed in the form of errors in price per cwt. of live animal derived by the conversion method described in this section.

they are measured on different scales.

In order to be able to make the direct comparison it was necessary to convert the yield and grade data into priced data. Because of several complicating factors encountered in the process, several assumptions were required. The assumptions resulted in the transformed data differing slightly from the actual conditions under which the sample was taken. Several sources of variation were evident in any given pricing situation. There was the variation in prices due to the differences in the yield and grade estimates, the variation basic to this study. Secondly, pricing variation resulted from differences in the degree of competition surrounding each sale. Another possible source of variation may arise in the procedure followed in converting carcass price to live price. Finally, since the samples contain animals purchased over a period of one month, variation in price could result from daily price changes. These factors combined to produce the result that in either of the two methods of selling, and for both packing firms, different prices were paid for animals estimated to be of the same quality and yield. Conversely, it was not unusual for the same price to be paid for animals estimated to be of different grades and yield.

Under these conditions it was impossible completely to isolate the effect of yield and grade errors on price. In order to overcome this problem, a method was devised which enabled approximation of the price errors resulting from the yield and grade errors. The results obtained by this method are not an exact and absolute measure of the effect of grade errors and of yield errors on the errors in pricing of the animals

in the sample. The method allowed an approximation of the pricing errors and an approximation of their relative importance. These approximations are, however, realistic for the price conditions prevailing in St. Boniface at the time of the sampling.

A further important consideration to be made before describing the actual method of isolating the components of pricing errors is that the relationship between yield and grade errors expressed in prices will not remain constant over time. Their relative magnitude will depend on two factors; the price differential between grades, and the prevailing price level. The former is important only to the magnitude of the price error caused by errors in estimating grade; the greater is the grade price differential, the greater will be the price effect of a grade error. The latter is important only to the pricing error resulting from errors in estimating yield; the higher the price level, the greater will be the price effect of a yield error. Since grade price differentials have a tendency to move in an opposite direction to price level, the magnitudes of the two price errors would tend to move in opposite directions. When supplies of top quality slaughter cattle are relatively light and prices rise, the magnitude of yield price errors relative to grade price errors would increase. The relative positions change because of the increasing price level and the decreasing grade price differential. Hence it can be concluded that the higher the price level, the greater will be the magnitude of yield price errors relative to grade price errors. Conversely the lower the price level, the greater will be the magnitude of the grade price error in relation to the yield

price error.

Since price levels were somewhat higher than normal during the sampling period, it can be concluded that the yield price errors are abnormally large compared to the grade errors. An offsetting tendency is suspected due to the fact that abnormal grade errors were occurring because of the heavy marketings of grass fed cattle. The results of the analysis will provide a representative evaluation of the errors resulting under the conditions of price and marketing during the sampled period.

With the limitations and necessity of the conversion of errors into price errors discussed, it still remains to describe in detail the actual technique used to accomplish this goal. In order to remove all sources of variation except that attributable to yield and grade, a method had to be found which ensured that all animals estimated to be of the same grade and yield were priced identically. Use of the recorded purchase prices did not meet this requirement for the reasons already discussed. It was assumed that the average price which buyers attempted to pay for each carcass grade of animal was the true value of that carcass to the firm. This provided the basis for a uniform price for identical animals. Since prices were not the same for each method of sale nor for each packer, an average attempted carcass price was calculated for each classification of animal.

The average attempted carcass price for each packer by each method of purchase was calculated as follows. The live price paid at the point of sale was converted to an attempted carcass price by the

estimate of yield. The attempted carcass prices of identically estimated carcasses were then grouped and the average value found. This average carcass grade price was then assumed to be the value of that grade of animal to the packer for which the value was calculated. The calculated value was not necessarily equal for both direct and indirect purchases. Although the above assumption is not completely valid, it establishes a workable value which was representative of the price conditions existing at that time.

A further assumption became necessary due to the existence of Ungraded animals erroneously occurring in the sample. Since the Ungraded animals resulted from overestimates of grades on the part of the buyers, no average carcass price was calculable for that classification. Therefore, it was assumed that the Ungraded animals would be valued at a discount from the Brown grade by the same amount as Browns are discounted from Blue grades. That is, if the Blue - Brown calculated average differential were $2.00 per hundredweight of carcass, the Brown - Ungraded differential was also assumed to be $2.00.[9]

Having determined the prices which are assumed to represent the value of a carcass, a value representing the combined yield and grade error could be easily calculated. This was accomplished by taking the difference between the appraised value of the animal and the true value of the animal. The true value of the animal was found by converting the true grade price to a live price by the actual recorded yield of the animal. For descriptive purposes, this value has been termed the

---

[9] Justification for this assumption was found in the Livestock Market Review. The relevant differentials for live grades displayed a relationship close enough to that assumed that serious disturbances of true values would not result from its use.

"Normal Price". The appraised value was calculated by converting the estimated grade price to a live price by the estimated yield. For descriptive purposes this value has been termed the "Attempted Price". The difference between the "Attempted Price" and the "Normal Price" is a measure of the total price error resulting from yield and grade errors.[10] If the animal were correctly appraised, this method would give equal Attempted and Normal prices and therefore, no price error. The value calculated is in each case, an exact measure of the total price error given the stated assumptions.

The total price error as calculated above has two possible components. It may be any combination of positive or negative yield and grade errors. Estimation of the two components is only an approximative procedure.

Calculation of the portion of total price error attributable to error in yield estimation involved use of the Normal Price and a price calculated from the average carcass price for the true grade and converted to a live price by the estimate of yield. The difference between the Normal Price and the live price calculated as above is an approximation of the required yield price error. Similarly a price error for grade was calculated by taking the difference between the Normal Price and a price calculated from the estimated grade price converted to a live price by the true yield.

---

[10] A positive difference represents an error favorable to the producer, unfavorable to the buyer. A negative difference represents an error favorable to the buyer and unfavorable to the producer.

These calculated prices are only close approximations of the true values. In the cases in which both errors were committed simultaneously, an error resulted which was due to their simultaneous occurrence. This small combined error was a form of interaction. It was found that the work involved in accounting for this extremely small interaction term was not warranted by the increased accuracy attained. The magnitude of the term was small in relation to the price errors resulting from yield or grade considered separately. If, for example, a grade estimation error of one represents a carcass price error of $2.00 per hundredweight, and a one percentage point error in yield results in $0.45 per hundredweight of live animal, the magnitude of the interaction term would be only $0.02 per hundredweight of live animal.[11] The information lost by neglecting this term is obviously small in relation to the other values. Furthermore, since there is no evidence of correlation of yield and grade errors, the interaction terms would be expected to tend to cancel out and therefore, not to bias the results.

An Illustrative Example

Consider a steer which is estimated to produce a Red carcass and to yield fifty-six per cent. If the average attempted Red carcass price was $46.38 per cwt., the Attempted price on this particular animal would be $25.97 ($46.38 x 56%) per cwt. live. If the carcass graded Blue, had an average value of $45.88 per cwt., and yielded fifty-seven per cent, the true value or Normal Price would be $26.15 ($45.88 x 57%) per cwt.

---

[11] The value is calculated by multiplying the grade price differential $2.00 by the yield error of 1 per cent.

live. Therefore, the steer was undervalued by $0.18 per cwt. of live animal.

The $0.18 underpayment is composed of two components, a negative component due to the yield estimation error and a positive component of the grade error. The approximate magnitudes of the true components are calculated as follows. The yield price error is the difference between the Normal Price ($26.15 per cwt. live) and the value of the Blue carcass converted to a live price by the estimate of yield. This value is $25.69 ($45.88 x 56%) and therefore, the difference is $-.46 or an underpayment of forty-six cents per hundredweight of live animal. Similarly the grade price error equals the difference between the Normal Price and the estimated Red carcass converted to a live price per pound by the true yield. This value is $26.44 ($46.38 x 57%) and the difference is $+.29 per cwt., or an overpayment of twenty-nine cents per hundredweight of the live animal. The total of the two errors is an underpayment of seventeen cents per cwt. live. This value is very close to the value found by calculating the difference between the Normal Price and the Attempted Price, hence the interaction term has been unimportant mathematically.

It must be repeated that these values are not the priced values of the errors committed in estimating yield and grade of the animals in the sample. They can be considered only as analytical approximations of the value of the actual errors committed. The nature of the raw data did not permit the direct calculation of yield and grade price errors.

CHAPTER IV

ANALYSIS OF THE HYPOTHESES

1. INTRODUCTION

In this chapter the statistical analysis and results of the statistical significance tests are reported. Conclusions regarding acceptance or rejection of the hypotheses are also drawn. The hypotheses lend themselves to separate discussion and presentation, hence a section is devoted to each hypothesis.

Since both the physical error and priced error[1] are usually reported together, and since the technique of pricing the errors has already been described, it remains only to present the average prices on which the transformations were based. This information is given in Table 3. It will be noted that in the case of Packer B, prices are given only for the Red and Blue carcasses purchased by the indirect method. Packer B procured all of its animals from the Public Markets Limited and attempted to purchase only Red and Blue carcasses. This objective was realized in all of the animals included in the sample from Packer B.

---

[1] "Priced error, priced data, yield price error, grade price error" refer to the results of the price transformation technique described in Section 6 of Chapter III.

TABLE 3

CALCULATED AVERAGE ATTEMPTED CARCASS PRICES
ON ANIMALS SAMPLED

		Packer A		Packer B	
	Grade	Steers	Heifers	Steers	Heifers
Indirect	Red	$46.00	$42.45	$46.38	$43.96
	Blue	44.02	41.52	45.88	43.02
	Brown	41.51	38.56	-	-
	Ungraded	39.00	35.60	-	-
Direct	Red	45.88	43.38	-	-
	Blue	45.18	39.25	-	-
	Brown	41.83	37.89	-	-
	Ungraded	38.48	36.54	-	-

2. ANALYSIS OF THE FIRST HYPOTHESIS

It was hypothesized that the average grade and yield errors of live purchased slaughter animals would be zero and that the resulting total price error would be zero. This hypothesis was tested by subjecting each of the means of the yield, grade and price errors to a Student's 't' test. The data used in the tests and the numerical results are summarized in table 4.

Reference to Table 4 for Packer A indicates that the hypothesis was supported for yield estimates for both steers and heifers. The mean error of yield estimates on 128 steers of +0.15 percentage points

TABLE 4

STATISTICAL ANALYSIS OF MEAN YIELD, GRADE, AND PRICE ERRORS

Packer	Classification	Units	Sample Size	Average error/100 lb. live	S Standard Deviation	$S/\sqrt{n}$ Standard Error	't' value[a]
A.	Total Steers	%[b]	128	+0.15	2.13	0.19	.81
Yield		price	98	$+0.02	$0.97	$0.10	.21
	Total Heifers	%	40	+0.30	2.01	0.32	.95
		price	29	$+0.15	$0.74	$0.14	1.09
A.	Total Steers	Grade[c]	178	0.29	.66	0.05	5.91**
Grade		price	98	$+0.28	$0.70	$0.07	3.95**
	Total Heifers	Grade	41	+0.76	0.83	0.13	5.89**
		price	29	$+0.81	$0.98	$0.18	4.45**
A.	Total Steers	price	100	$0.30	$1.23	$0.12	2.42**
Total Price[d]	Total Heifers	price	29	$0.96	$1.41	$0.26	3.67**
B.	Total Steers	%	108	-1.13	2.12	0.20	5.65**
Yield		price	100	$-0.55	$1.00	$0.10	5.51**
	Total Heifers	%	11	-1.96	1.54	0.46	4.22**
		price	10	$-0.80	$0.69	$0.22	3.69**
B.	Total Steers	Grade	108	-0.31	0.47	0.05	6.98**
		price	100	$-0.04	$0.15	$0.02	2.67**
	Total Heifers	Grade	11	-0.10	0.69	0.21	0.47
		price	10	$-0.05	$0.08	$0.03	1.98
B.	Total Steers	price	100	$-0.59	$1.04	$0.10	5.67**
Total Price	Total Heifers	price	10	$-0.85	$0.76	$0.24	3.53**

[a] "**" denotes statistical significance at $\alpha = 0.01$

[b] "%" denotes percentage points of error

[c] "Grade" denotes number of grades in error

[d] "Total Price" is the sum of the yield price error and grade price error.

(overestimation of yield by an average of 0.15 percentage points) was not statistically significant. Similarly a mean error of yield estimates on 40 heifers of +0.30 percentage points (an overestimation of yield by an average of 0.30 percentage points) was not statistically significant. The yield price errors for steers and heifers of $0.02 and $0.15 respectively were also not found to be significantly different from zero.

The data indicate that the hypothesis is rejected for yield errors from Packer B. The mean error of yield estimates on 108 steers and 11 heifers were -1.13 and -1.96 percentage points respectively where the negative sign indicates an underestimation of yield. The resulting price errors were $-0.55 and $-0.80 respectively for steers and heifers. Each of these four values was highly significant at $\alpha = 0.01$ as Table 4 indicates. Hence there is no evidence to support the hypothesis of mean errors being zero.

The average grade errors on steers and heifers purchased by Packer A were found to be statistically significant indicating that the mean error of grade is different from zero. The mean grade error on 178 steers of 0.29 and the resulting grade price error of $0.28 were highly significant. Similarly, the mean grade error of +0.76 on 41 heifers and the resulting average grade price error of $0.81 were highly significant.

The same conclusion is indicated by the data on steers from Packer B. The average grade error was -0.31 and the grade price error was $-0.04, both values highly significant indicating that the mean errors are not zero. The grade error of -0.10 on heifers and its resulting grade price error of -0.05 was not significant. This result would

support the hypothesis, but since the results were based on only 11 observations conclusive evidence in support of the hypothesis cannot be considered to have been given.

The data indicate that for both packers and for both the steer and heifer classes, the mean of the total price errors was statistically different from zero. This information warrants the conclusion that the hypothesis is rejected, i.e., that there is no evidence to indicate that the mean total price errors resulting from grade and yield errors are zero. The mean total price errors for steers and heifers purchased by Packer A were \$0.30 and \$0.96 respectively. The comparable results for Packer B were \$-0.59 and \$-0.85. The importance of these errors may be more readily understood by expression of their magnitude in terms of a live animal. If the average weight of the animals purchased was 1000 pounds, the price error per animal would be: overpayments by Packer A on steers and heifers of \$3.00 and \$9.60 respectively; underpayments by Packer B on steers and heifers of \$5.90 and \$8.50 respectively.

It is noted that the errors recorded from the two packers were of opposite sign in all cases. This indicates, although not every value was significant, that consistent overestimates were made by Packer A and consistent underestimates were made by Packer B. Existence of this difference in the case of prices could be explained by the fact that the average Attempted price for Packer B was considerably higher than for Packer A. In competitive bidding, differences in carcass price levels between firms could permit one firm to pay less than its Attempted price while another paid more. However, since the price errors recorded are

based on the yield and grade errors, the difference suggests a difference in the ability of the buyers of the two firms to visually appraise the qualities of a live animal. No reason for this difference in ability is suggested, if it does in fact exist.

In brief summary, it would appear that the hypothesis of mean errors equalling zero is supported only in the case of yield estimation on steers and heifers purchased by Packer A. Although there was some evidence of mean errors not differing from zero in the heifer purchases of Packer B, the small sample size detracts from the conclusiveness of this evidence. In all other instances tested there was evidence that the mean errors did not equal zero. There was evidence of differences in ability to evaluate animals between the two packers although this difference was not investigated further. In the case of Packer A, grade errors resulted in about the same mean pricing errors as did yield errors. The data on Packer B indicate that yield pricing errors were larger than the grade pricing errors.

3. ANALYSIS OF THE SECOND HYPOTHESIS

It was hypothesized that inability to estimate yield and grade accurately would result in considerable pricing errors on individual animals.

Evidence in support of this hypothesis is found in Tables 5, 6 and 7. These tables include the theoretical and recorded distribution of errors of specified magnitudes. The yield errors are given by whole percentage points since a finer distinction would add very little

information to the analysis. For the same reason price errors are given in increments of fifty cents per hundredweight of live animal.

From Table 5 it is seen that the largest errors in yield estimation for both packers were made on steers. Packer A committed yield estimation errors of up to eight percentage points. The effect of these errors was pricing errors as large as $3.50 per hundredweight of live animal. Packer B committed yield estimation errors on steers of up to seven percentage points which resulted in pricing errors as large as $3.50 per hundredweight live. Packer A committed errors on heifers of up to six percentage points resulting in price errors of up to $2.00. Packer B committed errors on heifers of up to five percentage points which resulted in pricing errors of up to $2.50. In both steers and heifers, the proportion judged accurately for yield was less than eighteen per cent. The proportion with less than a ten cent error was less than seventeen per cent.

The theoretical probabilities of errors of specified magnitude give the expected frequency of errors of given magnitudes. It is seen from Table 5 that the range of yield errors is as large as six percentage points in both directions from zero and the resulting errors as large as $2.50 for steers from Packer A. The values for heifers from Packer A are five percentage points and $2.00. Steers from Packer B would have errors ranging up to six percentage points and $3.00 while heifers would have errors as large as six percentage points and $2.50. Comparison of the theoretical and actual distributions

TABLE 5

THEORETICAL PROBABILITIES[a] AND RECORDED FREQUENCIES[b] OF OCCURRENCE OF YIELD ERRORS OF SPECIFIED MAGNITUDES

PACKER A

Steers						Heifers					
Error[c] %	Theo. Prob.	Rec. Freq.	Error Price	Theo. Prob.	Rec. Freq.	Error %	Theo. Prob.	Rec. Freq.	Error Price	Theo. Prob.	Rec. Freq.
0	-	.13	0	-	.17	0	-	.13	0	-	.10
±1	.36	.46	± .50	.40	.45	±1	.38	.53	± .50	.50	.59
±2	.64	.76	±1.00	.69	.72	±2	.68	.73	±1.00	.82	.79
±3	.84	.92	±1.50	.88	.92	±3	.86	.90	±1.50	.96	.97
±4	.95	.95	±2.00	.96	.94	±4	.95	.98	±2.00	.99	1.00
±5	.98	.95	±2.50	.99	.96	±5	.99	.98	±2.50		
±6	.99	.96	±3.00		.98	±6		1.00	±3.00		
±7		.98	±3.50		1.00	±7			±3.50		
±8		1.00	±4.00			±8			±4.00		

PACKER B

0	-	.18	0	-	.16	0	-	.09	0	-	.10
±1	.32	.49	± .50	.33	.42	±1	.24	.45	± .50	.30	.50
±2	.59	.67	±1.00	.62	.65	±2	.50	.63	±1.00	.59	.70
±3	.79	.81	±1.50	.81	.80	±3	.75	.82	±1.50	.83	.80
±4	.90	.93	±2.00	.92	.91	±4	.90	.91	±2.00	.95	.90
±5	.96	.93	±2.50	.97	.96	±5	.98	1.00	±2.50	.99	1.00
±6	.99	.99	±3.00	.99	.99	±6	.99		±3.00		
±7		1.00	±3.50		1.00	±7			±3.50		
±8			±4.00			±8			±4.00		

[a] The Theoretical Probabilities were calculated under the assumptions that the errors were normally distributed. The method of calculation did not permit calculation of a value for zero error, hence the absence of an entry in those cells.

[b] The Recorded Frequencies were calculated from the number of animals observed to fall within the limits specified.

[c] Error, expressed in percentage points, refers to the difference between the estimated yield and the true yield. Yield price error is the priced result of the estimation error.

TABLE 6

THEORETICAL PROBABILITIES AND RECORDED FREQUENCIES
OF OCCURRENCE OF GRADE ERRORS
OF SPECIFIED MAGNITUDES

PACKER A

Steers						Heifers					
Error Grade	Theo. Prob.	Rec. Freq.	Error Price	Theo. Prob.	Rec. Freq.	Error Grade	Theo. Prob.	Rec. Freq.	Error Price	Theo. Prob.	Rec. Freq.
0	-	.58	0	-	.58	0	-	.34	0	-	.34
±1	.82	.96	± .50	.49	.66	±1	.60	.76	± .50	.28	.34
±2	.99	1.00	±1.00	.83	.67	±2	.94	.98	±1.00	.56	.69
±3			±1.50	.95	.97	±3	.99	1.00	±1.50	.74	.83
			±2.00	.99	.98				±2.00	.88	.83
			±2.50		.99				±2.50	.96	.93
			±3.00		1.00				±3.00	.99	.93
			±3.50						±3.50		1.00

PACKER B

0	-	.69	0	-	.63	0	-	.55	0	-	.70
±1	.91	1.00	± .50	.99	1.00	±1	.85	1.00	± .50	.99	.70
±2	.99		±1.00			±2	.99		±1.00		1.00
±3			±1.50			±3			±1.50		
			±2.00						±2.00		
			±2.50						±2.50		
			±3.00						±3.00		
			±3.50						±3.50		

TABLE 7

THEORETICAL PROBABILITIES AND RECORDED FREQUENCIES OF OCCURRENCE OF TOTAL PRICE ERRORS OF SPECIFIED MAGNITUDES

PACKER A

Steers			Heifers		
Error Price	Theoretical Probabilities	Recorded Frequencies	Error Price	Theoretical Probabilities	Recorded Frequencies
0	-	.13	0	-	.14
± .50	.30	.40	± .50	.22	.34
±1.00	.57	.63	±1.00	.43	.48
±1.50	.77	.85	±1.50	.61	.66
±2.00	.89	.89	±2.00	.75	.69
±2.50	.96	.92	±2.50	.83	.79
±3.00	.98	.98	±3.00	.93	.90
±3.50	.99	.99	±3.50	.96	.97
±4.00		.99	±4.00	.99	1.00
±4.50		1.00	±4.50		

PACKER B

0	-	.16	0	-	.10
± .50	.31	.41	± .50	.28	.40
±1.00	.59	.64	±1.00	.67	.60
±1.50	.76	.77	±1.50	.79	.80
±2.00	.90	.90	±2.00	.94	.90
±2.50	.96	.96	±2.50	.98	1.00
±3.00	.99	.98	±3.00	.99	
±3.50		1.00	±3.50		
±4.00			±4.00		
±4.50			±4.50		

indicate that the errors are not exactly normally distributed but that the assumption of normality is not necessarily a limiting factor to the analysis.

From the above information it can be concluded that large and frequent yield errors do occur on individual animals and that the effect of the yield errors on price is to cause considerable pricing variation.

Table 6 gives the recorded and theoretical distribution of grade and grade price errors for Packer A and Packer B. It is indicated that the largest grade errors in the case of steers purchased by Packer A was two, although only four per cent of the animals were misjudged by an error of this magnitude. The resulting price errors were not greater than $2.50 on ninety-nine per cent of the animals. Packer A committed errors of up to three grades on the heifers purchased but the error was this great on only two per cent of the animals. The resulting price error was as great as $3.50 per hundredweight live but limited to $2.50 on 93 per cent of the animals. On 58 per cent of the steers and 34 per cent of the heifers there were no grade and no grade price errors.

Packer B estimated grade accurately on 69 per cent of its steers and 55 per cent of its heifers. Since this packer only attempted to buy Red and Blue carcasses and was successful in limiting its purchases to these grades the greatest error was one. The maximum price errors due to grade were fifty cents per hundredweight for steers and one dollar per hundredweight for heifers. The theoretical probabilities indicate that about 8 per cent of the steers and 14 per cent of the heifers would be misjudged in grade by an error of two grades.

Table 7 gives the theoretical probability and recorded frequencies of the total price errors resulting from both yield and grade estimation errors. It can be readily seen that errors as large as $4.50 per hundredweight live were committed (Steers - Packer A) and that as few as 10 per cent (Heifers - Packer B) were accurately appraised for true value.

Packer A accurately appraised about 15 per cent of its steer and heifer purchases (13% for steers, 14% for heifers). About one-third (37%) of its steer purchases were in error by more than $1.00 per hundredweight live and about one-half of its heifers (52%) were in error by more than $1.00 per hundredweight live. One per cent of its steers were misjudged by an error as large as $4.50 per hundredweight and three per cent of the heifers were misjudged by as much as $4.00 per hundredweight live.

The errors committed by Packer B appeared to be about the same in individual cases as those committed by Packer A, although the range of errors for Packer B was smaller than that for Packer A. Packer B correctly evaluated 16% of the steers and 10% of the heifers it purchased. About 65% of the steers and heifers purchased were included in the range of error up to one dollar per hundredweight live. Errors as large as $3.50 per hundredweight were committed on steers and as large as $2.50 per hundredweight live were committed on heifers.

In summary, it is concluded that considerable individual errors occurred on the live purchased animals from both Packers. Yield errors as large as eight percentage points, grade errors as large as three

grades (the maximum possible in the study) and total price errors as large as $4.50 per hundredweight of live animal were observed. The proportion of animals estimated correctly in yield was as low as 10%, in grade, as low as 34% and in total price as low as 10%. The relative importance of grade errors to pricing accuracy was less than yield error from a pricing variability standpoint. The theoretical probabilities of errors of specified magnitudes also indicate considerable individual variation and therefore, redistribution of livestock payments was in fact, the case in the samples drawn.

Reference to Table 4 provides an estimate of the relative variability experienced by the packers and producers of the animals included in the study. The Standard Deviation of any particular class represents a measure of the variation experienced by the seller. The Standard Error of Estimate is a measure of the variation experienced by the packer if it is interested only in aggregate accuracy. It is obvious from Table 4 that the relative variation of errors is many times greater for the seller of individual animals than for the packer buying according to its mean errors.

4. ANALYSIS OF THE THIRD HYPOTHESIS

It was hypothesized that yield, grade and pricing errors would not be as great for animals sold directly to the packing plant as those sold by the auction method.

The hypothesis was tested in two ways. First the difference between the means of the errors was tested for information about the

relative location of the distribution of errors. Second, the difference between the correlation coefficients of estimated values and actual values was tested for each class to provide information about the relative accuracies of estimating in both cases. The results of the statistical significance tests on the means are given in Table 8, the results of the tests on the correlation coefficients in Table 9. The data is from Packer A since it was the only packer making both direct and indirect purchases.

A significant difference was found from the test of mean yield errors between direct and indirect steers. The mean error indirect was found to be -0.15 percentage points compared with +0.61 percentage points for the mean error direct. This difference was significant at $\alpha = 0.05$. The difference between the resulting price errors of \$-0.06 and \$+0.14 was found to be not statistically significant. The test of significance on the heifer class indicated statistical significance at $\alpha = 0.10$. The mean errors of yield, indirect and direct, were -0.13 and +0.94 respectively. The priced effect of these errors, \$-0.11 and \$+0.37, was significant at $\alpha = 0.10$. Hence, there would appear to be some indication of difference between mean yield errors direct and indirect. This difference however, is contrary to that hypothesized since the absolute magnitudes of the errors direct are greater than the absolute magnitudes of the errors indirect.

The mean grade errors for steers and heifers by the direct and indirect methods of purchase were all positive. No significant difference was found between the mean grade errors. An indication of differ-

TABLE 8

TESTS OF SIGNIFICANCE OF THE COMPARISON OF MEAN ERRORS FROM DIRECT AND INDIRECT PURCHASES OF PACKER A

	Sample Size	Mean Error Indirect	Sample Size	Mean Error Direct	Mean Difference	't'[a]
Yield						
Steers - %	79	-0.15	49	+0.61	0.76	2.11*
Price	60	$-0.06	38	$+0.14	$0.20	1.05
Heifers - %	24	-0.13	16	+0.94	1.07	1.75#
Price	13	$-0.11	16	$+0.37	$0.48	1.92#
Grade						
Steers - Grades	79	+0.26	99	+0.24	0.02	0.18
Price	60	$+0.37	38	$+0.14	$0.23	1.76#
Heifers -Grades	25	+0.76	16	+0.81	0.05	0.19
Price	13	$+0.89	16	$+0.75	$0.14	0.36
Total Price						
Steers - Price	60	$+0.31	38	$+0.29	$0.02	0.09
Heifers -Price	13	$+0.78	16	$+1.11	$0.33	0.61

[a] "*" denotes statistical significance at $\alpha = 0.05$

"#" denotes statistical significance at $\alpha = 0.10$

TABLE 9

TESTS OF SIGNIFICANCE OF CORRELATION COEFFICIENTS CALCULATED FROM DIRECT AND INDIRECT PURCHASES OF PACKER A

	Sample Size	Indirect Correlation Coefficient	Sample Size	Direct Correlation Coefficient	'Z'[a]
Yield Price					
Steers	78	.764	38	.882	1.90
Heifers	13	.959	16	.943	.66
Grade Price					
Steers	78	.871	38	.963	3.02**
Heifers	13	.829	16	.930	1.12
Total Price					
Steers	78	.566	38	.811	2.46**
Heifers	13	.627	16	.799	.60

[a] "**" denotes significance at $\alpha = 0.01$

ence in pricing error due to grade was found in the case of steers. The mean error of indirect steers was found to be $0.37 and the mean error of direct steers was $0.14. The difference of $0.23 was significant at $\alpha = 0.10$. This difference is attributable to the different price levels existing in the two methods of sale rather than the mean grade error itself. The mean pricing errors due to grade for heifers were not statistically different.

The strongest indication of rejection of the hypothesis on the basis of means is found in the lack of significance between the means of the total price errors. The mean total price error of steers indirect was $0.31, the mean total price error of steers direct was -$0.29. The $0.02 difference was not significant. Similarly, the difference for heifers of $0.33 was not significant.

The information in Table 9 indicates that the variability of pricing steers differs between the two methods of sale. The test of the difference between correlation coefficients was highly significant on both grade and total price. The difference was not significant on the yield prices although a considerable arithmetic difference was found. The opposite results were found in the test on the correlation coefficients from heifers. There were no significant differences although arithmetic differences were found.

Therefore, it appears that the relative accuracy of pricing differed between direct and indirect sales for steers but not for heifers. The differences between steers and heifers may be partly accounted for by the small numbers of heifers recorded but this does not seem to completely

explain the difference since the difference was well defined.

In summary, the information obtained indicates some differences between the direct and indirect methods of sale. There was evidence to support the conclusion that the packer experienced differences in yield errors between direct and indirect procurements but this evidence indicated that errors from direct purchases were the larger. In the remaining cases of grade and total price errors, there was no substantial indication of the hypothesized differences. Differences between the correlation coefficients calculated between estimated and actual evaluations indicated that steers purchased by the direct method were significantly different from steers purchased indirect and that the accuracy was greater for direct procurements. No such difference was found for heifers. Based on this information, it would appear that there are some differences in the relative accuracies between direct and indirect purchases but more information is required to define these differences.

5. ANALYSIS OF THE FOURTH HYPOTHESIS

It was hypothesized that yield, grade and price errors on the steer class are smaller than those errors on the heifer class. This hypothesis was tested in the same manner as the third hypothesis. A test of significance on the difference between the mean errors from steers and heifers provided a statistical test of the difference in the relative locations of the distributions of errors. A test of significance on the correlation coefficients between estimated evaluation and

actual value from steers and heifers was a test of the relative accuracy in each case. The results of the tests are given in Tables 10 and 11.

Visual appraisal of the results from Packer A indicates that mean errors from heifers are consistently larger than the errors on steers. However, this observation was supported statistically only in the case of grade errors, grade price errors and total price errors. The average differences between yield and yield price errors on steers and heifers were found to be 0.15 and $0.13 respectively, the errors on heifers being the larger of the two. The difference between mean errors on grade and grade price were found to be 0.47 and $0.53 respectively, errors on heifers being the larger. The differences for the grade analysis were highly significant. The total price error of $0.66 was also highly significant.

There was no indication from the data from Packer B that the mean errors of steers and heifers differed. Although a mean difference of 0.83 was found in yield errors, this value was not statistically significant. Only in the case of yield errors was the calculated size of errors for steers smaller than those from heifers.

Comparison of the correlation coefficients from Packer A resulted in only one significant difference: the high correlation coefficient for heifers yield price (0.958) was found to be significantly different from the same coefficient for steers (0.813) suggesting greater accuracy for heifers. The comparisons from grade price and total price errors were not statistically significant, although in each of these cases, as

TABLE 10

TESTS OF SIGNIFICANCE OF THE COMPARISON BETWEEN MEAN ERRORS ON STEERS AND HEIFERS FROM PACKER A AND PACKER B

		Mean Error Steers	Mean Error Heifers	Difference	't'[a]
PACKER A					
Yield	%	+0.15	+0.30	0.15	.41
	Price	$+0.02	$+0.15	$0.13	.76
Grade	Grade	+0.29	+0.76	0.47	3.44**
	Price	$+0.28	$+0.81	$0.53	3.14**
Total Price	Price	$+0.30	$+0.96	$0.66	2.48**
PACKER B					
Yield	%	-1.13	-1.96	0.83	1.26
	Price	$-0.55	$-0.80	$0.25	.82
Grade	Grade	-0.31	-0.10	0.21	1.38
	Price	$-0.04	$-0.05	$0.01	0.22
Total Price	Price	$-0.59	$-0.85	$0.26	0.75

[a] "**" denotes significance at $\alpha = 0.01$.

TABLE 11

TESTS OF SIGNIFICANCE ON CORRELATION COEFFICIENTS CALCULATED FROM STEERS AND HEIFERS PURCHASED BY PACKER A AND PACKER B

	Sample Size	Correlation Coefficient Steers	Sample Size	Correlation Coefficient Heifers	'Z'[a]
PACKER A					
Yield Price	138	.813	41	.958	4.25**
Grade Price	138	.906	41	.901	0.16
Total Price	138	.672	41	.780	1.25
PACKER B					
Yield Price	100	.215	10	.582	1.14
Grade Price	100	.989	10	.942	2.27**
Total Price	100	.160	10	.481	0.66

[a] "**" denotes significance at $\alpha = 0.01$.

in the first, the value was higher for heifers than steers.

The comparison of correlation coefficients on the price data from Packer B showed only one significant difference; between grade prices. Both values were very high, 0.989 for steers and 0.942 for heifers. The difference between yield prices and total prices were not significant.

Hence, it was shown that although the mean yield errors from steers and heifers for both packers did not differ, there was indication that there was less accuracy in steers than heifers for Packer A. The relative accuracies were not statistically different for Packer B. This information is contrary to the results hypothesized. The mean grade errors from Packer A were found to be different as hypothesized, but the relative accuracy of estimate was about the same for steers and heifers. No difference in the mean grade errors was found from Packer B but the accuracy of estimate was greater for steers than for heifers. The mean total price errors were found to be statistically significant, the mean errors on heifers being larger for Packer A, but there was no detectable difference in the relative accuracies of estimate. The data from Packer B indicated no differences in mean errors or accuracy of estimate between steers and heifers indicating that accuracy of pricing steers and heifers in that firm did not differ.

6. ANALYSIS OF THE FIFTH HYPOTHESIS

It was hypothesized that evaluation errors committed on grade would be unfavorable to the producer of high quality animals and favorable to the producer of low quality animals. Restated, this hypothesis would suggest that high quality animals would be consistently undervalued and low quality animals would be consistently overvalued.

Test of this hypothesis was made difficult by two factors. First, since the grade designations are discrete there is no continuum over which to select values. Second, since only four possible grade designations were included in the study the extremes of grade were in effect, non-existent. The top and bottom grades included a large proportion of the total number of animals. In the case of Packer B, only two grades were available, hence the top and bottom grades included all the animals.

The only method of test available was that of calculating expected ranges for both actual and estimated evaluations by use of the mean and standard deviation of each distribution. It was necessary to assume that the distributions were normal. The range for ninety-five per cent of the observations was calculated for both Normal Price and Attempted Price. This information is summarized in Table 12.

If the range of the Attempted Prices is smaller than and within the range of the Normal prices, this could be considered as evidence in support of the hypothesis. However, it is not conclusive evidence since the errors themselves are not considered by this method. However,

TABLE 12

THEORETICAL RANGE FOR ACTUAL AND ESTIMATED GRADE PRICES[a]

	Theoretical Range	Size of Range
PACKER A		
Steers - Estimated Grades	$21.95 - $28.03	$6.08
Actual Grades	$21.44 - $27.96	$6.52
Heifers - Estimated Grades	$17.78 - $25.66	$7.88
Actual Grades	$16.47 - $25.37	$8.90
PACKER B		
Steers - Estimated Grades	$24.69 - $26.81	$2.12
Actual Grades	$24.42 - $28.26	$3.84
Heifers - Estimated Grades	$22.57 - $25.99	$3.42
Actual Grades	$22.64 - $26.02	$3.38

[a] Range within which 95% of animals would fall if Estimated Evaluation and Actual Evaluation were normally distributed.

for the reasons mentioned this was the only feasible method of testing the hypothesis.

It is seen from Table 12 that in all cases except one, the range of the Attempted Prices is smaller than, and within the range of the Normal Prices. The exception is found in Packer B, heifer purchases, which was based on a very small sample. In this case the ranges are almost identical at both extremes.

Therefore, the limited information available would tend to support the hypothesis of undervaluation of the high quality animals and overevaluation of the low quality animals, but further study is required to establish this relationship.

7. ANALYSIS OF THE SIXTH HYPOTHESIS

It was hypothesized that evaluation errors would be unfavorable to the producers of high yielding animals and favorable to the producers of low yielding animals. Stated more generally, it is hypothesized that high yielding animals are consistently undervalued and the low yielding animals are consistently overvalued.

The analysis of this hypothesis was considerably more meaningful than the analysis of the previous hypothesis. Two methods of analysis were possible, the results of which are presented in Tables 13 and 14. The operation of calculating ranges in which 95% of the observations of both Normal and Attempted Prices would fall was performed, the results being given in Table 13. In addition, means of the Normal

and Attempted prices from the upper and lower one-fifth of the true yields were calculated. The differences between the means of the Attempted and Normal prices so calculated at each extreme was tested for statistical significance. The results of these operations are summarized in Table 14. If statistical significance were found for the differences between Normal and Attempted prices at each extreme, and if the means of the Attempted Prices fell within the means of the Normal Prices, this would be further evidence in support of the hypothesis.

The evidence presented in Table 13 is, without exception, in support of the hypothesis of consistent overvaluing and undervaluing animals at the extremes. In every case the expected range of the Normal Prices is larger than and brackets the range of the Attempted Prices. In only one case, Heifers from Packer B, the two ranges differ only slightly. In this exception, the close values occur only at the lower end of the range and since this was based on only ten observations, it can not be considered as indicative contrary evidence.

Reference to Table 14 reveals that in all but one comparison, the hypothesis would be supported. However, not all the differences at the extremes were found to be statistically significant. The hypothesis is supported statistically on the purchases of steers from both packers based on twenty observations at each extreme. However, in the case of heifers, significance was found only for the upper extreme from Packer B. But, since these tests were based on only two observations from Packer B, and three from Packer A, the absence of significance is probably due to

TABLE 13

THEORETICAL RANGE FOR ACTUAL AND ESTIMATED YIELD PRICES[a]

	Theoretical Range	Size of Range
PACKER A		
Steers - Estimated Yield	$22.21 - $27.27	$5.06
Actual Yield	$21.44 - $27.96	$6.52
Heifers - Estimated Yield	$17.51 - $24.71	$7.20
Actual Yield	$16.47 - $25.37	$8.90
PACKER B		
Steers - Estimated Yield	$24.83 - $26.75	$1.93
Actual Yield	$24.42 - $28.26	$3.84
Heifers - Estimated Yield	$22.63 - $24.43	$1.80
Actual Yield	$22.64 - $26.02	$3.38

[a] Calculated by assuming that Actual and Estimated Yield prices were normally distributed. The range within which 95% of the values would be expected to fall is given.

TABLE 14

TESTS OF SIGNIFICANCE ON DIFFERENCE BETWEEN MEANS OF NORMAL PRICES AND ATTEMPTED PRICES OF HIGH AND LOW VALUED ANIMALS[a]

	Number of Observations		Mean Normal Price	Mean Attempted Price	Differences	't'[b]
PACKER A						
Steers	Low 20%	20	22.58	23.79	1.21	2.16*
	Hi 20%	20	26.32	25.29	1.03	3.12**
Heifers	Low 20%	6	18.90	20.05	1.15	1.32
	Hi 20%	6	24.55	23.82	.73	1.15
PACKER B						
Steers	Low 20%	20	25.19	25.63	0.44	3.26**
	Hi 20%	20	27.79	25.90	1.89	12.04**
Heifers	Low 20%	2	23.25	23.02	0.23	0.32
	Hi 20%	2	25.68	23.96	1.72	4.91*

[a] The "high" valued animals were considered to be the highest 20% of the true yields and "low" valued were considered to be the lowest 20% of the true yields.

[b] "*" denotes significant at $\alpha = 0.05$.

[c] "**" denotes significant at $\alpha = 0.01$.

the small sample size.

In summary, the two analyses considered jointly provide strong evidence that yield errors result in undervaluation of the high yielding animals and overvaluation of the low yielding animals.

CHAPTER V

SUMMARY AND CONCLUSIONS

1. THE LIMITATIONS IN RETROSPECT

It was mentioned early in the report that the study was, of necessity, limited to a case study of two St. Boniface Packing Plants. No attempt was made to compare the results of the two plants but apparent differences were noted in passing. Originally, the second packing plant was included only on the strong recommendation of certain members of the livestock trade who felt bias would be avoided by sampling two plants. On analysis, some interesting points for further study were revealed by inclusion of the second plant.

It was stated that the study was limited to the classes of animals estimated to grade Red, Blue and Brown carcasses. Since generalization is limited only to the classes sampled, this limitation was a problem only in the case of heifers where insufficient numbers were obtained for comprehensive analysis. Further, the limited number of grades sampled prevented a comprehensive analysis of the fifth hypothesis.

The short time period sampled was a limitation in two ways. First, since the sampling was done at a time when slaughter animals of the desired type were in short supply, inadequate numbers were obtained in some samples. Second, the influence of the grass-fed condition on the incidence of grade errors was not measurable. Whether this significantly affected the grade results is not known. Similarly, the effect of high

price levels on the relative size of yield errors and grade errors was not numerically considered.

In summary, the most serious limitation affecting the study was the inability to obtain larger sample sizes. Further statistical analysis and more information would have been available if sample sizes could have been increased, particularly in the heifer classes.

2. CONCLUSIONS

One of the most important findings of this study is the successful use of an identification system to maintain individual identity of animals. Once the method of identification had been adopted and was understood by all concerned, the method worked satisfactorily. Although improvements would be required for its use if it were to be adopted commercially, it proved to be a satisfactory method of gathering data for research purposes. Furthermore, the sampling indicated that cooperation for research in this field is readily secured from most firms. A deep interest was shown by the people in the livestock industry toward the study.

The analysis of the data supplied satisfactory information only in four problem areas. First it was found that mean yield, grade and price errors are not always zero, nor was the packer always protected against estimation errors on purchases in a given time period. Second, it was found that considerable individual errors do occur and that this can result in large losses and gains to sellers of individual animals. Third, fairly conclusive evidence was found to indicate that, in yield

errors at least, the live-purchasing method leads to inefficiency in undervaluing the exceptionally high yielding animals and overvaluing the low yielding animals. There was some evidence that the same result occurs from grade errors. Fourth, there was indication of considerable differences between the Packers as to buyers abilities to evaluate animals accurately. No attempt was made to study these differences but their existence was apparent in most of the results.

Evidence in support of, or contrary to, the hypotheses on a comparison of direct and indirect deliveries, and steers and heifers was not conclusive. Differences were noted between direct and indirect deliveries and some of the differences were statistically significant. Similarly, in some cases, steers were found to have less error than heifers. However, more study and larger samples are necessary to determine definite relationships in these areas.

The comparison of the effect on pricing of yield and grade errors did not reveal any particular pattern. The range of error due to yield seemed to be larger than the range due to grade. The means of each source of error, however, showed grade larger in some cases, yield larger in others.

In summary, the study indicates that, for the two packers studied, yield and grade errors both on an individual and average basis do exist and are important sources of pricing inaccuracies. From the standpoint of pricing individual animals, this study indicates that the live sale method of selling cattle does not meet the criterion of efficiency by which the same price is paid for the same commodity at the same time.

It is therefore concluded that improvements in the economic efficiency of selling cattle may be possible. However, further study of alternative methods of sale is necessary before the improvements could be implemented.

3. RECOMMENDATIONS FOR FURTHER STUDY

The present study provides a satisfactory method of securing data for this type of research and indicates several problem areas for further study.

One of the inefficiencies of the live sale method of marketing slaughter cattle has been analyzed and an approximation of the resulting price errors made. Other factors however, must be quantified and/or considered to properly evaluate the relative efficiency of the live sale method. These factors include: (1) relative costs of live sale and alternative methods of sale, (2) claimed loss of freedom to bargain which is available in the live sale method, and (3) general degree of satisfaction by processor and producer with the present live sale method. Policy and legislation aimed at improving livestock marketing efficiency would be premature and haphazard without quantification of these factors. Therefore, it is recommended that a study of several packing plants, of all types of cattle and over a longer time period be made. The study could be designed to test all of the factors mentioned.

An apparent difference was pointed out in the ability of the two packing plants to appraise live animals. A study of this difference may reveal methods of improving accuracy of evaluation under the present

live sale method of marketing.

Further, a difference in Attempted prices was noted between the two packers on purchases made on the same grades of animals in the Public Markets Limited. Since these purchases were made by the one firm in competition with the other on the same animals, this difference may point out imperfections in the claimed high degree of competition involved in sales by the auction method. However, it may also indicate imperfections in the present Grade Standards. It is therefore recommended that this problem be analyzed to determine which, if either, of the suggested causes is involved.

Finally, since large numbers of animals are sold in groups or "Lots", the results of this study may not truly represent the error position of many sellers. A study of the accuracy of pricing lots would, in conjunction with the results of this study, give a more complete picture of live sale pricing accuracy.

BIBLIOGRAPHY

BIBLIOGRAPHY

I BOOKS

Marshall, Alfred, Principles of Economics, London: Macmillan and Company Ltd., 1961.

Ostle, B. Statistics in Research, Ames, Iowa: The Iowa State College Press, 1956.

Steel, R.D.G. and Torie, J.H. Principles and Procedures of Statistics, New York, Toronto, London: McGraw-Hill Book Company Inc., 1960

II BULLETINS AND PERIODICALS

Carmichael, J.S., Rackham, T.S. Livestock Marketing In Western Canada, Research and Statistical Services, Department of Co-operation and Co-operative Development, Regina, Saskatchewan.

Chown, W.F., Hudson, S.C. and Lewis, J.N. The Direct Marketing of Live Stock. Ottawa: Publication No. 726, Farmers' Bulletin No. 107, Marketing Service, Economics Division, Canada Department of Agriculture, November, 1941.

Dowell, Austin A; Engelman, Gerald; Ferrin, Evan F. and Anderson, Phillip A. Marketing Slaughter Cattle By Carcass Weight And Grade. University of Minnesota Agricultural Experimental Station, Technical Bulletin 181, February, 1949

Maybee, H.J. Beef and Veal Grading In Canada. Livestock Division, Marketing Service, Canada Department of Agriculture, Ottawa, December, 1955.

Livestock Marketing In Manitoba. Report of the Select Committee of the Legislative Assembly of Manitoba. February, 1964

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

The Canada Gazette. Part II, Volume 92. Ottawa, August 13, 1958. No. 15.

An Analysis of the Accuracy of the Present Method of Pricing Livestock. Members of the North Central Livestock Marketing Research Committee.

Canada's Largest Public Market. Bulletin published by the Union Stockyards, St. Boniface, Manitoba.

Livestock Market Review. Markets Information Section, Production and Marketing Branch, Canada Department of Agriculture, Ottawa.

APPENDIX

APPENDIX A

EXCERPT FROM BEEF GRADING REGULATIONS[1]

LIVESTOCK AND LIVE STOCK PRODUCTS ACT

The following is an excerpt from the Beef Grading Regulations and defines the grades analyzed in the thesis. The purpose of its inclusion is to point out the subjective nature of the standards. This subjectivity may compound the difficulty of the livestock buyer to estimate the carcass grade of a live animal. Some of the terms such as "excellent conformation", "relatively blocky", "good conformation", "the neck short and thick" are qualitative terms but probably have objective connotation to experienced graders and livestock buyers. However, terms such as "at least moderately firm", "low medium conformation", "slightly less meaty" are highly subjective in interpretation and application to any given animal. Similar qualitative terms will be noted in the text of the following excerpt.

"The standards for the grades for beef carcasses established by section 3 of these Regulations are as follows:

1. Canada Choice beef carcasses are beef carcasses from steers and heifers having the following characteristics:

(a) excellent conformation, finish and quality, relatively blocky, heavily and uniformly fleshed, the neck short and thick, and the shanks fully muscled;

(b) the flesh is firm, velvety, fine grained and of a light or cherry red color;

(c) the bones are soft, red and porous when split, there are pearl-like capping cartilages on the lumbar vertibrae,

---

[1] The Canada Gazette Part II, Volume 92, August 13, 1958, p. 826.

and marked indications of youth in the chine, sternum, sacrum, and aitch bones, except that the cartilages may have slight granulation in the upper dorsal area;

(d) the exterior surfaces of the carcasses are covered with firm fat, white or slightly tinged with reddish or amber color, which is for the most part smooth and uniform in color; and

(e) the degree of finish may increase with the carcass weight but there is no excess proportion of fat at any weight.

2. Canada Good beef carcasses are beef carcasses from steers and heifers having the following characteristics:

(a) good conformation, finish, and quality; hips, loins and ribs, chucks and plates slightly less meaty than for Canada Choice; neck may be slightly less short and thick than for Canada Choice;

(b) flesh at least moderately firm, not excessively dark;

(c) the maximum bone maturity is the same as for Canada Choice;

(d) the fat covering extends well over exterior surface but may be somewhat lacking on the neck and lower parts of the hips and shoulders, and is firm, or slightly soft, smooth and white, or having a yellowish tinge; and

(e) the degree of finish may increase with carcass weight, but there is no excess proportion of fat at any weight.

3. Canada Standard beef carcasses are beef carcasses from steers and heifers having the following characteristics:

(a) top medium or better conformation, finish and quality; may have slightly less depth of fleshing in ribs, loins, and hips, than Canada Good; only a slight tendency to angularity with hip and shoulder points no more than barely noticeable;

(b) flesh at least moderately firm with the color ranging from bright red to somewhat darker;

(c) same maximum bone maturity as for Canada Choice;

(d) fat covering not exceeding the average of Canada Good, and at least a light covering extending over most of the exterior surface, fat covering firm to slightly soft and of a white to pale yellow color; and

(e) there is no excess proportion of fat.

4. Canada Commercial--Class 1 beef carcasses are beef carcasses of steers and heifers having the following characteristics:

(a) low medium conformation, finish and quality, relatively long in proportion to width and inclined to be slightly angular, with hip and shoulder points noticeable but not prominent;

(b) moderate fleshing but somewhat less than the minimum for Canada Standard;

(c) same maximum bone maturity as for Canada Choice;

(d) at least a light fat covering over most of the exterior surface, with the same maximum as for Canada Choice; and

(e) there is no excess proportion of fat.

5. Canada Commercial--Class 2 beef carcasses are beef carcasses from young cows and aged heifers having the following characteristics:

(a) the conformation, and finish are at least equal to that of Commercial Class 1; the hips are moderately thick, loins somewhat flat, rib, chuck and plate moderately well covered; there is progressively better conformation as age approaches the maximum;

(b) the flesh is firm, fine grained and of good color;

(c) the hind quarters have cartilage on the tips of the lumbar vertebrae or a red line where the cartilage was present, indicating that ossification was only recently completed, and on the front quarters, while there may be considerable ossification, some pearl-like cartilage is evident on the tip of the dorsal vertebrae and the sternum bone;

(d) the exterior fat extends well over the carcass, with the same maximum as for Canada Choice; and

(e) the fat is firm, and creamy to yellowish in color.

6. Canada Commercial--Class 3 beef carcasses are beef carcasses of steers, heifers and young cows having the following characteristics:

(a) overfat and wasty;

(b) conformation superior to Canada Utility; and

(c) maximum bone maturity same as for Canada Commercial Class 2."