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ALTERNATIVE PORK CARCASS EVALUATION PROCEDURES IN REFERENCE TO THE CANADIAN INDEX 100 SYSTEM

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INTRODUCTION

1.1 FOCUS OF THE STUDY

1.1.1 Quality, Differential Pricing, and Pricing Efficiency With Respect to Grading

Pricing efficiency in the slaughter hog market refers to the ability of prices paid for slaughter hogs to communicate the packing industry's preferences for slaughter hogs to producers. Two alternative meanings can be attached to the term "packers' preferences for slaughter hogs". Packers' overall derived demand for slaughter hogs is determined by the demand of consumers for retail pork and pork products. The interaction of this derived demand with the primary supply of slaughter hogs determines the overall market price, or "base price" for slaughter hogs in a given market.[1] The base price will be affected by factors (from the demand side) such as income levels of consumers, prices of substitute products, health fads, population changes, and/or (from the supply side) changes in swine production technology, prices of alternative outputs, and input prices.

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[1] In Canada, slaughter hogs are sold on a carcass weight and grade basis. This method is preferred over live animal sales because it eliminates the need to predict the dressing percentage of live hogs, a procedure made difficult by the practice of "filling" a live animal with feed immediately prior to delivery. In addition, carcass grading facilitates a more accurate determination of the potential yield of the carcass and the eating quality of the pork meat.

Alternatively, "packers' preferences for slaughter hogs" also refers to the fact that the unique physical traits of an individual pork carcass can make it either more or less desirable in comparison to other pork carcasses. For example, a carcass with a higher lean-to fat ratio, or with a higher percentage yield of the more valuable pork cuts (such as the loin or hams) will be of greater utility to packers. Naturally, such carcasses will be of greater net value to packers, and will be preferred over carcasses whose potential net value is smaller. (The potential net value [per kg.] of a pork carcass is determined by the percentage yields of its various component parts, the prices received for these parts, and the cost of transforming the live animal into wholesale-ready form). A price premium is paid for such preferred grades,[2] over and above the current base price, while prices are discounted for animals whose potential net value is below average. These premiums and discounts constitute the "grade-prices" paid for slaughter hogs.

In 1969, Rawls[3] determined the appropriate (i.e., efficient) relationship of prices for differing grades of animals in comparison to their net values to the packer. With net values defined as gross value less processing costs, plus an allowance for "normal" profit on the part

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[2] An excellent definition of grading appears in J.H. McCoy, Livestock and Meat Marketing, second edition, (Westport, Conneticut: Avi Publishing Co. Inc., 1979), p. 283. McCoy states that "[g]rading is the segregation of units of a commodity into lots, or groupings, which have a high degree of uniformity in specific attributes associated with market preferences and valuation". It follows that grades for pork carcasses should create an understanding among producers and packers as to the physical characteristics of carcasses, so as to facilitate differential economic valuation in accordance with their physical attributes.

[3] E.L. Rawls, "A Theoretical and Procedural Approach to Estimating the Differential Values of Pork Carcasses and Live Hogs," (unpublished Ph.D. dissertation, Virginia Polytechnic Institute, 1969), pp. 27-58.

of packers, the efficient relationship between net value and price is described as follows:

> The prices P1 and P2 for hogs of Grades 1 and 2 are determined by the interaction of supply and demand in the marketplace. If at a given point in time and space the price of Grade 1 (P1) equals the price of Grade 2 (P2), the processor should continue to purchase and process each grade until NV1 (net value of Grade 1) = P1 = NV2 (net value of Grade 2) = P2. If Grade 1 has a greater yield of the higher value parts than Grade 2 and/or can be processed for a lower marginal cost than Grade 2 causing NV1 > NV2, then if the market is in equilibrium, P1 should exceed P2 by the same amount. In equilibrium, the difference in the net value for the two grades should be equal to the difference in their prices. If the net values do not equal the difference in prices, the firm is not maximizing its profits, and price differences are not reflecting the true differences in the value of the two grades to the processor.[4]

If the price for a given grade is viewed as consisting of both a base-price and a grade-price, the above conclusions can be extended by applying them to each of the two components of price.

The market, or base price, reflects the overall desire of packers to purchase slaughter hogs. As such, it reflects the average net value per unit weight (with net value defined to include an allowance for "normal" profit) that packers expect to obtain through their pork operations. To be efficient, the base price at a given time should equal the average net value obtained from all pork carcasses for that time period. That is, packers should not be able to earn excess profits on their overall pork processing operations. An examination of pricing efficiency in the slaughter hog market would, in this case, require an analysis of the structure, conduct, and performance of the packing industry. However, the focus of the present study is on grading and differential pricing with respect to grades. Therefore, the base price is not of concern.

[4] Ibid., pp. 56-57.

Rather, the emphasis is on grade-prices; the price premiums or discounts associated with specific grades. Applying Rawls' conclusions to grade-pricing, efficient grade-prices are those which exactly reflect the net value differentials between grades. Thus, the focus of this study is the examination of the extent to which various pork carcass grading and pricing systems in Canada and the U.S. are able to establish grade-prices equalling the net value differentials between grades.

1.1.2 Comparing Canadian and U.S. Grade-Pricing Systems

Comparing the development of pork carcass evaluation procedures in Canada and the United States, as well as the existing and proposed procedures in these respective sectors, the differences between alternative procedures can be classified as belonging to two general types. Differences exist in the form of i) grade-pricing "policies" (i.e., the "course or method of action selected to guide and determine present and future decisions"[5]) followed, and ii) grade-pricing "mechanisms" (i.e., the "process[es] or technique[s] for achieving a result"[6]).

Two major policy areas are presented below to describe, by way of example, what is meant by "grade-pricing policies". In some instances, grade standards are used solely for the purpose of describing the physical attributes of an animal (i.e., for grading only), with the process of establishing differential prices being left to market forces. Alternatively, in Canada, and in some U.S. packing plants, grade standards

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[5] H.B. Wool, ed. in chief, The Merriam-Webster Dictionary, (Markham, Ontario: Simon and Schuster of Canada, Ltd., 1974), p. 434.

[6] Ibid., p. 537.

are used to sort hogs according to quality (i.e., potential net value) and also to assign the price differentials associated with the various grades. Any such systems, which both grade carcasses and assign grade-prices to them are hereafter referred to as "grade-pricing systems".

A second policy area exists in regards to the implementation of compulsory grade-pricing systems for packers. Since 1932, Canada has employed a policy of grading all hogs according to official, compulsory grade standards. The motive for an official, compulsory system stems from an early objective of the Canadian hog/pork sector; developing a uniform slaughter hog population, with the intent of making Canadian pork a more desirable commodity as viewed by pork importing countries. In comparison to the compulsory grading system used in Canada, the United States Department of Agriculture's (USDA) official grades are not compulsory, and in fact seldom are used by U.S. packers. Instead, packers are allowed to develop and implement their own grade-pricing systems according to their own individual preferences.

The grade-pricing policies adopted in a hog/pork sector are determined by the objectives of that sector (e.g. establishing a uniform hog population) and/or its philosophy towards government intervention in the market place. It was not the intent of this study to evaluate the objectives or philosophies of the Canadian and U.S. sectors. Rather, the focus was on the mechanisms (i.e., processes or techniques) by which differential prices can be assigned to carcasses of different physical type. Generally, carcass measurements of backfat and weight have been used (and muscle thickness measurements have been proposed) as a basis for estimating the potential net value of individual carcasses. This first requires that the relationship of the chosen carcass measurements to carcass quality be estimated. Alternative grade-pricing mechanisms in Canada and the U.S. differ, however, in i) the carcass measurements used to indicate carcass quality, and ii) the procedure used in estimating the relationship of carcass quality to the chosen carcass measurements. In light of these differences, this study focuses on an examination of the effect of the two factors mentioned above on the ability of a grade-pricing system to assign efficient grade-prices to pork carcasses.

1.2 OBJECTIVES OF THE STUDY

By applying various sets of carcass measurements and various estimating procedures to a common data set, an evaluation of how these factors affect the ability of a grade-pricing mechanism to assign efficient grade-prices was achieved. From this information, means for improving the performance of the Canadian Index 100 grade-pricing system were examined.

Three major objectives were established for this study. These were:

1. to compare the ability of alternative grade-pricing mechanisms to establish efficient grade-prices for pork carcasses, with the subsequent objective of
2. determining whether the grade-pricing performance of the Canadian Index 100 system could be improved through modification of its grade-pricing mechanism.

3. To assess the practical implications and feasibility of any such modifications to the Index 100 system.

Chapter II

DEVELOPMENT OF TESTABLE HYPOTHESES

2.1 ALTERNATIVE GRADE-PRICING PROCEDURES

A number of studies have recognized that seasonal fluctuations in the wholesale prices paid for pork cuts affect the relationship of carcass value to carcass measurements such as backfat and weight. In a recent U.S. study, the National Pork Producers Council (NPPC) noted the possible desirability of adjusting the grade-price premiums and discounts associated with carcass weight in response to seasonal fluctuations in the weight-based discounts for wholesale pork cuts.[7] In an earlier study, U.S. researchers Ikerd and Cramer proposed a system by which seasonal adjustments to the premiums and discounts could be determined based on current wholesale pork prices.[8] These and other studies thus had indicated that seasonal adjustments to a grade-pricing system for pork carcasses may serve to improve grade-pricing efficiency. This hypothesis was addressed in this study as follows:

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[7] Pork Value Task Force Report - Technical Appendix, undated, primary authors M. Hayenga (Iowa State University), R. Kauffman and B. Grisdale (University of Wisconsin), pp. 13-16.

[8] J.E. Ikerd and C.L. Cramer, "A Practical Computer Method for Pricing Pork Carcasses and Hogs", American Journal of Agricultural Economics, vol. 52, 1970, pp. 242-246.

1. Adjustment of the grade-price premiums and discounts associated with carcass measurements in response to short term fluctuations in wholesale pork prices has no significant effect on grade-pricing efficiency.

North American pork carcass evaluation procedures have also responded to factors of a more long term nature. For example, grade-pricing standards for pork carcasses in both Canada and the U.S. continually have been updated in response to trends in consumer preferences (which are reflected in wholesale pork prices) and in the physical traits of the hog population. However, these revisions have not occurred regularly. For example, the Canadian Index 100 grade-index table was revised in 1978, then again in 1979, but thereafter remained unchanged until March, 1982; a period in excess of two years.

It is unclear as to how often a grade-pricing system should be adjusted in response to trends in wholesale pork prices and in the physical traits of the hog population if grade-prices assigned by the system are to closely reflect the actual value differences between carcasses. In light of this uncertainty, the following hypothesis was addressed:

2. Adjustment of the grade-price premiums and discounts associated with carcass measurements in response to underlying trends over time in wholesale pork prices and to the physical trends in the hog population has no significant effect on grade-pricing efficiency.

The relationship of carcass value to carcass measurements also has been recognized as being unstable when observed over subsamples of specific carcass types. For example, in the Index 100 table of grade indices, the pattern of the discounts associated with incremental increases in backfat varies according to carcass weight range (see Figure 2.1a). Alternatively, the NPPC's Pork Value Guide grade index table maintains a constant index-discount for increasing backfat for all carcass weight ranges (see Figure 2.1b). How much, if anything, does the NPPC guide give up in terms of grade-pricing efficiency by not applying the principle followed in the Index 100 system? The following hypothesis addresses this question:

3. Grade-pricing efficiency is not affected significantly when the grade index premiums or discounts associated with incremental differences in carcass measurements are adjusted according to carcass backfat or carcass weight range.

2.2 ALTERNATIVE SETS OF CARCASS MEASUREMENTS

Six alternative sets of carcass measurements were examined to determine their respective abilities to indicate the economic value of pork carcasses. Since the measurement of carcass weight is required to determine total payment for a carcass, warm carcass weight was included in each of the six combinations. The sets of carcass measurements described below each were used, in conjunction with carcass weight, as a basis for carcass evaluation.

1. The sum of maximum backfat thickness over the shoulder and loin (measured in inches using a ruler). This was the measurement used in the Index 100 system prior to March, 1982.

A) Index 100

Loin Fat Thickness (inches)

Carcass Wt. (lb.)	<0.8	0.8	0.9	1.0	1.1	1.2	1.3
i) 140-149	108	107	105	103	102	100	98
ii) 150-159	110	108	107	105	103	102	100
iii) 160-169	113	112	110	108	107	105	103
iv) 170-179	114	113	112	110	108	107	105
v) 180-189	113	112	110	108	107	105	103
vi) 190-199	112	110	108	107	105	103	102
vii) 200-299	90	90	90	90	90	90	90

B) NPPC Pork Value Guide

Last rib fat thickness (inches)

Carcass Wt. (lb.)	0.7	0.8	0.9	1.0	1.1	1.2	1.3
i) 146-153	104	103	102	101	100	99	98
ii) 154-161	104	103	102	101	100	99	98
iii) 162-168	104	103	102	101	100	99	98
iv) 169-175	103	102	101	100	99	98	97
v) 176-182	102	101	100	99	98	97	96
vi) 183-190	101	100	99	98	97	96	95
vii) 191-197	100	99	98	97	96	95	94
viii) 198-204	99	98	97	96	95	94	93
ix) 205-212	98	97	96	95	94	93	92

Figure 2.1: Backfat Discounts -- Index 100 vs. NPPC Guide

2. A single measurement of maximum backfat thickness over the loin (measured in inches using a ruler). This measurement currently is used in the Index 100 grade-index table.

3. A single backfat measurement over the last rib, 70 millimeters (mm.) off the dorsal midline (measured in mm. using an electronic probe). The NPPC Pork Value Task Force used a last rib fat measurement in constructing their "Pork Value Guide" grade-index table.

4. A single backfat measurement over the 3-4th last rib interface, 70 mm. off the dorsal midline (measured in mm. using an electronic probe). A recent Agriculture Canada study showed this measurement provided superior predictions of lean yield in comparison to last rib fat thickness.[9]

5. The last rib backfat measurement described above, plus an accompanying measurement of muscle depth at the last rib (measured in mm. using an electronic probe).

6. The 3-4th last rib backfat measurement described above, plus an accompanying measurement of muscle depth at the 3-4th last rib (measured in mm. using an electronic probe).

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[9] A. Fortin, S.D.M. Jones, and C.R. Haworth, "Test of Electronic Probes for Grading Hog Carcasses", a report prepared for a Canadian Steering Committee on Electronic Hog Grading, Oct. 22, 1982.

This study also examined probe sites at the 4-5th and 5-6th last ribs, using the same electronic probe. When the same probe was used on the last rib, 3-4th, 4-5th, and 5-6th last rib sites, the 3-4th rib site was slightly superior in predicting commercial yield. For this reason, of the 3-4th, 4-5th, and 5-6th rib sites, only the 3-4th rib site was examined in the current study.

Hereafter, these combinations are referred to as "trials" 1 through 6, respectively.

A recent study by Agriculture Canada animal scientists[10] showed 3-4th last rib fat and muscle thickness produced slightly higher R-square values in comparison to last rib fat and muscle thickness, using carcass yield as the dependent variable. Similarly, last rib fat and muscle thickness produced higher R-square values in comparison to 3-4th last rib fat thickness alone, which produced higher R-square values in comparison to last rib fat thickness alone. In an earlier study,[11] a single (ultrasonic) fat measurement at the last rib was found to produce higher R-square values in comparison to a sum measurement of fat thickness at the loin and shoulder, which in turn produced a higher R-square than did a single fat thickness measurement at the loin (again with carcass yield as the dependent variable).

Based on the findings of the research cited above, the six combinations of carcass measurements of interest in this study can be ranked in terms of their ability to predict carcass yield. In descending order, the ranking is: trial 6, trial 5, trial 4, trial 3, trial 1, and trial 2.

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[10] Ibid.

[11] A. Fortin, A.H. Martin, D.W. Sim, H.T. Fredeen, and G.M. Weiss, "Evaluation of Different Ruler and Ultrasonic Measurements as Indices of Commercial and Lean Yield of Hog Carcasses for Commercial Grading Purposes", Canadian Journal of Animal Science, vol. 61, Dec., (1981), p. 898.

It is plausible that a similar ranking would result from comparing the ability of these meassurements to predict the economic value of carcasses as opposed to physical carcass yield. However, the relationship of carcass dollar value to carcass yield is itself dependent upon wholesale prices for pork cuts. As a result, one cannot say with certainty that a ranking of various carcass measurements' ability to predict carcass yield will necessarily coincide with a ranking of their ability to predict the economic value of carcasses. Therefore, the following hypothesis was considered:

1. Ranking carcass measurements according to their ability to explain carcass value will produce the same result as ranking carcass measurements according to their ability to explain carcass yield.

In addition to ranking these carcass measurements' ability to predict carcass value, of interest was the degree to which the various carcass measurements differed in terms of their ability to contribute to grade-pricing efficiency. That is, the following hypothesis was addressed:

2. The choice of carcass measurements used in a grade-pricing system has no significant effect on the ability of that system to predict the economic value of pork carcasses.

Chapter III

DESCRIPTION OF DATA AND EXPERIMENTAL DESIGN

3.1 CALCULATING NET VALUE DIFFERENTIALS FOR THE SAMPLE CARCASSES

3.1.1 Carcass Cutout Data

To facilitate the empirical tests required for the hypotheses presented, pork carcass cutout data and wholesale pork prices were required. The cutout data were obtained from Agriculture Canada, and were based on a test performed on a total of 247 pork carcasses. The test was conducted at the University of Guelph in the spring and summer of 1982, following cutout standards and specifications described by Martin[12]et.al. A stratified sample of carcasses was chosen to achieve a uniform distribution across carcass weight and backfat cells. Some extreme cells (i.e., cells containing carcasses of low weight, but heavy fat cover, or heavy weight but thin fat cover) contained fewer carcasses. However, all carcasses in all cells were included in the analysis since the intent was to produce results valid for the entire spectrum of carcass types. The characteristics of the sample carcasses had been judged to compare favorably with those of an extensive Agriculture Canada survey in 1981,[13] therefore the sample was believed to be representa-

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[12] A.H. Martin, H.T. Fredeen, G.M. Weiss, A. Fortin, and D. Sim, "Yield of Trimmed Pork Product in Relation to Weight and Backfat Thickness of the Carcass", Canadian Journal of Animal Science, vol. 61, 1981, pp. 299-310.

[13] A. Fortin, S.D.M. Jones, and C.R. Haworth, op. cit., p.2.

tive of the Canadian slaughter hog population. Summary statistics for the carcass sample are presented in Table 3.1.

The net value of each sample carcass was calculated, then expressed as an index of the average net value over the entire carcass sample. Thus, the units by which carcass quality was measured were "index points". Index grades reflecting the proportional net values of carcasses were calculated for each of the sample carcasses for each of 36 monthly time periods (spanning from January, 1980, to December, 1982, inclusive), using monthly average wholesale pork prices. These prices are more fully described in the following paragraphs, where the method and underlying assumptions employed in calculating the index grades for the sample carcasses are presented.

3.1.2 Gross Value

Approximately 52 percent of the weight of an average market hog is composed of primal cuts (see Figure 3.1), which are the main determinants of the gross value of an animal. By-products also contribute to the total gross value. Figure 3.1 illustrates that approximately 33 percent of an average market hog's weight is by-products (this figure includes fats used in rendering lard). It has been estimated that by-products add from 7 to 12 percent to the total value of a slaughter hog (when boning by-products are included).[14]

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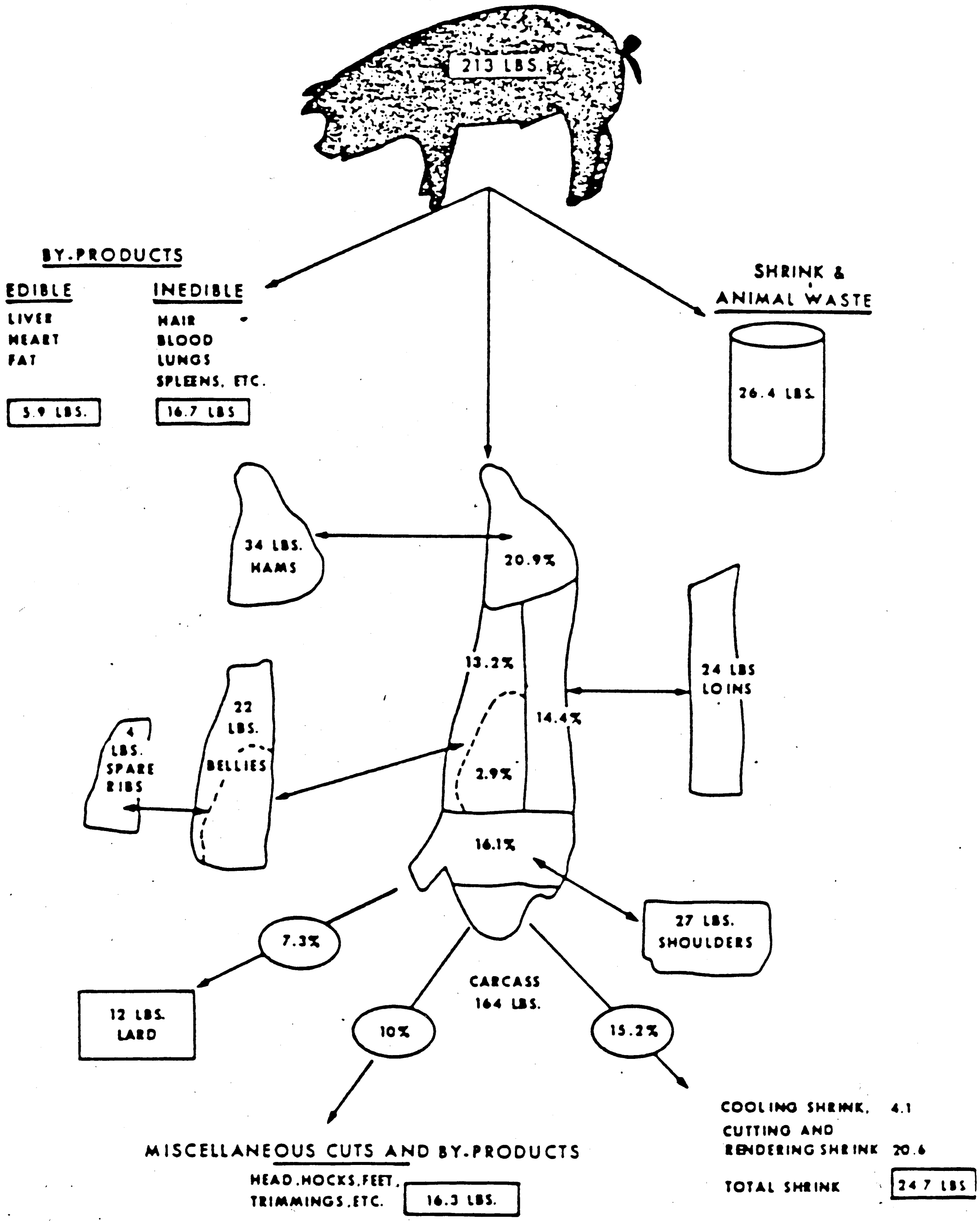
[14] R. Kennedy and M. Churches, Canada's Agricultural Systems, Dept. of Agricultural Economics, McGill University, Ste. Anne de Bellevue, Quebec, 1981, p. 13.25.

TABLE 3.1

Cutout Data -- Summary Statistics

VARIABLE	MEAN	STD.DEV.	MIN.VALUE	MAX.VALUE	STD.ERROR OF MEAN	COV.
WCW	75.897	6.492	57.000	94.500	0.413	8.554
RLOINF	1.294	0.240	0.500	2.100	0.153	18.518
RSHOULF	1.733	0.235	1.000	2.800	0.015	13.550
FMLR7F	21.709	4.706	13.000	38.000	0.299	21.676
FM34R7F	22.825	5.056	12.000	44.000	0.322	22.152
FMLR7M	50.792	8.202	32.000	84.000	0.524	16.148
FM34R7M	48.339	8.154	23.000	77.000	0.521	16.869
HAM	15.777	1.611	12.080	21.000	0.102	10.209
BELLY	9.279	1.289	5.160	13.400	0.082	13.892
PICNIC	6.928	0.902	4.920	15.480	0.057	13.016
BUTT	6.773	0.728	4.240	8.600	0.046	10.752
BACK	14.025	1.479	8.880	19.640	0.094	10.543
TNLOIN	0.760	0.117	0.520	1.160	0.007	15.410
BKRIBS	0.985	0.159	0.560	1.480	0.010	16.179
SDRIBS	19.521	1.760	15.480	25.500	0.112	9.015
BAKFAT	7.565	2.239	2.840	18.680	0.142	29.599
TRIMS	1.045	0.311	0.280	2.640	0.198	28.738
TAILS	0.514	0.116	0.200	0.800	0.007	22.610
JOWLS	1.42	0.303	0.560	2.360	0.193	21.341
HOCKS	1.364	0.088	0.840	2.000	0.012	12.937

WCW = warm carcass weight
RLOINF = ruler fat measurement at loin (inches)
RSHOULF = ruler fat measurement at shoulder (inches)
FMLR7F = electronic (Fat-O-Meater) fat measurement at last rib, 7cm off the dorsal midline (millimeters)
FMLR7M = electronic (Fat-O-Meater) muscle depth measurement at last rib, 7cm off the dorsal midline (millimeters)
FM34R7F = electronic (Fat-O-Meater) fat measurement at last rib, 7cm off the dorsal midline (millimeters)
FM34R7M = electronic (Fat-O-Meater) muscle depth measurement at last rib , 7cm off the dorsal midline (millimeters)
HAM = yield of commercial-trimmed ham (kg.)
BELLY = yield of commercial-trimmed belly (kg.)
PICNIC = yield of commercial-trimmed picnic (kg.)
BUTT = yield of commercial-trimmed butt (kg.)
BACK = yield of externally-defatted, boneless back (kg.)
TNLOIN = yield of tenderloin (kg.)
BKRIBS = yield of backribs (kg.)
SDRIBS = yield of sideribs (kg.)
BAKFAT = yield of backfat, including kidney fat (kg.)
TRIMS = yield of trimmings (kg.)
TAILS = yield of tail (kg.)
JOWLS = yield of jowl (kg.)
HOCKS = yield of hocks (kg.)



Source: Food Prices Review Board

Figure 3.1: Approximate Disposition of a Market Hog

In this study, cutout data and prices were available for only a limited number of carcass by-products. Yields of sideribs, tenderloin, backribs, backfat, jowl, trim, tail, and hocks were observed for each sample carcass,[15] and were included in the carcass value calculations. Excluded from the valuation process were carcass by-products such as riblets, feet, head, tongue, kidneys, rind, neck bones, fin bones, and scraps. Slaughter by-products (such as blood, hair, heart, lungs, liver, and spleen) also were excluded. These excluded products are low in value ($/kg.) in comparison to the primal cuts, and it is reasonable to expect, therefore, that their contribution to the percentage differentials in net value between hogs would be minimal. This expectation is given further support when one considers that most of these excluded products are not likely to differ greatly between animals in terms of their percentage carcass yields.

The greatest part of carcass value is, of course, derived from the primal cuts (ham, loin, belly, and the shoulder, which is composed of the picnic and the butt). For each monthly time period observed, the commercial-trimmed weight of each cut was multiplied by its appropriate price to obtain its dollar value. Primal cut prices were obtained from price sheets of the Ronald A. Chisolm Co. Ltd., as were the prices used in valuing the by-products and miscellaneous cuts.[16] The primal cut

[15] Sideribs, tenderloin, backribs, jowl, and tail weights were directly observed for each carcass. Yields of the other by-products and miscellaneous cuts were obtained as follows: backfat was equal to rough weight of loin and butt minus commercial- trimmed weight of loin and butt (kidney fat also was included in the backfat category); weight of hocks was determined by subtracting commercial-trimmed picnic from rough picnic; trim was defined as the difference between commercial-trimmed and rough weight belly, less the weight of the sideribs.

[16] Price quotes for pork trim were for trimmings of 35 percent lean con-

prices were modified to reflect the intrinsic values associated with specific weight ranges within a given cut. Weight-based premiums and discounts were developed from the weight- range-specific price quotations for U.S. pork, as quoted in the National Provisioner "Yellow Sheets". Prices used in valuing primal cuts thus were dependent on both the type of cut and its weight. Appendix A describes, by way of an example, the procedure employed in developing the weight-range-specific premiums and discounts applied to the primal cut prices.

The gross value per 100 kg. for each carcass was determined for each time period by summing the products of the percentage carcass yields of the carcass components by their respective prices, according to the folowing valuation formula:

$$\begin{aligned} GV_{it} = \, & ((PHAM_{kt})(HAM_i) + (PBELLY_{kt})(BELLY_i) + (PPICNIC_{kt})(PICNIC_i) \\ & + (PBUTT_{kt})(BUTT_i) + (PBACK_t)(BACK_i) + (PTAIL_t)(TAIL_i) \\ & + (PBACKFAT_t)(BACKFAT_i) + (PJOWL_t)(JOWL_i) + (PTRIM_t)(TRIM_i) \\ & + (PHOCK_t)(HOCK_i) + (PTENDERLOIN_t)(TENDERLOIN_i) \\ & + (PBACKRIBS_t)(BACKRIBS_i) + (PSIDERIBS_t)(SIDERIBS_i))/WCW_i \end{aligned}$$

where:

i refers to carcass "i",

t refers to time period "t",

k refers to weight range "k",

P "carcass component" refers to price ($ per 100 kg.) for the carcass component named,

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tent.

carcass component "i" refers to the yield (kg.) of the carcass component named obtained from carcass "i",

WCW refers to warm carcass weight, and

GV refers to gross value ($ per 100 kg.).

3.1.3 Processing Costs

Total processing costs per slaughter hog were assumed to be constant across carcasses. The nature of the assembling, killing, dressing, and chilling operations are such that the cost per head of performing these operations is obviously constant across carcasses. Since carcass cutting is now a highly mechanized operation employing power knives and saws, it was reasonable to assume that cutting costs also are unaffected by physical carcass characteristics such as size or fat cover. In addition, though carcasses differ in fat cover, it was assumed that this does not result in differential trimming costs per head. While fatter animals require that a greater amount of fat be removed, the difference in time required to remove a thin layer of fat as opposed to a heavy layer was assumed to be negligible. Finally, since it was assumed that total per-head processing costs are constant over all carcasses, when costs are expressed per unit weight of carcass, it follows that heavier carcasses are assumed to have a lower per-unit-weight processing cost in comparison to lighter carcasses.

Processing costs also were assumed to be fairly stable within a year, since they depend upon factors such as wages and other input costs, and processing technology. Estimates of yearly average processing costs per hog for an average-sized Canadian plant were provided by the Canada Meat Council. These estimates were: $7.50 (1980), $8.50 (1981), and $9.50 (1982).

For each carcass, processing costs per 100 kg. carcass weight were subtracted from gross value per 100 kg. to obtain the net value per 100 kg. carcass weight for each carcass in each time period.

$$NV_{it} = GV_{it} - C_{it}$$

where:

NV_{it} = net value per 100 kg. of carcass "i" in time period "t",

GV_{it} = gross value per 100 kg. of carcass "i" in time period "t",

C_{it} = processing costs per 100 kg. of carcass "i" in time period "t".

3.1.4 Net Value Percentage Differentials

The quality of each individual carcass was quantified by calculating its "index grade", i.e., "the percentage difference in the net value of carcass 'i' from the mean net value over all carcasses". If we denote this measure by Y_{it}, then

$$Y_{it} = ((NV_{it} - \overline{NV}_{t})/\overline{NV}_{it})100$$

where:

$\overline{NV}_{it}$ = mean net value per 100 kg. over all carcasses in time period "t".

Subsequent tests of grade-pricing efficiency were based primarily on the ability to predict these index grades for any of the sample carcasses, for any of the sample time periods.

3.2 EXPERIMENTAL DESIGN

The hypotheses tested were all concerned with determining how the use of different grade-pricing mechanisms for pork carcases can affect the degree to which grade-prices assigned to pork carcasses of different physical type match the actual differences in economic value between these carcasses; i.e., how closely does the index grade assigned to a particular carcass match its actual calculated index grade. Two measures were used to evaluate grade-pricing performance. These were i) grade-pricing bias, and ii) grade-pricing precision.[17]

The hypotheses were addressed in two steps. Using the bias and precision scores described below, it was determined whether statistically significant differences in bias or precision occur when different grade-pricing mechanisms are used in assigning index grades to pork carcasses. Subsequent to these statistical tests, an attempt was made to identify the probable benefits and costs associated with the application of different grade-pricing mechanisms in a practical grading situation. This was done to evaluate the feasibility of employing a given mechanism (other than that which is currently used) in the actual grade-pricing of pork carcasses in Canada.

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[17] Similar measures were used in J.E. Ikerd and C.L. Cramer, op. cit.

3.2.1 Grade-Pricing Bias

Bias was evaluated by regressing actual carcass index values versus assigned index grades. In the absence of bias, the estimated intercept of such a regression would equal zero, and the estimated coefficient would equal one. An example of bias is presented in Figure 3.2. From the example, one can see that bias measures whether the index premiums and discounts associated with varying levels of backfat thickness and carcass weight accurately reflect the actual effect of incremental changes in these carcass measurements on carcass value. Thus, a measure is provided as to how closely the grade-price signal generated by a given grade-pricing mechanism reflects the actual relationship of carcass value to these measurements.

In the case of positive bias (as illustrated in Figure 3.2), index grades for carcasses of below-average value will be expected to be underestimated by the assigned index grades, while index grades for carcasses of above-average quality will be expected to be overestimated. Under such circumstances producers who consistently deliver hogs of above-average quality will tend to receive grade-price premiums larger than what is justified by the extra value realized from these hogs by packers. Conversely, below-average quality hogs will tend to receive grade-price discounts larger than what is justified by the lesser value realized from these hogs by packers. The opposite situation would exist in the case of negative bias. Under negative bias, the assigned grade-price premiums and discounts will tend to be too small, thus benefiting producers of below-average quality animals.

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A_i = Actual carcass index grade (difference from mean) for carcass "i"
P_i = Predicted (assigned) carcass index grade (difference from mean) for carcass "i"
For any given time period, $\overline{A} = 0$
Any of the pricing models will produce values of P_i such that $\overline{P} = 0$

To test for bias, regress A_i on P_i , obtaining, for example,

$$\hat{A}_i = 0 + 0.8P_i \pm e_i$$

Bias is indicated since $0.8 \neq 1.0$. To indicate what this means, assume that carcass index grades are a function of backfat thickness (expressed as differences from the mean) alone, and that the relationship is as follows:

Backfat	-4	-3	-2	-1	0	1	2	4	4
A	4	3	2	1	0	-1	-2	-3	-4
P	5.00	3.75	2.50	1.25	0	-1.25	-2.50	-3.75	-5.00

If we judge the quality of carcasses of varying backfat thickness on the basis of predicted index grades, we would overestimate the impact of backfat on carcass quality. The size of the premiums and discounts would be too large. This will be referred to as positive bias. Alternatively, negative bias will refer to the underestimation of the impact of carcass traits on carcass quality (i.e., the size of the premiums and discounts are too small).

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Figure 3.2: Example of Bias in Quality-Pricing Accuracy

3.2.2 Grade-Pricing Precision

Grade-pricing precision refers to the variation of assigned index grades around actual calculated index grades; i.e., the degree of confidence one has that the index grade assigned to an individual carcass is within a certain range of its true index grade. It was measured by calculating the standard deviation of the residual "actual carcass index grade minus assigned index grade". Knowing the standard deviation of this residual value, one can calculate the overall probability that assigned index grades for individual carcasses will be within a given range of their actual index grades.[18] For each precision score calculated, accompanying figures were calculated to indicate i) the probability of an assigned index grade being correct within two index points, and ii) the range ("n" index points of the actual value index) within which 80 percent of the predicted grade indices for individual carcasses would be expected to fall.

3.2.3 Comparing Bias and Precision Scores

Bias scores for each grade-pricing mechanism were subjected to two-tailed t-tests to determine whether the index grades assigned by a given grade-pricing mechanism were significantly biased. Paired comparisons of grade-pricing precision scores for different grade-pricing mechanisms

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[18] Note that precision refers to the overall probability that predicted grade indices will be within a given range of actual value indices. If zero bias exists, then all grades of carcasses are equally likely to be assigned grade indices within a given range of their true value indices. But if bias exists, then the probability that a carcass will be assigned a grade index within a given range of its actual value index decreases as actual value indices deviate from the average (100) index.

were conducted (by means of an F-ratio) to ascertain whether the precision score for a given mechanism was significantly smaller than the precision scores for other mechanisms.

For the tests of both the bias and precision scores, there was a strong desire to limit the probabilities of Type 1 error (saying a grade-pricing mechanism produces bias when in fact it doesn't, or saying a mechanism improves precision when it doesn't) as well as Type 2 error (saying a mechanism produces no bias when actually it does, or saying a mechanism doesn't improve precision when actually it does). This is because it was assumed that the hog/pork industry is averse to having "less than the best possible" grade-pricing performance,[19] in addition to being averse to making a change to a grade-pricing system that produces no improvement in grade-pricing performance.[20] Consequently, all formal tests of bias and precision were administered using a 20 percent rejection region.

The reason for testing the effect on grade-pricing performance when alternative carcass measurements or alternative procedures for assigning grade-prices are used was that these effects are unknown. Therefore, it was unclear whether, in comparing alternative grade-pricing procedures, the results obtained would in some way be influenced by the carcass measurements used in the procedures. Similarly, in comparing the ability of alternative sets of carcass measurements to contribute to grade-

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[19] That is, the industry does not want to make the mistake of not adopting a given grade-pricing mechanism when it in fact would be beneficial to grade-pricing performance.

[20] That is, the industry does not want to make the mistake of adopting a particular grade-pricing mechanism when in fact it does nothing to improve grade-pricing performance.

pricing performance, it was unclear whether the results would in some way be influenced by the grade-pricing procedure in which the alternative carcass measurements are applied. In response to this problem, each grade-pricing procedure was tested using each of the six alternative sets of carcass measurements included in this study. Similarly, each set of carcass measurements was tested using three different grade-pricing procedures; i) one which adjusts for the effect of changing wholesale pork prices over time, ii) one which adjusts for instability in the carcass value-carcass measurements relationship over different carcass types and over time, and iii) one which adjusts for neither the instability in the carcass value-carcass measurements relationship over time or over carcass types. Thus, each test of a given grade-pricing procedure was conducted six times, (once for each set of carcass measurements), and each test of a given pair of carcass measurements was conducted three times (once for each of the three different grade-pricing procedures described above). In this way, the separate effects of the choice of carcass measurements and the choice of grade-pricing procedure on grade-pricing performance could be determined.

3.2.4 Interpreting the Results -- Implications for Grading and Differential Pricing in Canada

In the following chapter, subsequent to testing whether a given grade-pricing mechanism produces statistically significant bias or significantly improves grade-pricing precision, the results of the tests are interpreted to provide an assessment of whether changing the carcass measurements or the grade-pricing procedure employed in the Canadian Index 100 grade-pricing system would be worthwhile. This assessment was qualitative in nature, consisting of an identification of the probable benefits and costs associated with a given change to the Index 100 system.

Chapter IV

RESULTS AND INTERPRETATION

4.1 CHOICE OF GRADE-PRICING PROCEDURE

Previous studies have indicated the relationship between carcass value and carcass measurements of backfat thickness and weight to be unstable over time and over different carcass types. In this study, the merit of employing grade-pricing procedures which account for these instabilities was evaluated. This was done in two steps. First, the nature of the relationship between carcass economic value and carcass measurements was examined. This was followed by an evaluation of how the grade-pricing of pork carcasses in Canada i) might be affected by the "fine tuning" of the index grading system to reflect changes in wholesale pork prices over time, and ii) is affected by the existing fine tuning of the system to reflect the variability of the relationship between value and carcass measurements between subsamples of light and heavy, and subsamples of lean and fat carcasses.

4.1.1 The Relationship Between Carcass Value and Carcass Measurements

4.1.1.1 Behavior Over Time

Dollar values were calculated for the sample carcasses, for each of the months spanning from January, 1980, to December, 1982. For each of the 36 months, for each of the sample carcasses, these values then were converted to index grades. Ordinary Least Squares regressions of the dependent variable, "calculated index grades", on the independent variables "backfat" (the sum measurement of fat thickness at the shoulder and the loin measured in inches by a ruler)[21] and "warm carcass weight" (kg.)[22] then were performed. Thus, a time series of thirty six estimated regression coefficients reflecting the effect of backfat thickness and carcass weight on carcass value was produced (Table 4.1).

Two tests; one for trend (initially suggested by Mann,)[23] and one for periodicity (initially suggested by Wallis and Moore)[24] were applied to the above series of coefficients.[25] Mann's test for trend is based on the calculation of a rank correlation coefficient to indicate the degree of randomness in a series of estimated coefficients. Wallis and Moore's test for periodicity is based upon the observed number of turning points and phases in a series of estimated coefficients. Applying these tests to the sample data, it was concluded that the response of carcass index grades to backfat thickness exhibited a positive trend over the time period spanning January, 1980 to December, 1982, but that periodic move-

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[21] This particular backfat measurement was chosen for this portion of the analysis somewhat arbitrarily, mainly because of its familiarity to the Canadian hog/pork sector.

[22] The variables all were expressed as differences from their respective means.

[23] H.B. Mann, "Non-Parametric Tests Against Trends," Econometrica, vol. 13, (1945), p. 246.

[24] W.A. Wallis and G.H. Moore, "A Significance Test for Time Series Analysis," Journal of the American Statistical Association, vol. 30, (1941), p. 401.

[25] These tests are presented in G. Tintner, Econometrics, (New York: John Wiley and Sons, Inc., 1952), pp. 211-215 (trend test) and pp. 234-238 (test for cyclical movements).

TABLE 4.1

Series of Estimated Fat and Weight Coefficients -- 1980-1982

Month		Backfat Coefficient	Weight Coefficient
Jan., 1980	1	-5.226	-0.062
	2	-5.435	-0.048
	3	-5.185	-0.109
	4	-5.325	-0.141
	5	-4.842	-0.233
	6	-6.020	-0.055
	7	-6.080	0.048
	8	-5.262	-0.004
	9	-5.249	-0.026
	10	-5.380	-0.033
	11	-5.217	-0.049
	12	-4.952	-0.128
Jan., 1981	13	-5.383	-0.063
	14	-5.500	-0.033
	15	-5.882	-0.014
	16	-5.069	-0.778
	17	-5.090	-0.089
	18	-5.424	-0.012
	19	-5.173	-0.049
	20	-4.752	-0.036
	21	-4.668	-0.054
	22	-4.676	-0.076
	23	-4.376	-0.120
	24	-3.943	-0.227
Jan., 1982	25	-4.339	-0.065
	26	-4.682	-0.009
	27	-4.472	-0.078
	28	-4.726	-0.031
	29	-4.656	-0.017
	30	-4.815	-0.004
	31	-4.679	-0.017
	32	-4.465	0.011
	33	-4.574	-0.039
	34	-4.557	-0.112
	35	-4.601	-0.121
Dec., 1982	36	-3.798	-0.223

ment was absent. On the other hand, the response of index grades to carcass weight exhibited significant periodicity, but no significant trend.

Figures 4.1 and 4.2, showing plots of the estimated backfat (Figure 4.1) and weight (Figure 4.2) coefficients over time, reveal patterns concurring with the above results. The positive trend in the backfat coefficients indicates that, over time, the degree to which the backfat thickness of an individual carcass deviates from the mean backfat thickness of the carcass population has had a less severe impact upon carcass quality. This may reflect a concurrent trend in wholesale pork prices; for the 36 month time span under study, the price difference between hams (the largest lean cut in a carcass) and bellies has exhibited a decreasing trend (see Figure 4.3). Since the percentage carcass yield of belly is positively related to backfat thickness,[26] a relative increase in the value of bellies in comparison to other cuts would result in a smaller "penalty" being associated with increasing backfat thickness.

An explanation for the cyclical movements in the weight coefficients evident in Figure 4.1 can be found in the seasonal patterns in consumer demand for various pork cuts. In particular, the price difference between light and heavy hams follows a distinct seasonal pattern (see Figure 4.4). Comparing Figures 4.4 and 4.2, the troughs in the estimated weight coefficients directly coincide with the peaks in the price discount for heavy hams. For example, during the Easter and Christmas seasons, when whole hams are likely to be in high demand, the price difference between light and heavy hams increases dramatically. During these

[26] See A.H. Martin et. al., op. cit., p. 306.

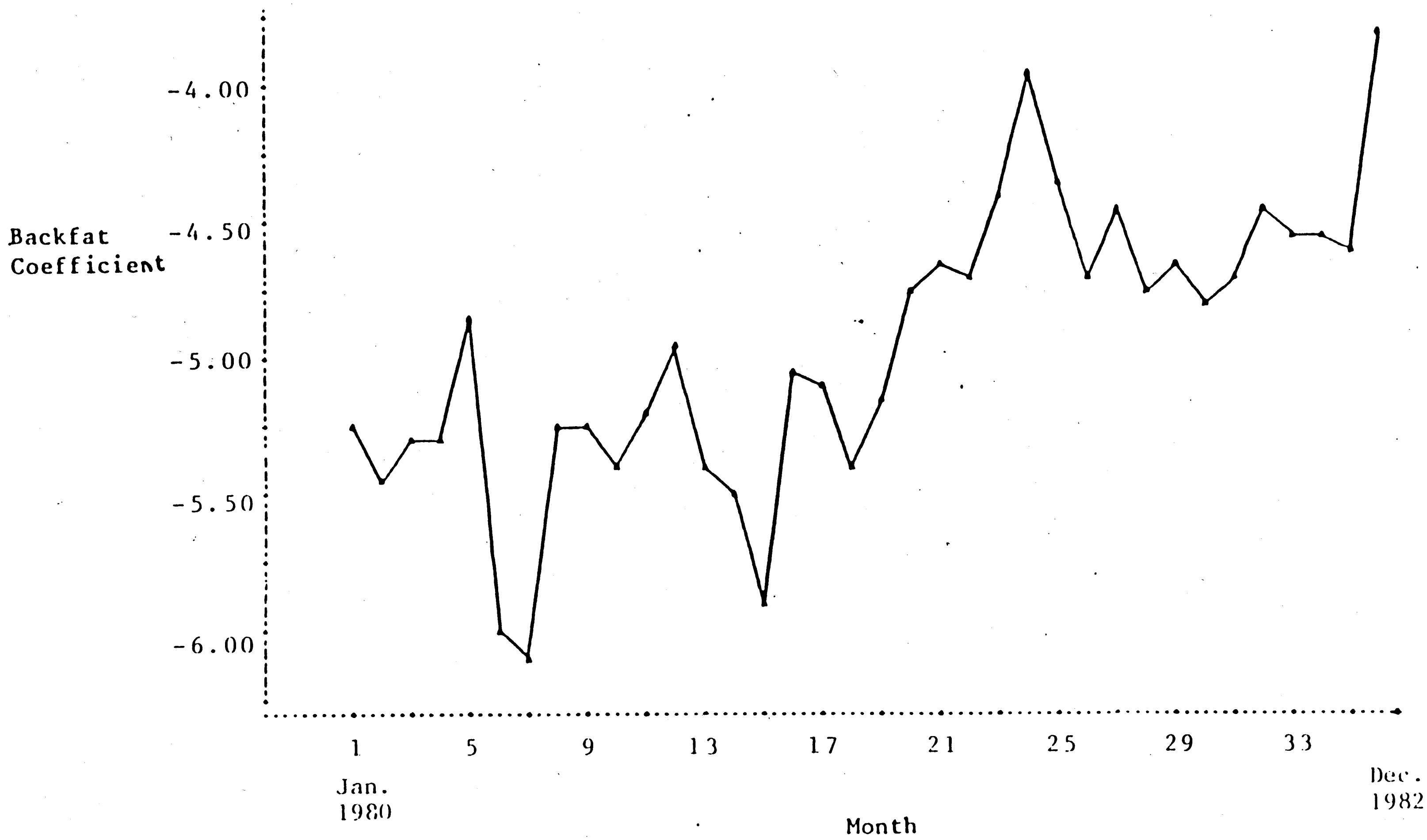

Figure 4.1: Plot of Estimated Backfat Coefficients Over Time

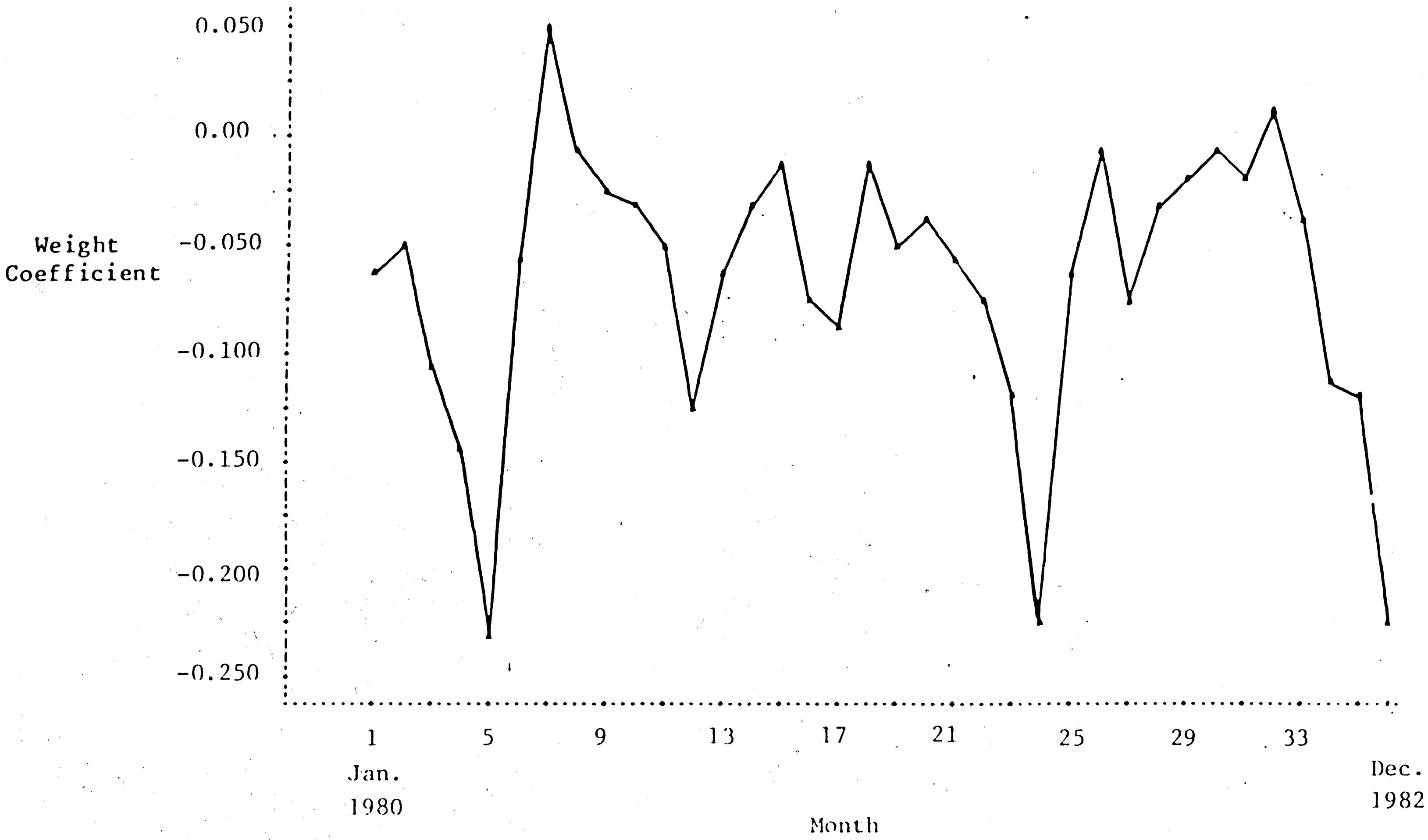

Figure 4.2: Estimated Weight Coefficients Over Time

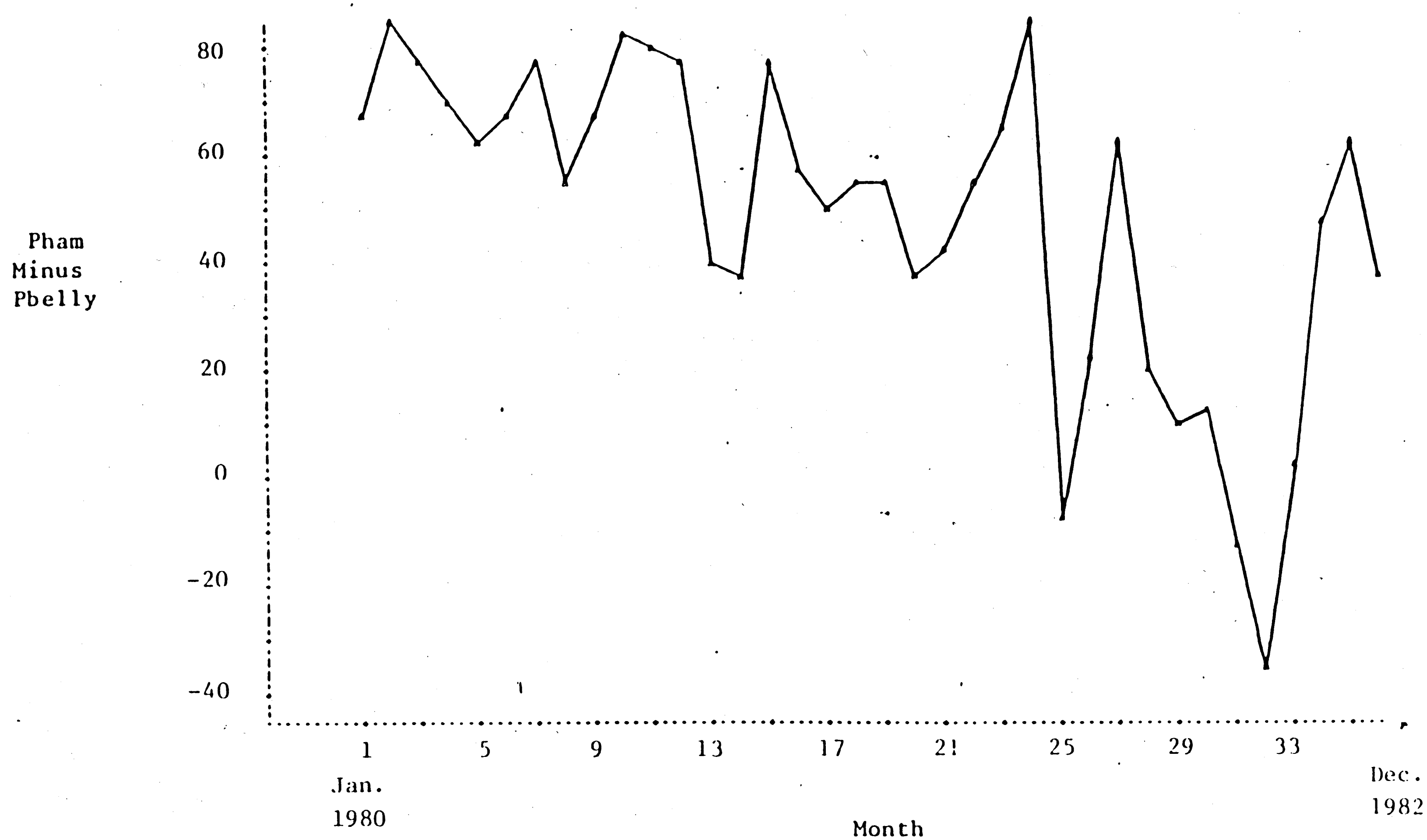

Figure 4.3: Price Difference Between Hams and Bellies Over Time

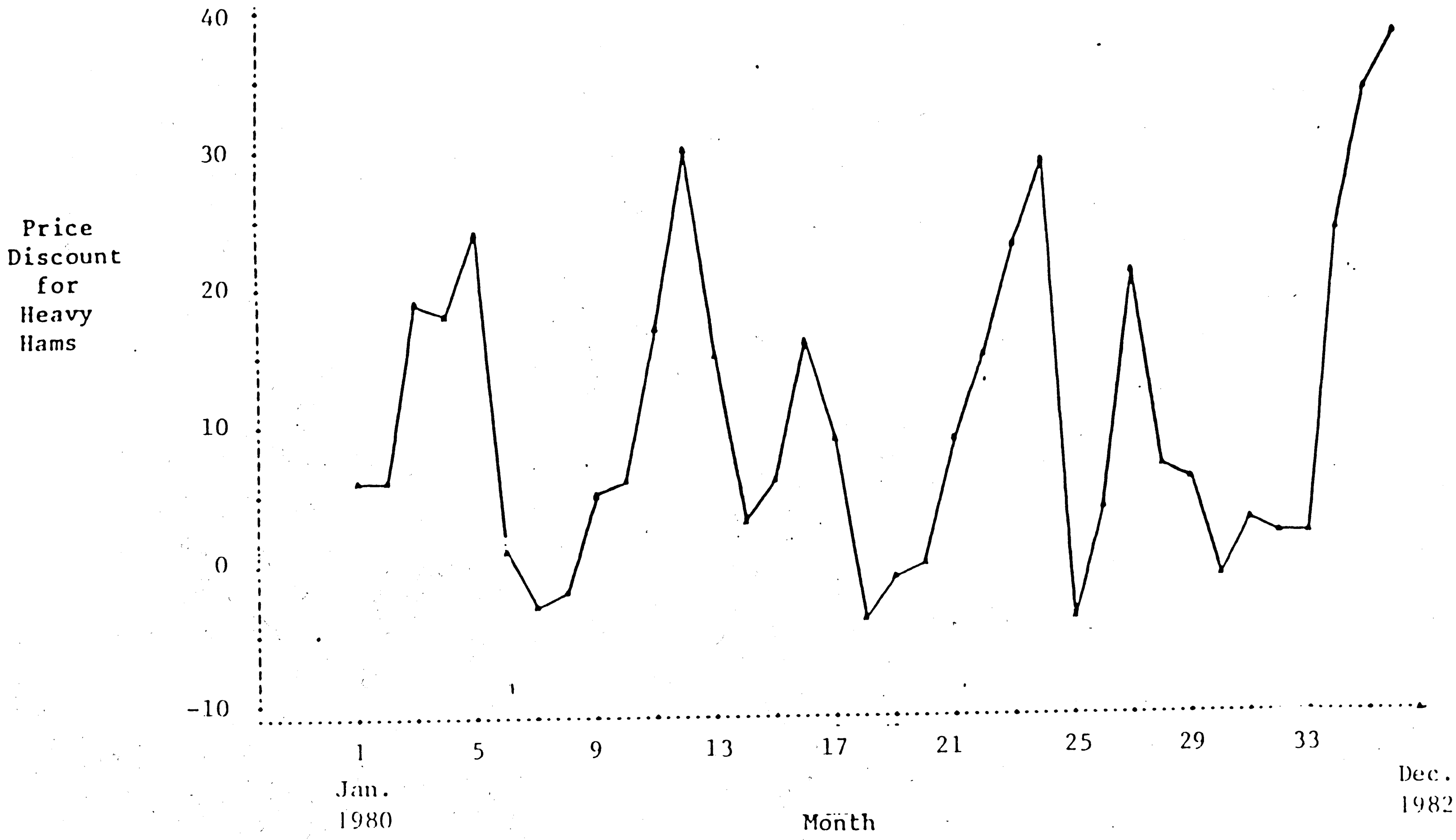

Figure 4.4: Price Discounts Between Light and Heavy Hams Over Time

same seasons, the estimated weight coefficients take on their greatest negative values.

4.1.1.2 Behavior Over Different Carcass Types

Classifying the sample carcasses according to carcass weight, two subsamples were created; carcasses with warm carcass weight less than 72 kg., and those weighing in excess of 77 kg. The index value of each carcass then was calculated using wholesale pork prices averaged over 1982. For each of the two subsamples, an ordinary least squares regression of index values on backfat and carcass weight was performed. A test suggested by Chow[27] then was used to determine whether the estimated regression coefficients differed between the two subsamples.

The same procedure was applied to a second set of two carcass subsamples, where carcasses were classified according to backfat thickness; carcasses with backfat (summed measure of maximum shoulder and loin fat) of less than 2.9 inches, and those with backfat in excess of 3.2 inches.

The results of these tests, presented in Table 4.2, indicated that the relationship of carcass value to backfat and weight was unstable when compared between light and heavy weight carcasses. The major cause of this instability is believed to be packers' general preference for small and medium sized pork cuts. Individual cuts that are considered too large to be desirable for sale in whole form in the wholesale market generally are subjected to substantial trimming, or are used in the production of processed meat products. Once a carcass is considered "too

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[27] G.C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica, vol. 28, (1960), pp. 591-605.

large" for the production of whole cuts, additional increases in size are less detrimental (and may be desirable) to the net value (per kg.) of a carcass. In addition, price discounts associated with increasing backfat thickness would be expected to be smaller for heavier carcasses. If wholesale cuts obtained from heavy carcasses undergo substantial trimming in order to decrease their size, or are directed for use in processed products, there will be less concern over whether an excess fat cover is present on these cuts.

Comparing the estimated coefficients obtained for the lean and fat carcass subsamples, the Chow tests revealed no significant difference in the relationship between carcass value and carcass measurements. This indicated that the response of carcass value to backfat and weight differences between carcasses is not significantly affected by the overall level of backfat thickness in the pork carcass population.

TABLE 4.2

Chow Test Results -- 1982 Data

Regression	Intercept	Backfat Coefficient	Weight Coefficient	R^2	D.F.	Σe^2
A1) Light subsample < 72 Kg.	-1.417 (1.045)[1]	-5.141 (1.020)	-0.269 (0.124)	.364	67	868.529
A2) Heavy subsample > 77 Kg.	-1.624 (0.467)	-4.051 (0.576)	0.218 (0.071)	.336	106	646.330
A3) Subsamples pooled	0.165 (0.231)	-4.599 (0.555)	-0.061 (0.033)	.360	176	1677.353
Chow F-ratio*						6.186
B1) Lean subsample < 2.9 inches fat	0.123 (0.640)	-3.958 (1.311)	-0.147 (0.057)	.163	99	1322.378
B2) Fat subsample > 3.2 inches fat	-0.473 (0.705)	-4.139 (1.343)	0.049 (0.055)	.113	76	620.771
B3) Subsamples pooled	0.054 (0.250)	-4.445 (0.534)	-0.070 (0.041)	.360	178	2010.180
Chow F-ratio*						2.012

1 Standard errors
* Critical F-value for the 0.05 level is 2.60; for the 0.01 level is 3.78.

4.1.2 Comparison of Grade-Pricing Procedures

From the analysis described in the preceeding section, it was concluded that the relationship of carcass value to carcass measurements of backfat and weight exhibited (for the sample data) the following behavior:

1. short term (i.e., seasonal) instability, especially in the estimated coefficients for carcass weight, apparently resulting from seasonal fluctuations in the weight-based wholesale price discounts associated with heavy wholesale pork cuts;
2. ii) long term (trend) instability, especially in the estimated coefficients for backfat, apparently resulting from a decreasing trend in the price differences between bellies and wholesale "lean cuts" (particularly ham)
3. iii) instability over carcass weight ranges.

In the sections which follow, the merits of allowing the Canadian Index 100 carcass evaluation system to reflect the above instabilities are examined.

4.1.2.1 Adjusting for Seasonal Fluctuation

The hypothesis addressed is:

Adjustment of the index grade premiums and discounts associated with carcass measurements of backfat and weight in response to seasonal fluctuations in wholesale pork prices has no significant effect on i) grade-pricing bias, ii) grade-pricing precision, or iii) the practical achievement of grade-pricing efficiency in the slaughter hog market.

Two procedures were developed (one which adjusted for seasonality, and one which did not) by which index grades were assigned to the sample carcasses. The index grades assigned by these two procedures then were compared to the actual index grades for the sample carcasses, as calculated for each month in 1980.

Procedure 1a -- No Adjustment for Seasonal Fluctuation

In procedure 1a, actual index grades for the sample carcasses first were calculated using wholesale pork prices averaged for 1980. These indices then were regressed on carcass measurements (this was done for each of the six combinations, or "trials" of carcass measurements). The resulting estimated regressions thus reflected the average structure, for 1980, of the relationship between carcass value and each of the respective combinations of carcass measurements. Index grades were assigned to the sample carcasses using each of these estimated relationships. These index grades then were compared to the actual index grades calculated for these carcasses for each individual month in 1980 to determine the extent to which the carcass value-carcass measurements relationship deviates, in individual months, from the average relationship for the year. Measures used to determine how closely assigned index grades matched the actual index grades calculated for these carcasses were grade-pricing "bias" and grade-pricing "precision".

Effect on Grade-Pricing Bias[28] -- Procedure 1a indicated that short term (i.e., monthly) fluctuations in wholesale pork prices occasionally can be of sufficient magnitude as to render the grade-price signal generated by a yearly average estimate of the carcass value-carcass measurements relationship to be significantly biased (20 percent level). From Table 4.3, for each of the six combinations of carcass measurements applied in procedure 1a, the greatest positive seasonal bias, occurring in August, tended to be approximately 0.90. The greatest negative seasonal bias, occurring in May, tended to be approximately 1.10. Translating these bias scores into practical terms, a positive bias of 0.90 implies that carcasses with actual index grades within 4 index points of 100 would be expected to be graded accurately (assuming that assigned index grades are rounded to the nearest one index point).[29] Carcasses with actual index grades within 5 to 13 (-5 to -13) index points of 100 would be expected to be graded one index point too high (low). A negative bias of 1.10 means that carcasses with actual index grades within 5 index points of 100 would be expected to be graded accurately. Carcasses with actual index grades within 6 to 16 (-6 to -16) index points of 100 would be expected to be graded one index point too low (high).

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[28] As was described earlier, bias was determined by regressing actual on assigned indices, then noting whether the estimated intercept differs significantly from zero, and whether the estimated response coefficient differs significantly from one. For all of the bias tests performed in this study, a regression of actual on assigned index grades produced estimated intercepts essentially equal to zero. Therefore, bias was evaluated on the basis of the value of the estimated response coefficient alone.

[29] That is, if all carcasses with an actual index grade of (for example) 104 were graded using a grade-pricing system where a positive bias of 0.90 existed, the mean of the assigned index grades for these carcasses (rounded to the nearest 1 index point) would be expected to equal 104.

TABLE 4.3

Procedure 1a Bias Scores -- 1980 Data

Month	Estimated Coefficient					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
January	0.969	0.970	0.969	0.971	0.973	0.973
February	0.986	0.982	0.989	0.989	0.993	0.993
March	1.023	1.034	1.019	1.028	1.019	1.026
April	1.087	1.098	1.077	1.089	1.074	1.086
May	1.124*	1.144*	1.106	1.127*	1.097	1.117*
June	1.095	1.078	1.089	1.088	1.091	1.092
July	0.972	0.952	0.978	0.967	0.984	0.975
August	0.900	0.889	0.914	0.899*	0.915	0.902*
September	0.926	0.923	0.937	0.929	0.938	0.929
October	0.958	0.954	0.962	0.956	0.964	0.958
November	0.951	0.955	0.957	0.953	0.956	0.951
December	1.008	1.021	1.004	1.004	0.996	0.999
Mean	1.000	1.000	1.000	1.000	1.000	1.000

*Indicates values of estimated coefficients (from the regression of assigned carcass value indices on actual indices) significantly different from 1 at the 20 percent level of significance.

Grade-Pricing Precision -- Recall that grade-pricing precision is measured by the standard deviation of the residual "actual index grade less assigned index grade". "Precision scores" were calculated for procedure la for each month of the 1980 price data. The highest (worst) and lowest (best) of these precision scores are presented in Table 4.4. Using procedure la, the probability of an individual carcass being assigned an index grade falling within 2 index points of its actual (calculated) index grade was, for the worst precision score (July), approximately 41 percent. Put another way, producers would have 80 percent confidence that an individual carcass would be assigned an index grade within approximately 4.8 index points of its actual index grade (see Table 4.4). The corresponding figures for the month with the best precision scores (December) were 47 percent and 4.0 index points.

<u>Procedure lb -- Adjustment for Seasonal Fluctuation</u>

In procedure lb, an ordinary least squares regression of calculated index grades on the chosen carcass measurements was performed for each separate month in 1980. Each estimated regression then was used to assign index grades to the sample carcasses. In this way, the assigned index grade for any given carcass was adjusted for each month in 1980, thus ensuring that seasonal fluctuations in wholesale pork prices were accounted for.

Grade-Pricing Bias -- As expected, when actual calculated index grades were regressed on index grades assigned using procedure lb, the estimated coefficient always equalled 1.0; i.e., the assigned index grades were unbiased. An observation worth noting is that, using procedure lb, bias was not exhibited for any of the six different trials of

TABLE 4.4

Procedures 1a and 1b Precision Scores -- 1980 Data

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Procedure 1a						
Lowest Std. Dev. Res. (Dec.)	3.244	3.270	3.134	3.120	3.066	3.072
80% C.I. (index points)	±4.15	±4.19	±4.01	±4.00	±3.93	±3.93
$P(\hat{Y} = Y \pm 2$ index points)	46%	46%	48%	48%	48%	48%
Highest Std. Dev. Res. (July)	3.796	3.871	3.691	3.704	3.606	3.637
80% C.I. (index points)	±4.86	±4.96	±4.73	±4.74	±4.62	±4.66
$P(\hat{Y} = Y \pm 2$ index points)	40%	39%	41%	41%	42%	42%
Procedure 1b						
Lowest Std. Dev. Res. (Dec.)	3.224	3.252	3.114	3.100	3.044	3.051
80% C.I. (index points)	±4.13	±4.16	±3.99	±3.97	±3.90	±3.91
$P(\hat{Y} = Y \pm 2$ index points)	47%	46%	48%	48%	49%	49%
Highest Std. Dev. Res. (July)	3.728	3.807	3.621	3.637	3.534	3.569
80% C.I. (index points)	±4.77	±4.87	±4.64	±4.66	±4.53	±4.57
$P(\hat{Y} = Y \pm 2$ index points)	41%	40%	42%	42%	43%	43%
F-Ratio*						
December	1.012	1.011	1.013	1.013	1.015	1.014
July	1.037	1.034	1.039	1.037	1.041	1.038

*Critical F value for the 0.20 level is 1.11.

carcass measurements. This result indicated that bias is caused only when a grade-pricing mechanism does not adjust to instability in the carcass value-carcass measurements relationship over time; it is not affected by the choice of carcass measurements used to indicate carcass value.

Grade-Pricing Precision -- Since grade-pricing procedure 1b assigned index grades which were unbiased, one might expect that these index grades would exhibit greater precision than those assigned by procedure 1a. Table 4.4 presents the precision scores obtained by procedures 1a and 1b for December (in which the best precision scores were obtained) and July (in which the worst precision scores were obtained). For all six trials, for each of the twelve months of price data, precision scores obtained by procedure 1b consistently were superior to those of procedure 1a. However, the magnitude of the improvement in grade-pricing precision for the seasonally-adjusting procedure was very small. Table 4.4 indicates that the probability of an index grade assigned to a given carcass by procedure 1b being within 2 index points of its actual index grade for a given carcass tended to be only about 1 percent higher than that for procedure 1a. In Table 4.4, an F-test comparison of corresponding precision scores obtained by procedures 1a and 1b indicates that the improvement in grade-pricing precision offered by the seasonally-adjusting procedure for any of the six trials was not statistically significant at the 20 percent level.

Interpretation

Results indicated that applying the principle of accounting for seasonal fluctuations in wholesale pork prices as opposed to not applying this principle theoretically would tend to improve grade-pricing precision scores. However, the magnitude of the improvement in any one of the tests performed here was small, indicating that seasonal adjustments to the Canadian Index 100 grade index table would not produce a perceptible improvement in the ability of the system to assign appropriate grade-prices to individual carcasses.

By adjusting the Index 100 table monthly, grade-pricing bias would, of course, be eliminated. That is, adjusting the grade-pricing system in response to monthly fluctuations in wholesale pork prices would ensure that the grade-price signal being communicated to producers correctly identifies packers' preferences for carcasses of different physical type, for any given month. Furthermore, it was determined that the consequence of not applying the principle of accounting for seasonal fluctuations is that the resulting grade-price signal can be expected to be significantly biased for certain months.

The major function of a grade-pricing system is to encourage the production of the types of pork carcasses desired by packers. That is, a grade-pricing system must be able to reflect without bias the general preferences of packers for hogs of different physical type. Though the Canadian Index 100 system does not attempt to reflect seasonal variations in packers' preferences, it does attempt to communicate packers' general preferences to producers. That is, producers are encouraged to market hogs whose physical characteristics generally are in line with what packers want.

A major concern with the performance of any grade-pricing system is that it should not favor either producers or packers. The equity of the Index 100 grade-pricing system would not be affected by the presence of seasonal grade-pricing bias. The grade distribution of the Canadian slaughter hog population is unaffected by season.[30] Regardless of the bias present for an individual season, as long as the 100 index grade continues to accurately identify pork carcasses of average value, the total dollar effects of bias for a given month will be equal but opposite for carcasses of above and below average quality. For positive seasonal bias, the total dollar amount paid out in overly-large grade-price premiums will be balanced by the total dollar amount not paid out due to overly-large grade-price discounts. Thus, (assuming a normal grade distribution about the mean, 100 index) under positive bias, producers of above average quality hogs benefit at the expense of packers, while packers benefit to an offsetting amount at the expense of producers of hogs of below average quality. Similarly, under conditions of negative bias, producers of below average quality hogs benefit at the expense of packers, while packers benefit to an offsetting degree at the expense of producers of hogs of above average quality. As long as the occurrences of positive and negative seasonal bias balance out over the year (i.e., if the grade-pricing system is unbiased, on average, for the year), there is no aggregate gain or loss for either producers or packers over the course of the year.

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[30] A perusal of 1980, 1981, and 1982 data in the Canadian Livestock and Meat Trade Report indicated the grade distribution of the Canadian slaughter hog population to be unaffected by season.

The above discussion suggests there may be no justification for the seasonal adjustment of the Canadian Index 100 carcass evaluation system. There is, however, one possible benefit that potentially may be realized with the application of seasonal adjustments to the Index 100 grade index table. If a seasonally adjusting system were established, and if, as a result of its application, producers tended to deliver more heavy hogs in the summer[31] and fewer heavy carcasses prior to Christmas,[32] packers may be able to reduce their overall cutting, trimming, and processing costs. That is, an improvement in packers' operational efficiency may be obtained. While this argument seems plausible, further research is required to determine whether such an improvement actually could be achieved, and what the magnitude of the resulting cost reduction would be. If it could be shown that such a streamlining of packers' operations could be achieved through the application of a seasonally adjusting carcass evaluation system, the magnitude of this benefit would need to be compared to the costs of developing and maintaining such a system. The majority of these costs likely would be administrative. In addition, an analysis would be required of whether a seasonally adjusting grade-price signal would be seen by industry members as a means for more closely communicating packers' preferences to producers, or if it would be viewed by packers and producers as adding unnecessary complexity to the carcass evaluation process. Finally, the effect of

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[31] Figure 4.2 illustrated that excess weight is less detrimental to carcass value in July, August, and September. This is probably because consumers demand fewer roasts and whole hams during this period, and more processed meats.

[32] Figure 4.2 illustrated that excess weight is most detrimental to carcass value prior to the Christmas-New Year season. This is probably because consumers demand more whole hams and roasts during this period, and fewer processed meats.

such a seasonally adjusting system on the desirability of Canadian pork carcasses in export markets also would need to be considered. The introduction of seasonal variability in the average weight of Canadian pork carcasses may be viewed as being undesirable by importers of Canadian hogs and pork carcasses.

4.1.2.2 Accounting for Underlying Trends Over Time

The hypothesis addressed in this section is:

Adjustment of the index grade premiums and discounts associated with carcass backfat and weight in response to underlying trends over time in the preferences exhibited by consumers for different pork cuts has no significant effect on i) grade-pricing bias, ii) grade-pricing precision, or iii) the practical achievement of grade-pricing efficiency in the slaughter hog market.

To test this hypothesis, two procedures were developed by which index grades were assigned to the sample carcasses; one which adjusts for such trends, and one which does not. The index grades assigned by these procedures then were compared to the actual index grades of the sample carcasses as calculated using the data for each month in 1981 and 1982.

<u>Procedure 2a -- No Adjustment for Trend</u>

In procedure 2a, an estimated regression reflecting the average structure of the carcass value-carcass measurements relationship for 1980 was used to assign index grades to the sample carcasses. These index grades then were compared to the actual index grades for these carcasses, as calculated for each monthly price data set for 1981 and 1982.

In this way, an indication was obtained of the ability of the carcass value-carcass measurements relationship for 1980 to reflect the average relationship for 1981 and 1982.

Grade-Pricing Bias -- The average of the 12 bias scores (Table 4.5) for 1981 was (for all six trials) approximately 0.94, reflecting the fact that the assigned "average 1980 carcass index grades" tended to overestimate the response of carcass value to carcass measurements for the 1981 data. The magnitude of this overestimation can be measured in practical terms; a positive bias of 0.94 means that carcasses with actual index grades of 108 or higher (92 or lower) would be expected to be assigned an index grade 1 index point higher (lower) than their actual index grade.

The average of the 12 bias scores for 1982 was (for all six trials) approximately 0.85. This indicated that the index grades assigned by the average 1980 relationship of carcass value to backfat and weight tended to become increasingly positively biased over time. In practical terms, a positive bias of 0.85 means that only those carcasses with actual indices within 2 index points of 100 would be expected to be graded accurately. Carcasses with actual indices within 3 to 8 (-3 to -8) index points of 100 would be expected to be graded 1 index point too high (low). Carcasses with actual indices within 9 to 14 (-9 to -14) index points of 100 would be expected to be graded 2 index points too high (low).

TABLE 4.5

Procedure 2a Bias Scores -- 1981 and 1982 Data

	Estimated Coefficient					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1981 Max. Neg. Bias (March)	1.019	1.009	1.018	1.010	1.022	1.014
Max. Pos. Bias (Aug.)	0.855	0.850	0.877	0.868	0.872	0.867
Avg. Bias Measure	0.941	0.942	0.949	0.946	0.945	0.943
#Bias Measures ≠1 (80% level)	4	2	4	4	4	4
1982 Max Neg. Bias	-	-	-	-	-	-
Max. Pos. Bias (Aug.)	0.746	0.739	0.770	0.758	0.768	0.754
Avg. Bias Measure	0.847	0.849	0.861	0.858	0.856	0.853
#Bias Measures ≠1 (80% level)	9	9	9	9	10	9

Procedure 2b -- Adjustment for Trend

Procedure 2b was the same as procedure 1b in the previous section, with assigned index grades for a given month being generated by an estimated regression of actual carcass index grades (as calculated for that month) on the chosen carcass measurements. Thus, in procedure 2a, separate regressions were estimated for each month in 1981 and 1982. This assured that the assigned index grade for any given carcass was adjusted to reflect any trend, as well as any seasonality in the carcass value-carcass measurements relationship. As a result, when actual index grades were regressed on index grades assigned using this procedure, the estimated coefficient always equalled 1.0 (i.e., there was no grade-pricing bias).

Grade-Pricing Precision -- One might expect the unbiased index grades assigned by procedure 2b to exhibit greater precision than those of procedure 2a. In Table 4.6 precision scores are presented for procedures 2a and 2b for 1981 and 1982. Comparing precision scores for a given month and trial, procedure 2b consistently produced superior (i.e., smaller) precision scores. However, the magnitude of the difference in precision scores between the two procedures was small. The probability of an index grade assigned by procedure 2b being within 2 index points of the actual index for an individual carcass tended to be about 1 percent higher than for procedure 2a. As shown in Table 4.6, an F-test comparing corresponding precision scores obtained by the two procedures indicated none of the pairs of precision scores for a given trial were significantly different at the 20 percent level.

TABLE 4.6

Procedures 2a and 2b Precision Scores -- 1981 and 1982 Data

1981	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Procedure 2a						
Lowest Std. Dev. Res. (Nov.)	3.137	3.157	3.024	3.014	2.980	2.982
80% C.I. (index points)	±4.02	±4.04	±3.87	±3.86	±3.82	±3.82
$P(\hat{Y} = Y \pm 2$ index points)	48%	47%	49%	49%	50%	50%
Highest Std. Dev. Res. (March)	3.488	3.555	3.377	3.383	3.284	3.316
80% C.I. (index points)	±4.47	±4.55	±4.32	±4.33	±4.20	±4.25
$P(\hat{Y} = Y \pm 2$ index points)	43%	43%	45%	45%	46%	45%
Procedure 2b						
Lowest Std. Dev. Res. (Dec.)	(Nov.) 3.107	3.129	3.004	2.982	(Nov) 2.945	2.946
80% C.I. (index points)	±3.98	±4.01	±3.85	±3.82	±3.77	±3.77
$P(\hat{Y} = Y \pm 2$ index points)	48%	48%	50%	50%	50%	50%
Highest Std. Dev. Res. (March)	3.470	3.538	3.359	3.367	3.265	3.299
80% C.I. (index points)	±4.44	±4.53	±4.30	±4.31	±4.18	±4.22
$P(\hat{Y} = Y \pm 2$ index points)	44%	43%	45%	45%	46%	46%
1982						
Procedure 2a						
Lowest Std. Dev. Res. (Nov.)	3.074	3.099	2.966	2.950	2.915	2.914
80% C.I. (index points)	±3.94	±3.97	±3.80	±3.78	±3.73	±3.73
$P(\hat{Y} = Y \pm 2$ index points)	48%	48%	50%	50%	51%	51%
Highest Std. Dev. Res. (Jan.)	3.308	3.339	3.195	3.186	3.143	3.156
80% C.I. (index points)	±4.24	±4.28	±4.09	±4.08	±4.02	±4.04
$P(\hat{Y} = Y \pm 2$ index points)	45%	45%	47%	47%	48%	47%

TABLE 4.6 (Continued)

Procedures 2a and 2b Precision Scores -- 1981 and 1982 Data

1982	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Procedure 2b						
Lowest Std. Dev. Res. (Dec.)	2.979	2.999	2.877	2.861	2.841	2.832
80% C.I. (index points	±3.81	±3.84	±3.68	±3.66	±3.64	±3.63
P($\hat{Y}$ = Y±2 index points)	50%	50%	51%	52%	52%	52%
Highest Std. Dev. Res. (Jan.)	3.276	3.309	3.165	3.156	3.109	3.122
80% C.I. (index points)	±4.20	±4.24	±4.05	±4.04	±3.98	±4.00
P($\hat{Y}$ = Y±2 index points)	46%	45%	47%	47%	48%	48%
F-ratio*						
1981 - Lowest Std. Dev. Resid.	1.019	1.018	1.013	1.022	1.024	1.025
Highest Std. Dev. Resid.	1.010	1.010	1.011	1.010	1.012	1.010
1982 - Lowest Std. Dev. Resid.	1.065	1.068	1.063	1.063	1.053	1.059
Highest Std. Dev. Resid	1.020	1.018	1.019	1.019	1.022	1.023

*Critical F value for the 0.20 level is 1.11.

Interpretation

Since the Canadian Index 100 grade index table has at times gone without being updated for periods in excess of two years (e.g., January, 1979 to March, 1982; and March, 1982 to present), it is likely that the premiums and discounts assigned by the table have tended to exhibit increasing positive bias over such periods. The practical implications of such bias are discussed below.

In regards to the grade-price signal being communicated to producers, positively biased grade-prices put a greater emphasis on the production of higher quality (particularly leaner) carcasses than is warranted by the actual response of carcass value to differences in carcass measurements (particularly backfat) between carcasses. Thus, packers' preferences for higher quality hogs are magnified, thererby distorting the communication of packers' preferences to producers. Theoretically, this distortion of the grade-price signal results in the production of a greater quantity of high quality (i.e., low backfat) carcasses than is optimally required to maximize packers' satisfaction.[33] It may be argued, however, that an overemphasis on leanness is desirable if this is in anticipation of future market preferences for lean carcasses. Overemphasizing market preferences for leanness may allow a given pork exporting sector to maintain a "competitive edge" in terms of the desirability of its pork carcasses for export.

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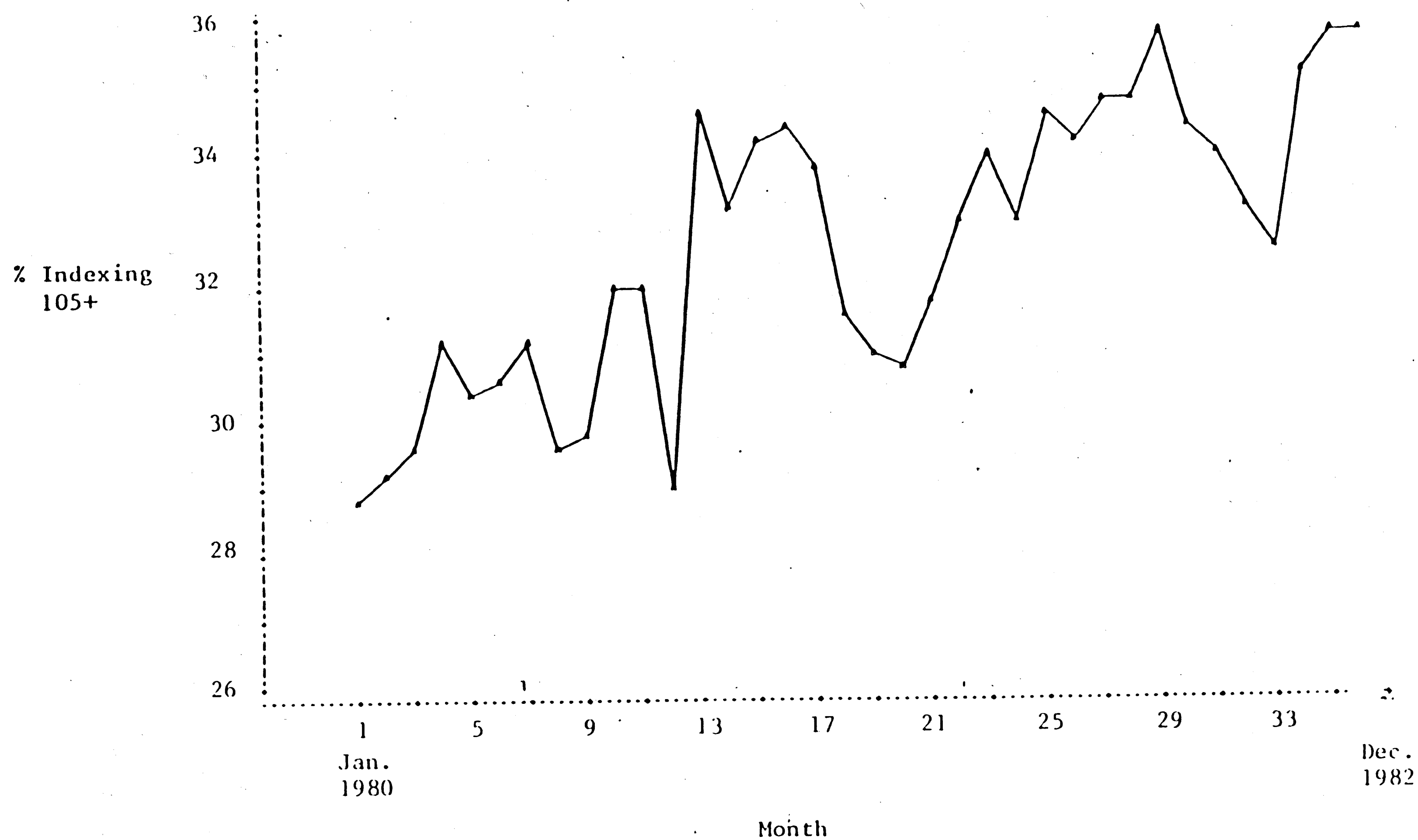
[33] It is assumed that packers maximize their satisfaction by maximizing profits in their pork processing operations. Rawls, op. cit., determined that if packers are maximizing profits, the grade-prices paid for pork carcasses will be equated to their net value differentials.

In regards to the equity of the grade-pricing system, the presence of increasing positive yearly bias means that carcasses of above average quality would tend to receive premiums in excess of what is warranted by their differentials in economic value, while below average quality carcasses would tend to receive price discounts which are larger than warranted. As a consequence, producers of high quality pork carcasses benefit at the expense of packers, while packers benefit at the expense of producers of lower quality carcasses. Therefore, producers of higher quality hogs are made better off, and producers of lower quality hogs are made worse off, than they would be under a grade-pricing system that was adjusted yearly. Canadian producers of slaughter hogs may consider such a situation to be objectionable, since all producers are not treated equitably.

The effect of positive yearly bias with regards to the equitable treatment of producers versus packers requires careful interpretation. This study has indicated that the observed decreasing trend in the response of carcass index grades to backfat thickness may be due, at least in part, to a decreasing trend in the wholesale price difference between hams (the largest lean cut in a carcass) and bellies (whose percentage carcass yield is positively related to backfat thickness). If we assume that a change in the relative structure of wholesale pork prices is the only trend which has occurred in Canada, (so that the grade distribution of pork carcasses has remained normal about the mean index, 100) then neither packers nor producers as a whole would be affected by the presence of positive yearly bias -- i.e., neither packers nor producers would benefit at the expense of the other (although producers of high quality carcasses would benefit at the expense of producers of low quality carcasses). However, in the case of the Canadian slaughter hog industry, the average physical traits of the slaughter hog population also have been changing. Figure 4.5 reveals that a higher percentage of the slaughter hog population graded at an index of 105 or higher in 1980 and 1981, as compared to 1979 (based on the Index 100 table which was in force from 1979 to early 1982). Figure 4.6 indicates that a lower percentage of the slaughter hog population graded at an index of between 85 to 95 in 1980 and 1981.

Thus, during this period, it appears the 100 index grade no longer identified carcasses of average value. Rather, a 100 index carcass would be expected to be of slightly lower than average value. At the same time, the grade-price differentials being assigned by the 1979 Index 100 table were likely increasingly positively biased over 1980, 1981, and early 1982. Since more carcasses received above average (i.e., 100+) index grades, and the premiums and discounts of the 1979 Index 100 Table were likely positively biased for 1980 and 1981, then the total dollar amount of grade-price overpayment for carcasses indexing above 100 presumeably exceeded the total dollar amount of grade-price underpayment for carcasses indexing below 100 during the 1980-1981 time period. However, this does not mean that producers as a whole benefitted at the expense of packers. Since packers determine their base price bids (i.e., 100 index price bids) for pork carcasses according to the average net value realized from their operations for all carcasses, they cannot unwittingly, through the fault of the grade-pricing system, be put in a position where they end up paying more for carcasses, on av-



Based on data from the <u>Canadian Livestock and Meat Trade Report</u>, 1979-1981

Figure 4.5: Percent of Canadian Hog Population Indexing 105+ Over Time

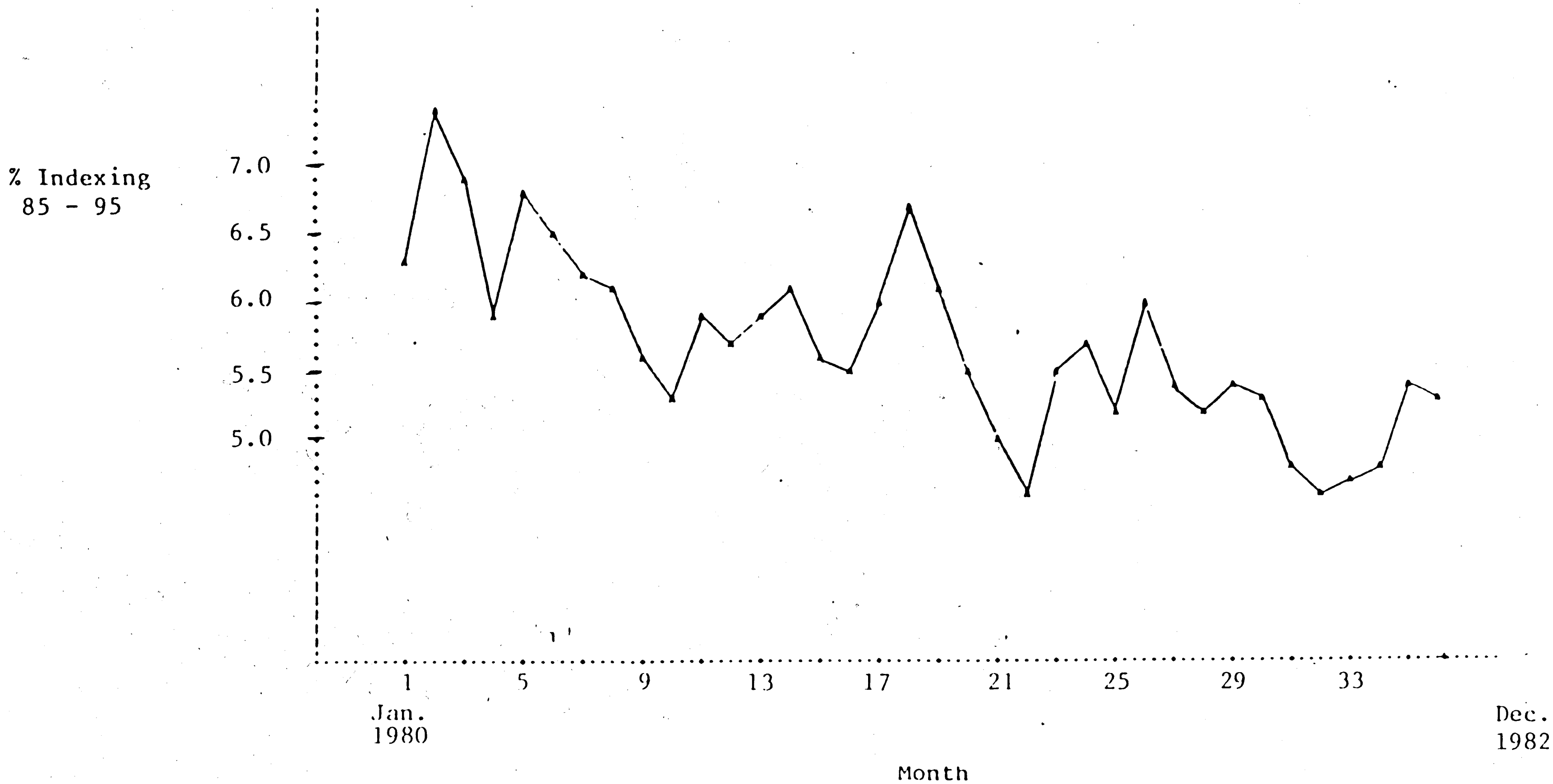


Figure 4.6: Percent of Canadian Hog Population Indexing 85-95, Over Time

erage, than the average net value realized from these carcasses would dictate. If, for example, a trend occurs in the hog population such that the Index 100 grade identifies a carcass of less than average net value, packers will simply adjust their base price bids accordingly downward. Therefore, although the Index 100 table has at times remained unchanged for periods in excess of two years, serving to produce a grade-price signal that tends to overemphasize the effects of differences in backfat and weight on carcass value, this probably has not resulted in inequitable treatment between packers and slaughter hog producers. The likely result of the maintenance of the same Index 100 grade index table from 1979 to early 1982, therefore, was that producers of hogs of above average quality benefitted from grade-price premiums which increasingly became larger than warranted, while producers of below average quality hogs received grade-price discounts which also became increasingly larger than warranted.

Further research is required to determine the actual dollar value impacts of such overall positive grade-pricing bias with regards to the equitable treatment of all slaughter hog producers, and on the effect of an overemphasis on carcass quality on the ability of Canadian pork to expand its export markets. With this information, the Canadian hog/pork industry then could weigh the detriments (inequitable treatment among producers) of yearly positive grade-pricing bias versus its benefits (higher quality of the Canadian slaughter hog population). On this basis, it could be decided whether the presence of positive bias in fact is undesirable.

If the industry's aversion to such positive bias is strong, then yearly updates to the Index 100 premiums and discounts may be justified. Otherwise, updates every two years may be sufficient, as this practice would allow a certain degree of positive bias to occur, but would ensure that the grade-price signal generated by the system does not become too seriously out of line with packers' preferences.

4.1.2.3 Adjusting Premiums and Discounts Over Carcass Weight Ranges

The hypothesis addressed in this section is:

Adjusting the pattern of the grade-price premiums and discounts associated with incremental differences in backfat and weight between carcasses of different weight ranges has no significant effect on i) grade-pricing precision, or ii) the practical achievement of grade-pricing efficiency in the slaughter hog market.

Two grade-pricing procedures were applied to the sample data. Both procedures accounted for the seasonality and trend in the carcass value-carcass measurements relationship by assigning index grades for a given month according to an estimate of the relationship for that specific month. Therefore, neither procedure exhibited any grade-pricing bias. The difference between the two procedures was that while procedure 3a used one regression (using the entire carcass sample) for each month, procedure 3b used three estimated regressions[34] for each month (one for

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[34] For each month, a regression of carcass value on the chosen carcass measurements was performed for i) a subsample of carcasses weighing less than 72.4 kg., ii) a subsample of carcasses weighing between 72.4 and 81.5 kg., and iii) a subsample of carcasses weighing in excess of 81.5 kg.

each of three different weight ranges of carcasses).

Comparison of Procedures 3a and 3b

It has been demonstrated that grade-pricing bias is eliminated for a given time period if the grade-pricing system is adjusted to reflect the structure of prices in the wholesale pork market for that time period. Grade-pricing bias therefore is not affected by whether or not the grade-pricing system is adjusted over carcass weight ranges.

Grade-Pricing Precision -- Table 4.7 presents the precision scores obtained by procedures 3a and 3b when they were applied to the 1980 data.[35] Comparing precision scores for a given month and trial, procedure 3b consistently produced precision scores superior to those of procedure 3a. The improvement in grade-pricing precision obtained by using procedure 3b in comparison to 3a tended (over the six trials) to be statistically significant at the 20 percent level. However, the magnitude of the improvement in the precision scores would not be great enough to have a perceptible influence on market participants' confidence in the ability of the system to assign correct index grades to individual carcasses. The probability of an index grade assigned by procedure 3b to an individual carcass being within 2 index points of its actual index grade tended to be only about 2 or 3 percent higher than that for procedure 3a. This improvement is small in comparison to the overall level of grade-pricing precision that one could, at best, expect. For procedure 3a, the highest probability of grading individual carcasses accurately within 2 index points was approximately 48 percent, while for

[35] Results were presented for 2 of the 12 months (i.e., the highest and lowest precision scores obtained for the year) only, in order to limit the volume of numerical results presented.

TABLE 4.7

Procedures 3a and 3b Precision Scores -- 1980 Data

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Procedure 3a						
Lowest Std. Dev. Resid.	3.224	3.252	3.114	3.100	3.044	3.051
80% C.I. (index points)	±4.13	±4.16	±3.99	±3.97	±3.90	±3.91
$P(\hat{Y} = Y \pm 2$ index points)	47%	46%	48%	48%	49%	49%
Highest Std. Dev. Resid.	3.728	3.807	3.621	3.637	3.534	3.569
80% C.I. (index points)	±4.77	±4.87	±4.64	±4.66	±4.53	±4.57
$P(\hat{Y} = Y \pm 2$ index points)	41%	40%	42%	42%	43%	43%
Procedure 3b						
Lowest Std. Dev. Resid.	3.108	3.136	2.924	2.809	2.840	2.851
80% C.I. (index points)	±3.98	±4.02	±3.74	±3.60	±3.64	±3.65
$P(\hat{Y} = Y \pm 2$ index points)	48%	48%	51%	52%	52%	52%
Highest Std. Dev. Resid.	3.544	3.630	3.336	3.340	3.228	3.236
80% C.I. (index points)	±4.54	±4.65	±4.27	±4.28	±4.13	±4.14
$P(\hat{Y} = Y \pm 2$ index points)	43%	42%	45%	45%	46%	46%
F - Ratio*						
Lowest Std. Dev. Resid.	1.076	1.075	1.134	1.174	1.149	1.145
Highest Std. Dev. Resid.	1.107	1.100	1.178	1.186	1.199	1.216

*Critical F value for the 0.20 level is 1.11.

procedure 3b, this probability was approximately 51 percent.

Interpretation

The practical benefits of accounting for the instability of the carcass value-carcass measurements relationship over different weight ranges of carcasses in the Index 100 table were shown to be small. However, the cost of currently applying this practice in the Canadian system also is small. There is little extra effort involved in estimating the carcass value-carcass measurements relationship for separate carcass weight ranges, as opposed to estimating the relationship once for all weight ranges. Therefore, since this procedure produces a small contribution to grade-pricing precision at negligible cost, it is felt that instabilities in the carcass value-carcass measurements relationship over carcass weight ranges should continue to be reflected in the Index 100 grade index table. At the same time, it is recognized that the failure to reflect this instability (as is the case in the NPPC's proposed grade index table) does not result in a serious loss of grade-pricing precision.

4.2 CHOICE OF CARCASS MEASUREMENTS

4.2.1 Ranking the Carcass Measurements

Here, the hypothesis of interest is:

Ranking carcass measurements according to their ability to explain carcass economic value will produce the same result as ranking carcass measurements according to their ability to explain carcass yield.

Index grades were calculated for the sample carcasses using average wholesale pork prices for 1980. Six regressions then were estimated using these calculated index grades as the dependent variable; one regression for each of the six sets of carcass measurements. In all six regressions, all estimated coefficients had their expected signs (positive for muscle thickness, and negative for carcass weight and backfat thickness).

The estimated intercept was, in all six regressions, essentially equal to zero (.0001 level).[36] The estimated coefficients for carcass weight ranged from -0.07 to -0.11, indicating that carcass index grades tend to decrease at a rate of about one index point for every ten kilogram increase in carcass weight. This compares reasonably with the index discounts associated with overly-large carcasses, as reflected in the current Index 100 grade-index table. The magnitude of the estimated coefficients for fat thickness also were reasonable in comparison to the Index 100 table discounts associated with increasing backfat (though the Index 100 backfat discounts tend to be more severe). The Index 100 table associates a discount of roughly 0.6 index points for a one millimeter increase in backfat thickness, while the coefficients in Table 4.8 suggest approximately a 0.5 index point discount for every additional millimeter of backfat. Therefore, the estimated coefficients obtained for the various carcass measurements all compared reasonably with theoretical expectations. In addition, none of the six trials exhibited signs of serious multicollinearity, or significant (10 percent level)

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[36] Because the dependent and independent variables all were expressed as differences from their respective mean values, the expected value of the intercept was, in all cases, zero.

heteroscedasticity.

Given that there was basically nothing to choose between the six trials in terms of the "theoretical" and "econometric" properties of the estimated regressions, the trials were ranked on the basis of the "statistical" properties of the estimated regressions. That is, ranking was determined on the basis of R-square , with the condition that every estimated coefficient in a given regression be significant at the 10 percent level or better.

The six estimated regressions are presented in Table 4.8. All estimated coefficients were significant at the 10 percent level or higher. Based on the R-square values presented in Table 4.8, the trials can be ranked, in descending order, as follows:

1. warm carcass weight, last rib fat and muscle thickness (trial 5);
2. warm carcass weight, 3-4th last rib fat and muscle thickness (trial 6);
3. warm carcass weight, 3-4th last rib fat thickness (trial 4);
4. warm carcass weight, last rib fat thickness (trial 3);
5. warm carcass weight, sum of loin and shoulder fat thickness (trial 1);
6. warm carcass weight, loin fat thickness (trial 2).

Note, from Table 4.8, that the difference in R-square between trials 5 and 6 was very small, indicating virtually no difference in the ability of the last rib fat and muscle thickness measurements to explain variations in carcass value, as compared to the 3-4th last rib measurement site. A similar observation is true in comparing the last rib and 3-4th

TABLE 4.8

Alternative Carcass Measurements: Estimated Regressions --.Avg. 1980 Data

	Intercept	FSUM	RLOINF	FMLR7F	FM34R7F	FMLR7M	FM34R7M	WCW	R^2
Trial 1									
Estimate	2.3614^{-8}	-5.3479						-0.0699	.3641
Standard Error	0.2163	0.5255						0.358	
Prob. >ltl	1.0000	0.0001						0.0519	
Trial 2									
Estimate	3.6065^{-8}		-9.4081					-0.0858	.3455
Standard Error	0.2194		0.9719					0.0359	
Prob. >ltl	1.0000		0.0001					0.0175	
Trial 3									
Estimate	2.5250^{-9}			-0.5319				-0.0705	.4054
Standard Error	0.2091			0.0471				0.0341	
Prob. >ltl	1.0000			0.0001				0.0267	
Trial 4									
Estimate	1.2929^{-9}				-0.4917			-0.0945	.4094
Standard Error	0.2084				0.0431			0.0335	
Prob. >ltl	1.0000				0.0001			0.0052	
Trial 5									
Estimate	2.1569^{-9}			-0.4832		0.0955		-0.1102	.4354
Standard Error	0.2042			0.0479		0.0266		0.0346	
Prob. >ltl	1.0000			0.0001		0.0004		0.0017	
Trial 6									
Estimate	1.6671^{-9}				-0.4648		0.0793	-0.1160	.4310
Standard Error	0.2050				0.0433		0.0262	0.0337	
Prob. >ltl	1.0000				0.0001		0.0027	0.0007	

Note* - F - statistics for all six regressions were significant at the .0001 level.

TABLE 4.8 - (Continued)

Alternative Carcass Measurements: Estimated Regressions -- Avg. 1980 Data

FSUM = sum of loin and shoulder fat measurements (inches; ruler measurement)

RLOINF = loin fat thickness measurement (inches; ruler measurement)

FMLR7F = last rib fat thickness measurement (millimeters; fat-o-meater probe)

FM34R7F = 3-4th last rib fat thickness measurement (millimeters; fat-o-meater probe)

FMLR7M = last rib muscle thickness measurement (millimeters; fat-o-meater probe)

FM34R7M = 3-4th rib fat thickness measurement (millimeters; fat-o-meater probe)

WCW = warm carcass weight (Kilograms)

last rib sites when muscle thickness measurements are excluded. Based on these observations, a more appropriate ranking of the six trials would be, beginning with the best ability to explain carcass value:

1 and 2. trial 5 or trial 6;

3 and 4. trial 4 or trial 3;

5. trial 1;

6. trial 2.

Interpretation

The above ranking is essentially similar to the ranking of these same carcass measurements on the basis of their ability to explain carcass yield. On the basis of this simple comparison, justification is provided for the currently common practice of examining the suitability of alternative carcass measurements as standards for carcass quality, based on their ability to predict physical measures of carcass yield. When quality is defined in terms of carcass value, as in this study, those measurements which best explain variations in carcass yield generally can be expected to best explain variations in carcass economic value.

4.2.2 Effect on Grade-pricing Precision

The choice of carcass measurements does not increase or decrease grade-pricing bias, as bias has been shown to result strictly from the instability of the carcass value-carcass measurements relationship over time. In examining the effect of the choice of carcass measurements on grade-pricing performance, the hypothesis of interest thus can be stated as follows:

The choice of carcass measurements used in a grade-pricing system has no significant effect on i) grade-pricing precision, or ii) the practical achievement of grade-pricing efficiency in the slaughter hog market.

To evaluate the effect of the choice of carcass measurements on grade-pricing precision, the six combinations of carcass measurements were used to assign index grades to the sample carcasses for each month in 1980, using three different grade-pricing procedures. In this way, if the choice of grade-pricing procedure used had an effect on the relative precision scores for the alternative trials of carcass measurements, this would become apparent. Procedure 1a did not account for seasonality or trend in the carcass value-carcass measurements relationship, or for variation in this relationship over carcass weight ranges. Procedure 1b accounted for all seasonality and trend in the carcass value-carcass measurements relationship for 1980, but did not account for any variation in the relationship over carcasses of different weight ranges. Procedure 3b accounted for instability in the relationship over time and over weight range by assigning index grades for each month based on separate regressions for light, medium, and heavy weights of carcasses, re-estimated for each of the twelve months.

Table 4.9 presents the mean of the 12 precision scores obtained by each of the above procedures when applied to the 1980 wholesale pork price data. In the table, the trials are presented, from left to right, in order from least grade-pricing precision to greatest precision. No significant (20 percent) improvement in grade-pricing precision was exhibited between adjacent trials (with one exception; procedure 3a, trials 1 vs. 3). Comparing the best trial to the worst (trial 5 vs. trial

2), statistically significant (20 percent level) differences in grade-pricing precision were indicated consistently, for all three grade-pricing procedures. In addition, regardless of the grade-pricing procedure used, the last rib and 3-4th last rib sites consistently produced smaller (superior) precision scores compared to the loin site.

For procedures 1a and 1b, the improvement in precision was just short of being significant at the 20 percent level. The improvement was significant at the 20 percent level using procedure 3b. The inclusion of muscle thickness measurements at either of the 3-4th last rib or last rib sites consistently improved the precision scores obtained, although the magnitude of this improvement was not significant (20 percent level) in any of the trials.

<u>Interpretation</u>

The use of carcass weight and either fat thickness at the last rib or the 3-4th last rib could slightly improve the precision scores obtained by the single measurement of loin fat thickness and carcass weight currently used in the Index 100 system. In the tests performed here, the probability of an individual carcass being assigned an index grade within 2 index points of its actual index grade was improved by about 1.5 percent; from approximately 45.0 percent to approximately 46.5 percent. Though such an increase in grade-pricing precision is, in practical terms, small, there would appear to be little practical difficulty associated with graders obtaining either last rib or 3-4th last rib fat measurements in place of the loin fat measurement used currently. However, while a loin fat thickness measurement can be obtained using either ruler or electronic probe, the last rib and 3-4th last rib measure-

TABLE 4.9

Alternative Carcass Measurements: Grade-Pricing Precision -- 1980 Data

	Trial 2	Trial 1	Trial 3	Trial 4	Trial 6	Trial 5
Procedure 1a	Assigned indices not adjusted for month or carcass weight range					
Avg. Std. Dev. Resid.	3.500	3.452	3.342	3.332	3.273	3.261
80% C.I. (index points)	±4.48	±4.42	±4.28	±4.27	±4.19	±4.18
$P(\hat{Y} = Y\pm2$ index points)	43%	44%	45%	45%	46%	46%
F - ratio*	1.028	1.067	1.006	1.036	1.007	Trial 5 vs. 2: 1.152
		1.097		1.043	1.044	
Procedure 1b	Assigned indices adjusted for each month					
Avg. Std. Dev. Resid.	3.473	3.424	3.314	3.303	3.244	3.231
80% C.I. (index points)	±4.45	±4.38	±4.24	±4.23	±4.15	±4.14
$P(\hat{Y} = Y\pm2$ index points)	44%	44%	45%	46%	46%	46%
F - ratio*	1.029	1.067	1.007	1.037	1.008	Trial 5 vs. 2: 1.155
		1.098		1.043	1.045	
Procedure 3b	Assigned indices adjusted for light, medium and heavy weight carcasses, for each month					
Avg. Std. Dev. Resid.	3.335	3.283	3.090	3.090	3.010	2.995
80% C.I. (index points)	±4.27	±4.20	±3.96	±3.96	±3.85	±3.83
$P(\hat{Y} = Y\pm2$ index points)	45%	46%	48%	48%	49%	50%
F - ratio*	1.032	1.129	1.000	1.054	1.010	Trial 5 vs. 2: 1.240
		1.165		1.054	1.064	

*Critical F value for the 0.20 level is 1.11

ment sites examined in this study require the use of electronic probe measuring techniques.

From this, one can conclude that a small increase in the grade-pricing precision of the Index 100 system could be obtained through the use of electronic measurements of fat thickness at the last or 3-4th last rib in place of the current ruler measurement of fat thickness at the loin. At the same time, it can be concluded that the current use of ruler-measured loin fat is not seriously detrimental to the grade-pricing precision of the Index 100 system, compared to the degree of precision that could be obtained by the use of the electronically-determined fat measurements. The use of either the last or 3-4th last rib fat measurement sites thus would be recommended for use in the Index 100 system only if the implementation of electronic measuring techniques could be shown to be practically feasible.[37] However, it is felt that the improvement in grade-pricing precision obtained by the electronic measurements examined here would not be great enough to warrant the introduction of electronic grading technology if there was a substantial cost associated with this technology.

The addition of an accompanying measurement of muscle thickness at either the last or 3-4th last rib sites was shown to provide additional improvement to grade-pricing precision, though this improvement was very small. Physically obtaining and recording an accompanying muscle depth measurement likely would not be a problem if an electronic probe is

[37] The capital cost of the electronic equipment may be offset by gains in the operational efficiency of graders. Electronic grading equipment could automatically record the carcass measurements, determine the appropriate grade index, calculate the subsequent price per kg. for the carcass, and print out a cheque in payment to the producer.

used. However, the Index 100 grade-index table currently used is designed to accomodate the use of only two carcass measurements. The introduction of a third carcass measurement would require that a new format be developed for expressing the index grades associated with varying levels of backfat, weight, and muscle thickness. Because the improvement in grade-pricing precision attainable through the inclusion of muscle thickness measurements was shown to be minimal, and the inclusion of a third measurement would require a new format to replace the two-dimensional grade index table currently used, the inclusion of muscle thickness at the last rib and 3-4th last rib measurement sites would not appear to be justified.

Chapter V

SUMMARY AND CONCLUSIONS

The concept of pricing efficiency dictates that market preferences be communicated to producers via the medium of price, so that producers can allocate their productive resources in a manner which will produce a mix of goods that maximize consumer satisfaction and producer welfare. Therefore, pricing efficiency requires that the price differentials paid to reflect the quality differentials between pork carcasses of varying physical type should be equated to the actual value differentials between those carcasses. At the same time, the desire to maintain physical efficiency in the hog/pork industry requires that the grading/differential pricing process be relatively quick and inexpensive.

The general problem addressed in this study was to examine various mechanisms for assigning differential prices to pork carcasses. Alternative mechanisms tested differed in terms of i) the procedure used in estimating the relationship of carcass quality to the carcass measurements used to define the grade standards, and ii) the carcass measurement used to define the grade standards. Of interest was whether these mechanisms could serve to aid in the establishment of grade-pricing efficiency in the slaughter hog market. The specific objectives were:

1. to compare the ability of various grade-pricing mechanisms to contribute to pricing efficiency;

2. to determine whether the pricing efficiency achieved by the Canadian Index 100 system might be improved;
3. to assess the practical feasibility of attaining any such improvements.

The first objective was achieved by using econometric models to represent various grade-pricing mechanisms for pork carcasses and observing the degree of pricing efficiency achieved by these alternative mechanisms. The second and third objectives were achieved by interpreting the results obtained from these models.

Cutout data were obtained (from Agriculture Canada) for a stratified sample of 247 pork carcasses. Carcass weight and various measurements of backfat and muscle thickness also were recorded for each carcass. The value of each carcass was calculated (expressed as an index of the mean carcass value) for each of 36 sets of monthly average Canadian wholesale pork price data (spanning 1980, '81, and '82), modified to reflect packers' preferences for specific weight ranges of individual wholesale cuts.

Pricing efficiency was measured by examining how closely the index grades assigned by a particular grade-pricing mechanism matched the actual calculated index grades for the sample carcasses. Two measures of pricing efficiency were used. "Bias" measured whether a given grade-pricing mechanism tended to either over or underestimate the actual response of carcass value to differences in carcass weight, backfat, and muscle thickness. "Precision" measured the probability that the index grade assigned to an individual carcass would be within 2 index points of the actual index grade for that carcass. After determining the bias and precision scores for the various grade-pricing mechanisms, an attempt was made to identify the practical benefits and probable costs that would be associated with the actual implementation of a given mechanism. The results of the study are summarized within the following five general recommendations.

Seasonal Adjustments to a Grade-Pricing System

An analysis of the data indicated seasonal fluctuations in the degree by which carcass value is affected by carcass weight. It was determined that if a grade-pricing system (like the Index 100 system) does not adjust seasonally to reflect the seasonal preferences of packers for heavy carcasses, the grade-price discounts for heavy carcasses will tend to be larger than warranted during the summer months, and smaller than warranted prior to the Christmas season. Further analysis, however, indicated that this seasonal bias in grade-pricing has no serious implications for the Canadian slaughter hog industry. Since seasonal biases in grade-pricing balance out over the year, in the long run, they do not result in inequitable treatment between producers and packers, or amongst producers.

One possible justification for seasonally adjusting the Index 100 table was identified; the seasonal "tailoring" of the average carcass weight of the slaughter hog population to packers' seasonal preferences might facilitate a reduction in packers' cutting, trimming, and processing costs. Further research is required to determine whether seasonal adjustments to the Index 100 table would in fact achieve this.

Based on the above, the following recommendation is made:

1. Seasonal adjustments to the Index 100 grade index table are not recommended at present. Further research is recommended to establish whether there is a realistic potential for this practice to reduce packers' operational costs, and to determine the costs that would be incurred in seasonally updating the Index 100 table.

Adjustment in Response to Long Term Trends

Analysis of the sample data indicated that, for the time period studied, the premiums and discounts which accurately reflect the effect of backfat thickness and carcass weight on carcass value for a given year tend to be larger than those warranted for the following year. The estimated relationship of carcass value to backfat and weight for 1980, when applied to 1982 data, tended to overestimate the index grade for carcasses of above average value. Carcasses of below average value tended to receive index grades which were too low. Subsequent analysis determined that such a situation does not unjustly benefit either producers or packers in aggregate. However, it does benefit producers of higher quality hogs at the expense of producers of lower quality hogs. While this is inequitable, it may help establish a slaughter hog population of superior quality; a result which may be desirable for a pork exporting country such as Canada.

In examining the adjustment of grade-pricing systems in accordance with trends in market preferences for pork products, the question of most practical relevance is to determine how often such adjustments should take place. The following recommendation is made in regards to the Canadian Index 100 system:

2. Updates to the Index 100 system in response to trends in market preferences (such as the continued preference for lean pork) should be performed every two years. This would be adequate to ensure that the grade-price signal generated by the system does not become seriously biased in relation to the actual relationship of pork carcass value to backfat thickness and weight.

Adjustment for Carcass Physical Type

An analysis of the data indicated instability in the effect of backfat and weight on carcass value for carcasses subsampled according to weight range. It was determined that accounting for this instability (as is done in the Index 100 system) improves grade-pricing precision, but only to a small degree. Therefore, a grade-pricing system which does not account for this instability (such as the United States National Pork Producers Council's [NPPC] proposed grade index table) would be expected to exhibit only a slightly lower level of grade-pricing precision.

Although the practice of accounting for this instability contributes only slightly to grade-pricing precision, it requires only minimal extra effort or cost. Therefore, since this practice produces a small benefit in terms of grade-pricing efficiency at essentially zero extra cost, the following recommendation is made:

3. The Index 100 system should continue to reflect in its grade index table the instability of the relationship between carcass value and carcass measurements for different weight ranges of carcasses.

Use of Electronic Probe Measurements of Backfat Thickness

In comparing the ability of various carcass backfat and muscle thickness measurements to contribute to the establishment of efficient grade-pricing, electronic probe backfat thickness measurements at either the last rib or 3-4th last rib sites were examined. These were shown to provide slightly better grade-pricing precision compared to the backfat measurement currently used in the Index 100 system (i.e., backfat thickness over the loin, measured using a ruler). However, the magnitude of the improvement was small.

The concept of employing electronic measuring techniques for pork carcass grading has generated much interest in the slaughter hog industry. The implementation of this technology could eliminate manual errors in recording carcass measurements. Moreover, it could eliminate all manual paperwork involved in recording index grades for individual carcasses, calculating prices, and filling out cheques for producer payment. Further research is required to determine whether the improvements in operational efficiency would be sufficient to offset the capital cost of acquiring and implementing electronic grading technology. The results of this study have indicated that electronic probe grading techniques could be implemented in Canada with no loss in grade-pricing efficiency. In fact, the adoption of this technology would be expected to provide a slight improvement in grade-pricing precision (based on the backfat measurements examined in this study). Research into the cost-effectiveness of implementing electronic grading technology should be undertaken by the Canadian hog/pork industry. If this technology can be shown to be desirable from the perspective of operational efficiency, then from the perspective of pricing efficiency, the following recommendation can be made:

4. The use of electronic probe measurements of backfat thickness at the last rib or 3-4th last rib sites are recommended over the ruler measurement of backfat at the loin, currently used in the Index 100 system.

Use of Electronic Probe Measurements of Muscle Thickness

In the U.S., the NPPC's "Lean Guide" grade index table includes a subjective measurement of the degree of carcass muscling. To provide an incentive for the production of "meaty" carcasses, a 1.5 index point premium is assigned to thickly muscled carcasses, while thinly muscled carcasses receive a 1.5 index point penalty. The NPPC has noted that the use of objective measurements of carcass muscling requires the implementation of electronic probe or ultrasonic measurement techniques by packers.

Electronic probe measurements of muscle thickness at the last rib and 3-4th last rib sites were examined in this study to determine their ability to contribute to grade-pricing efficiency. The analysis indicated the inclusion of muscle thickness measurements would provide only minimal improvement to the degree of grade-pricing efficiency that can be obtained by use of carcass weight and backfat alone. The inclusion of electronic measurements of muscle thickness in addition to measurements of backfat thickness may reduce the rate at which carcasses could be graded. In addition, the implementation of this practice in Canadian slaughter hog grading would not be accomodated by the current format of the Index 100 grade index table (which is designed to accomodate only two carcass measurements). The inclusion of a third carcass measurement would require the development and implementation of a new format for the Index 100 grade standards. In addition to the dollar cost of such a program, since the current format of the Index 100 grade index table is easily understood by Canadian packers and producers, the introduction of a new format to accomodate the inclusion of muscle thickness measurements may be undesirable. Therefore, although the inclusion of muscle thickness measurements in the Index 100 system would provide a minimal improvement in grade-pricing precision, this benefit would likely be outweighed by the extra costs associated with this practice. Consequently, the following recommendation is made:

5. The inclusion of accompanying (in addition to backfat) electronic measurements of muscle thickness at the last rib and 3-4th last rib sites in the evaluation of pork carcasses appears to be unjustified.

In conclusion, after comparing the ability of various grade-pricing procedures and carcass measurements to contribute to grade-pricing efficiency, it was determined that the current practices employed in the development and maintenance of the Index 100 system provide a level of pricing efficiency upon which only minor practical improvements could be made, given current grading technology.

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Appendix

WHOLESALE PORK PRICE DATA

In calculating carcass values, weight-range-specific prices were developed for hams, bellies, butts, and shoulders. Ideally, loins also would have been priced in this manner, but this was not possible due to inconsistencies between the definition of a Canadian wholesale meats (where loins are defined as boneless backs) and in the National Provisioner prices for U.S. wholesale meats (where prices are quoted for entire loins). Consequently, the weight-range-specific price premiums and discounts for U.S. loins were not applied to the Canadian price data, though this was achieved for the other primal cuts.

The procedure used to develop weight-range-specific prices for Canadian primal cuts is described below, using the example of hams for the time period of October, 1981 (Table A.1). For this time period, monthly average U.S. prices for four weight ranges were obtained. These prices were converted to price ratios by dividing the price for each weight range by the price quoted for the "optimal" weight range. In the case of hams, the optimal weight range was that of 14 to 17 pounds.[38] The

[38] An optimal weight range was defined as that weight range that consistently receives the highest price. Weight ranges observed for the various cuts were as follows (* denotes the optimal weight range for a cut).

Hams - *14 to 17, 17 to 20, 20 to 26, 26 to 30

Bellies - 10 to 12, 12 to 14, *14 to 16, 16 to 18, 18 to 20, 20 to 25

Picnics - *4 to 8, 8 and up

TABLE A.1

Developing Weight-Range-Specific Canadian Prices -- Hams

Weight Range (lbs)	14 - 17	17 - 20	20 - 26	26 - 30
U.S. Price ($/cwt)	84.450	80.750	78.875	76.200
Price Ratio	1.000	0.956	0.934	0.902
Canadian Price ($/100 kg.)		225.972		
Adjusted Canadian Price ($/100 kg.)	225.972	216.029	211.058	203.827

Canadian price for ham, averaged for October, 1981 then was multiplied by each of the computed price ratios to obtain a series of Canadian prices for ham, adjusted for weight-range preferences. A similar procedure was carried out for hams, bellies, butts, and picnics, for each observed time period.

Butts - *4 to 8, 8 and up

LIST OF WORKING PAPERS PUBLISHED IN 1985

No. 1 The Food Marketing Cost Index. O. Al-Zand, S. Barewal and G. Hewston. January 1985.

No. 2 The Parameters of Consumer Food Demand in Canada. S. Barewal and D. Goddard. January 1985.

No. 3 Canadian Greenhouse Vegetable Industry. Robert W. Anderson. February 1985.

No. 4 Alternative Pork Carcass Evaluation Procedures in Reference to the Canadian Index 100 System. Terrance P. Chabluk and Norman J. Beaton. February 1985.

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