December 1, 1971

To the Graduate Council:

I am submitting herewith a dissertation written by Warren Carl Couvillion, Sr., entitled "Pricing Efficiency, Physical Characteristics, and Wholesale Values of Slaughter Hogs." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

Irving Dubov
Major Professor

We have read this dissertation
and recommend its acceptance:

Luther H. Keller

James ...

Hans S. Jensen

Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

PRICING EFFICIENCY, PHYSICAL CHARACTERISTICS, AND WHOLESALE VALUES OF SLAUGHTER HOGS

A Dissertation

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

Warren Carl Couvillion, Sr.

December 1971

ACKNOWLEDGMENTS

The author expresses appreciation to several persons who have contributed to this study. Dr. Irving Dubov, his major professor, assisted and made helpful suggestions and criticisms throughout his program. Appreciation is expressed also to Dr. James Snell, Dr. Luther Keller, and Dr. Hans Jenson for their suggestions and constructive criticisms.

The author is deeply indebted to Mr. John Conger, Jr., for technical assistance in gathering and compiling the data for the study.

Sincere thanks are extended to members of the Agricultural Economics Department clerical staff for preparation and typing of preliminary manuscripts.

Special thanks go to my wife, Mike, for her help and encouragement throughout my program.

ABSTRACT

The objectives of this study were: (1) to estimate the cutout characteristics of U.S.D.A. Grades 1, 2, and 3 hogs at different weight intervals; (2) to determine the gross margin differentials[1] among these animals and to identify variables affecting this margin; (3) to use cutout characteristics established in Objective I to calculate GMD's for a different sample of animals, taking into account differences that may be attributable to both season and procurement method; and (4) to determine relationships that may exist between physical characteristics and wholesale values per hundredweight of hot carcasses under different situations of wholesale cut prices.

The facilities and records of a large, federally inspected meat packing company were made available to this researcher and provided the primary data source. Cut-out data were gathered on 180 animals. Sixty of these animals were from U.S.D.A. Grade 1, while U.S.D.A. Grades 2 and 3 provided 70 and 50 animals, respectively. They fell into 18 categories of 10 animals each, based on liveweight and grade. Cut-out data from these 180 animals were used to attain Objective I.

Linear multiple regression equations were used to test relationships among variables included in the last three objectives.

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[1]Gross Margin Differential per Hundredweight, hereafter referred to as GMD = $\frac{\text{Wholesale Value-Acquisition Cost}}{\text{Carcass Weight in Hundredweight}}$, where acquisition cost is the cost of the live animals delivered to the plant. This cost does not include costs associated with holding or slaughtering. Wholesale value is the estimated value of the carcass.

Analysis for Objective II revealed that increases in hot carcass weights and increases in liveweight prices were associated with lower GMD's. Lower GMD's were also associated with Grade 3 animals. However, as weights increased within this grade, GMD's increased.

Results of the analysis for Objective III also showed negative relationships between GMD's and increases in hot carcass weights, and increases in liveweight prices. Animals procured through order buyers, and animals purchased on a carcass basis had significantly lower GMD's than animals purchased on a direct liveweight basis. The GMD's for the second, third, and fourth quarter of the year were significantly higher than those for the first quarter. Results revealed also that GMD's for Grades 2 and 3 were significantly higher than those for Grade 1.

Analysis for Objective IV revealed that the degree of association between physical characteristics and wholesale values varied, depending on the wholesale cut prices used to estimate carcass values. The magnitude of the b coefficient varied widely for the variable hot carcass weight. Results indicated that there would be no advantage to using more than one backfat measure in carcass buying models. Assuming that the proper muscling score or grade would be given, results of the equations in each of the pricing situations for wholesale cuts indicate that carcass buying programs including grade or muscling as variables along with hot carcass weights would be as accurate as those using backfat measurements.

Several sources of potential inaccuracies in the buying practices of the firm were revealed in this study. One source may be a failure to discount properly for the heavier weights of some animals. Another may stem from a failure of the liveweight pricing system to reflect value differences between grades.

The GMD's received by a packer could be affected by the methods of procurement used (this may be only for the short run).

Many carcass buying models are based on systems of premiums and discounts based on the associations present between physical characteristics and wholesale values. Results would lead one to conclude that there are factors other than physical characteristics which are associated with change in wholesale values of animals. An example would be inconsistencies from one season to another in differences between prices of light and heavy hams or other wholesale cuts.

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CHAPTER I

INTRODUCTION AND GENERAL CONSIDERATIONS

I. INTRODUCTION

For many years hogs have been purchased on a liveweight basis. The assumption that buyers could adequately assess the value of an animal or group of animals was one of the bases for this procurement method. The structure of the market and sizes of lots sold by individual farmers also perpetuated this method of pricing. The problem of identity maintenance for individual animals after slaughter and costs associated with gathering more than an "eyeball" evaluation are other reasons that liveweight pricing has remained popular with both buyers and sellers. To the extent that returns to farmers are not in accordance with the wholesale value of the animals, a system using this method of pricing would not be efficient. From an individual firm's standpoint, however, a pricing system using a blend price may not affect the profitability of its operation.

It has been known for some time that the purchasing of animals on a carcass basis would help to improve pricing efficiency. Shepherd, et al., in 1940 listed the advantages of pricing slaughter animals on a carcass weight and grade basis, with grades determined by a disinterested third party:

> As far as can be determined, packers would pay out about the same amount of money for a given year's supply of hogs under the carcass system of sale as they would under the present live weight system. If the carcass system were adopted, the benefits to hog producers would come not from

> any increase in the total amount of money for a given run of hogs but from three other sources:
>
> (1) The money paid for the hogs would be distributed more equitably among the different hog producers than at present. Each producer would get more nearly what his particular hogs were worth. The producer of high-yielding and high-grade hogs would get more than under the present live weight system, and the producer of low-yielding and low-grade hogs would get less.
>
> (2) Under the stimulus of this incentive for raising high-yielding and high-grade hogs, with the passage of time hog producers would bring in hogs of higher average grade and yield than under the present system. A year's run of these higher grade hogs would be worth more to packers, and would enable them to pay more money to hog producers.
>
> (3) The carcass basis of sale would remove any incentive for 'filling' hogs, and hog producers would save the cost of the feed now wasted on this practice.
>
> Shifting the basis of sale from the live hog to the carcass and putting the carcass grading in government hands would involve the minimum disturbance of existing livestock trade practices. It would simply mean moving the scales inside the plant and putting a government grader beside them. This would (1) protect farmers and others dealing with more experienced hog buyers, (2) remove the need for 'haggling and bargaining' over the yield and grade of the carcass and (3) provide a uniform language for price quotations. By thus providing a clear, uniform and accurate language for buyers and sellers it would raise the plane of competition for hogs.[1]

Even though the advantages of such buying methods have long since been recognized, this method of marketing slaughter hogs has been slow to develop in this country. In fact, as of 1969 only 4.3 percent of hogs slaughtered in the United States were purchased by this method. In the State of Tennessee only 0.3 percent were marketed in this manner. Although these figures appear small, it should be noted that across the nation utilization of this marketing method has approximately doubled since 1963. In Kansas this method of marketing accounted for

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[1]Geoffrey Shepherd, Fred J. Beard, and Arval Erikson, Could Hogs Be Sold by Carcass Weight and Grade in the United States? (Iowa Experimental Station Research Bulletin 270, January 1940), p. 450.

14.1 percent of animals slaughtered, according to packers reporting to the Packers and Stockyards Administration.[2]

In addition to pricing efficiency, one must also take into account operational efficiency. Williams and Stout define these two measures of market performance as:

> (1) 'Physical' or 'operational' efficiency, which measures input-output relationships in moving agricultural products from farms to consumers and in adding the necessary services along the way, and (2) 'pricing efficiency,' which attempts to measure performance of the marketing system in establishing equitable prices and values and in providing services that prices in a free society are expected to supply.[3]

Both types of efficiency are important to packers and cannot be considered independently. The end result of improvement in either of these measures could lead to improved allocation of resources.

When considering pork, it is not difficult to suggest methods to improve pricing efficiency which would reflect itself in a more efficient allocation of resources. Greater accuracy can be achieved when added information is gathered and used to differentiate between the various grades and classes of animals slaughtered. However, as Jebe and Clifton pointed out:

> Innovations that do not improve the operational efficiency may not offer an immediate economic incentive for their adoption, even though they improve pricing efficiency.[4]

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[2]United States Department of Agriculture, Packers and Stockyard Administration, Packers and Stockyards Resume, Statistical Issue, VIII, No. 13 (December 1970), 22-23.

[3]Willard F. Williams and Thomas T. Stout, Economics of the Livestock-Meat Industry (New York: The Macmillan Company, 1964), p. 121.

[4]Emil H. Jebe and Elliot S. Clifton, "Estimating Yields and Grades of Slaughter Steers and Heifers," Journal of Farm Economics, XXXVIII (May 1956), 585.

Added information gathered in an effort to improve the accuracy of prices often results in added cost to the packer. Thus, if increased costs are not more than covered by new pecuniary gains, there is no incentive for the packer to adopt a new pricing practice.

Several reasons have been offered for farmers' reluctance to accept the carcass grading method of marketing. Farmers are often reluctant to accept company graders' decisions as to the quality of their animals. There is also argument that graders are not consistent. Since there is a large element of subjectivity entering into the decision as to the proper grade for an animal in any category, there may be some substance to the arguments set forth for the slow acceptance of carcass selling. Another reason given is the desire of the seller to receive payment upon delivery of the animal.

The establishment of more uniform grade standards, an increase in the size of lots sold by farmers, improved breeding and feeding practices, and the increasing use of computerized accounting systems are all reasons that this writer believes that selling animals on a graded basis will continue to increase.

Most of the animals bought by the cooperating concern are purchased on a liveweight basis. From conversations with company representatives, this writer deduced that the concern would ideally like to set differentials so as to maintain a constant gross margin per hundredweight of animal purchased. Inconsistencies in the gross margin could be interpreted as a failure of the pricing mechanism to accurately account for the existing physical differences and resulting values to the packer.

II. OBJECTIVES OF THE STUDY

The overall objective of the study was to examine the accuracy of the pricing system for slaughter hogs bought by a meat packer. Factors contributing to inaccuracies (if any) will hopefully be identified.

More specifically, the objectives are:

1. To estimate the physical characteristics of United States Department of Agriculture (U.S.D.A.) Grade 1, 2, and 3 hogs at different weight intervals.
2. To determine the gross margin differential[5] in dollars per hundredweight of hot carcass and to identify variables associated with changes in this margin.
3. To use the yield characteristics established in Objective I to estimate GMD's for a different sample of animals to determine if any variations in these GMD's are associated with differences in season and method of live animal procurement.[6]
4. To determine relationships between carcass yield characteristics and wholesale value per hundredweight of hot carcass under different situations for prices of wholesale cuts.

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[5]Gross Margin Differential per Hundredweight, hereafter referred to as GMD = $\frac{\text{Wholesale Value-Acquisition Cost}}{\text{Carcass Weight in Hundredweight}}$ = where acquisition cost is the cost of the live animal delivered to the plant. This cost does not include costs associated with holding or slaughtering. Wholesale value is the value of the animal as specifically pointed out in Objective II of this study.

[6]These could not be taken into account in Objective II because of the time period and sampling procedure.

III. DATA SOURCES

The records and facilities of a large, federally inspected meat packing company were used as a primary source of data for the analysis. The National Provisioner Daily Market Service sheets were used as a source of product price data.[7]

IV. LIMITATIONS OF THE DATA

For the purposes of this study, the data are limited in several respects. First, some measurements recorded are subjective in nature and were based on the opinion of one individual. For example, all of the muscling scores were given by the same company representative. Every qualified individual may not have given the same score on every animal. The grade classification assigned to each animal may also reflect a degree of subjectivity. Application of U.S.D.A. standards can be subjective in nature and, therefore, may not always reflect actual variations among animals graded.

As noted above actual live weights had to be estimated.[8]

Another limitation was that observations for individual animals could be made on only six major cuts, namely: loins, hams, picnics, butts, bellies, and spare ribs. The remaining components of the carcasses were weighed as a group. This occurred because of the nature of the production line and the amount of time allotted by the management of the firm for halting the line to assemble test information.

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[7]The National Provisioner Daily Market Service, Series AV and AW, West Huron Street, Chicago, Illinois.

[8]Based on standards shown in Appendix A.

These same factors set a limit on the number of animals entering each cell.

Proportional samples were not drawn for the two samples used in the analysis. Operating procedures and policies for the cooperating concern did not make it possible to obtain a proportional sample for each grade and weight category where cut out data were gathered.

A proportional sample for the analysis of Objective III would have caused unusually small numbers of observations on direct liveweight and carcass purchased animals. Conversely, there would have been an unusually large number of observations for animals purchased from order buyers. Thus, inferences drawn may be limited to the extent to which sample proportions differed from the true population. For this study, estimates used for each stratum were not used to calculate estimates for the total population. Calculations of estimates for the total population from the sample estimates for the strata would have required recognition of the different sampling rates.

CHAPTER II

REVIEW OF THE LITERATURE

Past research pertinent to this study was concerned with (1) the relationships of physical characteristics to the most desired carcass types, (2) relationships between physical traits and economic values, and (3) ability of the pricing system to communicate these relationships in an equitable manner throughout the marketing system, from the farm to the consumer. This research guided the development of standards to aid in the communicative process, and are reflected in the standardized grades for pork established by the United States Department of Agriculture.

Williams and Stout discuss the objectives in grading:

> The immediate objective of grading, then, is to classify units of a commodity like beef, lamb, or pork into groups according to quality. But any system of classification necessarily is a compromise. It is a compromise between (1) minimizing the variation within each grade or class and thereby increasing the usefulness of the system and (2) minimizing the cost in terms of time, effort, or dollars required in making and maintaining the segregation. Grades, therefore, are simply systems of classifying and their 'effects' depend largely on the system of classification adopted and on the manner and extent to which they are used.
>
> Two of the more basic economic effects or objectives frequently sought through grading are (1) reduction in marketing costs and operational inefficiency, and (2) improvements in pricing accuracy.[9]

The United States Department of Agriculture developed the first standardized grading system for grades of slaughter barrow and gilt carcasses in 1952. Present standards were adopted in 1968.[10]

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[9] Williams and Stout, p. 467.

[10] United States Department of Agriculture, Consumer and Market

Tuma, et al., conducted a study at Kansas State to determine the accuracy with which individuals could estimate carcass characteristics. Three staff members, a graduate student, and two prominent commercial hog breeders appraised 39 animals with respect to estimates of average backfat thickness, carcass length, percent lean cuts, and live grade. Results of this study indicated: (1) Estimation of percent lean cuts was not significantly correlated for any scorer, (2) live grade was accurately estimated in 65 percent of the cases, (3) scorers tended to underestimate, rather than overestimate, traits incorrectly scored.[11]

I. CARCASS RESEARCH

Several researchers have studied the relationships of traits to value. In a Tennessee study, Cole, et al., estimated monetary value of the right sides of 110 pork carcasses and studied the magnitude of the relationships with various carcass traits. More than 47 percent of the variation in monetary value was accounted for by average backfat thickness. However, only 18 percent or less of the variation in the values were based on the liveweight class from which the animal was obtained. Ham plus loin percentage of carcass weight proved to be the best single factor as a predictor of value using both the carcass

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Service, Part 53, Livestock, Meats, Prepared Meats, and Market Products (Grading, Certification, and Standards), Federal Register (June 22, 1968), p. 1.

[11] H. J. Tuma, R. A. Merkel, and D. L. Mackentosh, "Correlation Between Live Hog Scores and Carcass Measurements," Journal of Animal Science, XVII, No. 4 (November 1958), 1158.

and liveweight bases. Loin eye area was significantly associated with monetary values, but the magnitudes of these monetary values were low. Seventy-four percent of the variation in the monetary value was accounted for by a predicting equation containing the variables, average backfat thickness, carcass weight, and ham plus loin as percentage of total carcass weight.[12]

Lasley, et al., in a study conducted at Iowa State analyzed various live and carcass traits of 222 barrows in an effort to determine their ability to predict lean cuts. Squared multiple correlation coefficients of particular interest for predicting lean cuts were:

> (1) Shrunk liveweight (24 hours) and probe, .44; (2) carcass weight, backfat, and length, .50; (3) carcass weight, backfat, and loin eye area, .69; (4) carcass weight, backfat, length, and loin eye area, .70; (5) carcass weight and ham weight, .82; (6) carcass weight, backfat, and ham weight, .82; (7) carcass weight, backfat, length, loin eye area, and ham weight, .91.[13]

Pearson, et al., in a Michigan State study, used data from 1,002 hogs to analyze relationships between live and carcass values. Their work indicated that a single measure of backfat thickness taken at the last lumbar vertebra reflected carcass value more accurately than the average backfat measurement. A regression equation incorporating live slaughter weight, dressing percent, and backfat thickness at the last

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[12] J. W. Cole, J. R. Lynn, and C. B. Ramsey, "Relationships of Commonly-Used Pork Carcass Evaluation Traits with Monetary Values," Journal of Animal Science, XXVI, No. 1 (January 1967), 210.

[13] E. L. Lasley, L. N. Hazel, and E. A. Kline, "Predicting Lean Cuts from Live Hog and Easily Measured Carcass Traits," Journal of Animal Science, XV, No. 4 (November 1956), 1268.

lumbar vertebra accounted for 72 percent of the variation in estimating live value of the animal.[14]

In an Illinois study, Rosendale used a total of 524 animals whose known live weights ranged from 180 to 240 pounds. Of the criteria analyzed by Rosendale, backfat thickness, loin eye area, and carcass length, respectively, were the top predictors of the percentage of the four lean cuts, dollar value per hundredweight alive, and dollar value per hundredweight of carcass. However, he stated,

> Carcass length was of little value for estimating percentage of four lean cuts, dollar value per hundredweight of carcass, or dollar value per hundredweight alive. Carcass length accounted for a highly significant ($p<.01$) percentage of the variance of each dependent variable, but the portion accounted for was, nevertheless, insufficient to be of practical value.[15]

In addition, he concluded that when backfat was included carcass length was of little value. Among backfat measurements taken, the last lumbar vertebra ranked first in importance as an explanatory variable.[16] These results correspond to those found by Pearson regarding the value of the various backfat measurements.

II. PRICING STUDIES

The problem of the inefficiencies of liveweight pricing of hogs has been recognized for some time. A 1949 study by Dowell and Engelman

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[14]A. M. Pearson, et al., "Influence of Various Traits Upon Live and Carcass Value for Hogs," Journal of Animal Science, XXXI, No. 2 (August 1970), 318-322.

[15]V. M. Rosendale, "Relationships Between Live Hogs and Hog Carcasses" (unpublished Master's thesis, The University of Illinois, Urbana, 1964), p. 43.

[16]Rosendale, p. 44.

conducted at the University of Minnesota found:

> It is generally recognized that the physical operations in a modern meat packing plant leave little to be desired either from a standpoint of efficiency in slaughtering and processing or from a standpoint of utilization of by-products. It is in other areas between producers and consumers that greater efficiency is an urgent need.[17]

They pointed out that there was a tendency toward generalized prices paid to farmers rather than specifically paying for the actual weight and grade of the products delivered.

Dowell and Engelman concluded that carcass buying would aid in the elimination of pricing errors due to errors in yield and grade. Additionally they stated that elimination of some of these errors would "permit more accurate reflection of consumer preferences back to livestock producers and hence tend to bring about more effective allocation of resources on the farm."[18]

In a discussion of this paper, Lewis pointed out some practical problems involved in carcass marketing that still plague packers. Some of these are: (1) maintaining identity of animals, (2) determination of shrink allowance, (3) handling condemnations, (4) time lag in payment, (5) reluctance of producers and buyers both to place value determination in the hands of a government grader, and (6) increase in expense involved thus increasing the margin between producer and consumer.[19]

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[17] Austin A. Dowell and Gerald Engelman, "Research Into the Problems Involved in Marketing Slaughter Livestock by Carcass Weight and Grade," Journal of Farm Economics, XXXI, No. 1 (February 1949), 343.

[18] Dowell, p. 360.

[19] George M. Lewis, "Discussion of 'Research Into the Problems Involved in Marketing Slaughter Livestock by Carcass Weight and Grade,'" Journal of Farm Economics, XXXI, No. 1 (February 1949), 363-364.

Ikerd and Cramer presented a method of measuring the accuracy of pricing at one level of the pork market.

The objective of the analysis was to study price refraction in the packer segment of the pork system. Price refraction was defined as:

> The failure of differences received at the wholesale level of pork of various weights and backfat thickness to be accurately reflected in price differentials paid at the live hog market level.[20]

Ikerd's and Cramer's sample included cut-out data from 300 carcasses ranging in weight from 135 to 191 pounds and in average backfat from 1.0 to 2.2 inches. Average prices of live hogs and wholesale cuts for the period 1960-1965 were used to estimate cost and revenue differentials for animals in the study. Wholesale cut prices were calculated using National Provisioner weight categories and prices. "Purchase costs were based on U.S.D.A. weight and grade standards and prices reported by U.S.D.A. for the Chicago terminal market."[21]

Ikerd's and Cramer's analysis used hot carcass weight and average backfat thickness as the independent variables. Results showed that price refraction attributable to various weights was insignificant, whereas the portion attributable to backfat was large and highly significant.[22]

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[20] John E. Ikerd and Charles L. Cramer, "Price Signal Refraction in Pork Processing," American Journal of Agricultural Economics, L, No. 2 (May 1968), 225-226.

[21] Ikerd, p. 227.

[22] Ikerd, pp. 225-231.

At Iowa State, Gaarder studied the relationships between physical characteristics and the value of hogs and hog carcasses. He had as his specific objectives:

> (1) To ascertain the relationship of carcass weight and various measurements and evaluations to yield of the various cuts and to market values of the carcasses and (2) to use the above relationships to establish the basis for determining appropriate paying-price differentials between grades for hog prices.[23]

To accomplish his objectives, Gaarder selected 379 live hogs and measured and evaluated their carcasses. He found that for a given weight of animal, the percentage of lean cuts increased with a corresponding decrease in backfat thickness at the rate of one percentage point (of hot carcass weight) increase to a one-tenth inch decrease in backfat. Data revealed:

> For typical hogs, and 1956-59 Chicago wholesale prices for fresh carlot cuts, the U.S. No. 1-2 value difference was estimated in this study to be $0.67 per hundredweight of carcass. The U.S. No. 2-3 value difference was estimated to be $0.84 per hundredweight.[24]

Bowers, et al., in a Florida study, compared muscling scores with other carcass attributes in predicting the percent of the four lean cuts.[25] Correlation techniques and linear models were used to establish relationships. An equation with only backfat accounted for 42.1 percent of the variation in the percentage of lean cuts. When the

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[23] R. O. Gaarder, "Relationships Between Physical Characteristics and the Value of Live Hogs and Hog Carcasses" (unpublished Master's thesis, Iowa State University, Ames, 1962), p. 10.

[24] Gaarder, p. 88a.

[25] D. H. Bowers, et al., "Indices of Lean Cuts of Pork Carcasses," Journal of Animal Science, XXVIII, No. 1 (January 1969), 129.

variables, average length and muscling score, were added to the equation, 46.2 percent of the variation was explained.

III. CARCASS EVALUATION

Ikerd and Cramer present:

> . . . a practical means by which a computer can be used to ascertain the value of individual hog carcasses with greater accuracy than a computer system presently used by a progressive firm in the industry.[26]

Their model is based on carcass weight and backfat thickness. They describe their model in the following manner:

> The model utilized both cross-sectional and time series data in a two-step least squares procedure to estimate carcass value on an individual carcass basis, given a set of wholesale prices. The first step was to estimate coefficients associating carcass value with backfat and weight at specific points in time. Carcass value was estimated as a linear function of backfat and carcass weight using various sets of prices. The second step generalized the model to allow estimation of the coefficients for any given point in time (i.e., for any set of wholesale prices). The coefficients of the regression equations were estimated as linear functions of price differentials between different weights of wholesale cuts (e.g., between light and heavy hams) and an overall composite carcass value.[27]

The model was applied to 300 carcasses selected from the kill line of a commercial meat packer. Three estimates of the value of each carcass were made using ten different sets of price data. They computed the actual total value of the carcass, packer model estimate of the total carcass value, and the Ikerd and Cramer estimate of total carcass value.

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[26]John E. Ikerd and Charles L. Cramer, "A Practical Computer Method for Pricing Pork Carcasses and Hogs," American Journal of Agricultural Economics, LII, No. 2 (May 1970), 242-246.

[27]Ikerd and Cramer, "A Practical Computer Method," pp. 242-243.

Ikerd and Cramer reported with respect to their model: ". . . in general the model estimates were more accurate than the packer estimates. Standard deviations of the error were smaller for the model:"[28]

With their model, slaughter hogs would be priced on a basis of three prices: (1) Base price (estimated value per hundredweight of a carcass assumed to have the mean backfat and weight characteristics), (2) a price differential per tenth of an inch of backfat thickness, and (3) a differential per pound of carcass weight. All carcasses would be priced with a system of premiums and discounts above and below the base price.[29]

Hayenga, in a study at Michigan State University, conducted a study similar to the one reported above. He stated:

> This procedure differs from that shown by Ikerd and Cramer by our substitution of one backfat measurement for the average of several backfat measurements used in their procedure. Further, an index of full carcass value was used rather than the primal cut value used in their study, as well as the full range of wholesale cut premium and discounts by weight class.[30]

In the footnotes of the study, Hayenga states: "Using only one measurement at the last lumbar region was always equal or superior to the average of measurements at three different locations."[31]

Using carcass measurements considered in the purebred swine association's meat hog certification program (backfat thickness,

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[28] Ikerd and Cramer, "A Practical Computer Method," p. 244.

[29] Ikerd and Cramer, "A Practical Computer Method," pp. 242-246.

[30] Marvin L. Hayenga, An Evaluation of Hog Pricing and Grading Methods, Agricultural Economics Report No. 129 (Lansing: Michigan State University, May 1971), p. 7.

[31] Hayenga, p. 15.

carcass length, loin eye area at the tenth rib, and carcass weight), 69 percent of the variation in carcass value was explained.

Several of the studies investigated relationships of the physical characteristics and carcass values. These studies were valuable in guiding this researcher with respect to relevant variables to include in the analysis of data. They also provided insight as to the statistical techniques to use in analysis conducted in the study.

No studies were found investigating the particular margin investigated by this writer.

CHAPTER III

PROCEDURE

The objectives of the study, data sources, and a review of some literature pertinent to this study were presented in the first two chapters. Chapter III presents the procedures used to accomplish the stated objectives.

I. OBJECTIVE I

The first objective was to estimate the physical cut out characteristics of U.S.D.A. Grades 1, 2, and 3 hogs at selected weight intervals. To accomplish this objective 180 animals were placed into 18 cells. Each of the cells contained 10 animals representing a 20-pound weight range based on live weight (Appendix A). Data were gathered in the time period extending from September 17, 1970, to June 3, 1971. With the exception of three sample days, all of the data were gathered in the period from September 17, 1970, to January 12, 1971. Original plans for the study were wider in scope, but due to the small number of animals slaughtered in various weights and grades, representative data were not available except for those cells shown in Appendix A. Animals included in the study were chosen at random by the company grader (i.e., those coming off the line). The grader selected from 6 to 20 animals in each specified cell. Company policy dictated that a minimum of six animals and a maximum of 20 could be used in gathering test data. For some cells tests had to be run on more than one day in order to get a complete cell. An authoritative sample[32] was selected by the researcher and a company official so as to be the most representative of the particular weight range. After animals were selected on a given day, they were marked so that individual weights of loins, hams, spare ribs, picnics, butts, and bellies could be obtained for each carcass. In addition, individual measurements were recorded for: hot carcass weight, muscling, length, supplier, sex, and backfat thickness at the first, fifth and last rib, and at the last lumbar vertebra. The remaining cuts were weighed as a group. Animals suspect of not falling into the cell in question were removed before the cut.

Due to complications beyond the researcher's control, it was not possible to obtain individual live weights. Therefore, the live weights used in the analysis were estimated from the plant's standardized conversion factors, which are shown in Appendix A.

In several instances, test animals had missing parts, such as front feet or jowls. When this occurred, the weights of these parts were estimated and added to the appropriate animal's hot carcass weight. This was done because missing parts were assumed to be a function of assembly line problems rather than a function of the pricing system.

The selected animals were cut using the regular assembly line procedure followed by the packer. Test animals were cut at the beginning of each day's operation. After all test animals were cut, the assembly line was stopped. All of the cuts were then gathered and separated so that they could be weighed by the researcher or other

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[32] Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics (New York: McGraw-Hill Book Company, Inc., 1960), p. 412.

company personnel. Weights were recorded on the forms shown in Appendix B. All weights were recorded in tenths of pounds.

Calculations were made to determine the percentage of hot carcass weight that should be assigned to each of its components. The hot carcass weight is based on the entire carcass dressed packer style (split down the back into two sides, jowls attached, but with head, ham facings, leaf fat, and kidneys removed). Standard cut with standard trim was used.

The wholesale cuts used and their various breakdowns are shown in Appendix C.

Weights that fell at a breaking point were assigned to the lighter category; e.g., a 12.0 pound ham was assigned to the 10-12 pound category.

II. OBJECTIVE II

The second objective was to determine the GMD for the animals in the study and identify variables associated with changes in this margin. Using the cut out data derived in reaching Objective I, invoices from suppliers and the National Provisioner Daily Marker Service price lists[33] on dates which animals were purchased, GMD's were calculated for animals included in the cut out study.

The wholesale value of each animal was determined from the previously mentioned price list (Appendix D).

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[33]The National Provisioner Daily Market Service, Series AV and AW, 15 West Huron Street, Chicago, Illinois.

The value of the offal was not included in the wholesale value of the animals because the offal was removed before animals were selected. The costs associated with holding and slaughtering were not included in calculating the costs of the individual animals due to the unavailability of data.

Variables Included

The gross margin differential per hundredweight calculated on each animal was used as the dependent variable in the relationships examined under this objective. This margin was selected as the dependent variable as it was assumed to be a proxy for the level of profitability and an indicator of the accuracy of buying practices. Data availability for estimating cost and wholesale values of animals also influenced the selection of this particular dependent variable.

Independent variables selected were: hot carcass weight in pounds, price in dollars per hundredweight of liveweight, and grade.

Equations

Least squares regression was used to fit linear equations to the data. The general form of the equations was as follows:

$$X_1 = b_1 + b_2X_2 + \ldots + b_iX_i + e$$

where:

X_1 = gross margin differential

b_1 = constant term

b_i = estimated parameters

X_i = variable i, and

e = error term.

III. OBJECTIVE III

The third objective was to use the yield characteristics established in reaching Objective I to estimate GMD's for a different sample of animals to determine if any variations in these GMD's were associated with differences in season and method of animal procurement.

The local cooperating concern makes a record of each animal slaughtered. The information therein includes the date, sex, hot carcass weight, grade, and supplier.

Slaughter animals can be acquired by one or more of three major procurement methods: order buying, direct liveweight purchasing at the plant, and purchasing on a carcass basis.

After consultation with personnel of the company whose facilities were used for gathering the data, 9 of the 18 cells used in the analysis for Objective II were selected. Only nine cells were used because, according to the company representative, virtually all of the animals purchased on a carcass basis fell into these nine categories. The cells selected are shown in Table 1.

Table 1. Cells Included in Analysis of Objective III

Grade	Hot Carcass Weight		
U.S. #1	132-146	147-161	162-177
U.S. #2	132-146	147-161	162-177
U.S. #3	133-150	151-165	166-181

The sample consisted of 10 animals in each cell for each method of procurement for each month (May 1970 to April 1971). It should be noted here that for the purpose of this analysis, it had to be assumed that this sample was representative of the true population. Therefore, inferences drawn from the data could be limited by the extent to which the proportions in the true population differ from that of the sample. The following data on 3,240 animals were taken from sources indicated above:

1. Hot carcass weight, which was converted to liveweight using established company standards.
2. Grade.
3. Price paid on a liveweight basis.
4. Date animals were purchased (to take seasonality into account).

A GMD[34] was calculated for each of the 3,240 animals.

The wholesale value of the animals included in the sample were calculated as follows:

1. The assumption was made that the physical characteristics established in Objective I for the cells in each respective grade were the same as those in the new sample.
2. The average percent of each of the wholesale cuts for the three cells in each grade were calculated.
3. Simple regressions were made of percent of hot carcass weight (for each of the six cuts for animals in the sample) on hot carcass weight of the animal.[35]

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[34]As defined on page 6.

[35]This was done to see if it could be assumed that the percentage of the cuts was equal throughout the weight range in question.

4. When warranted (see footnote 35) the weight of each of the cuts to use in computing the wholesale value of the sample animals for Objective III was estimated by using the results of the regression equation (see 3 above) rather than an average percentage as was used for the other wholesale cuts.
5. The pounds of each of the cuts for each of the categories shown in Appendix C were estimated for each grade at one pound intervals for the ranges shown in Table 1, page 22.

The cost of each animal bought from order buyers was estimated by:

1. Estimating the liveweight of selected animals using the standardized dressing percentages shown in Appendix A.
2. Using the estimated liveweight and actual invoice prices from invoices, the cost of each animal was estimated.

The cost of each animal bought by the direct liveweight purchase method was estimated by:

1. Estimating the liveweight of each animal.
2. Obtaining company's quoted price for each day of purchase for the respective categories.

Cost of each of the animals purchased on a carcass basis[36] was derived from instructions of the company buying program shown in Appendix E.

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[36]There was an insufficient number of animals purchased on a carcass basis to fill all of the nine cells. The cells were filled with synthetic animals having the same weight distribution as that for order buyers.

The gross margin differentials were then calculated.

Least squares regression equations were fit to the data to determine the association of selected variables and GMD's.

IV. OBJECTIVE IV

The purpose of this objective was to determine the relationships between carcass yield characteristics and wholesale value per hundredweight of hot carcass under different situations for prices of wholesale cuts.

Using the procedure for obtaining the wholesale value outlined above, four sets of wholesale values of the 180 sampled animals based on different sets of wholesale prices were estimated.

Many carcass buying models set their schedule of premiums and discounts based on the effects that physical characteristics have upon the variation in wholesale value.

If the system of premiums and discounts is to take into account the actual differences that take place over time and is to be based on physical characteristics, then the ability of physical characteristics to explain variations in wholesale values should be consistent under different pricing situations of wholesale cuts.

Four different sets of prices of wholesale cuts were used to study the association between the physical characteristics and the wholesale values of the animals.

Least squares regression equations were fitted to the data to determine the association between selected physical characteristics and the wholesale values of animals under the various selected wholesale cut prices. The selected price situations and physical characteristics used in the equations are shown in Chapter IV.

CHAPTER IV

RESULTS

I. OBJECTIVE I

The animals included in the sample were from U.S.D.A. Grades No. 1, 2, and 3. Of the 180 animals evaluated in this part of the study, 60 head (33.3 percent) were Grade 1, 70 head (38.89 percent) were Grade 2, and 50 head (27.78 percent) were Grade 3.

A company representative assigned a muscling score to each animal examined in this part of the study. The scoring results were as follows: very thick muscling--18 animals; thick muscling--51 animals; moderately thick muscling--79 animals; and slightly thin muscling--32 animals.

The average percentages of the sum of the four lean cuts as a percentage of hot carcass weight, along with other observed variables, are shown in Table 2. Tables 3 through 5 give the same information for each of the individual grades.

The mean percentages and standard deviations for each of the wholesale cuts calculated for the sample are shown in Tables 6 through 9.

II. OBJECTIVE II

The data collected on the 180 animals in Objective I were used along with additional information in the analysis for this objective. Linear regression equations were estimated in an effort to identify variables associated with changes in the gross margin differential.

Table 2. Means and Standard Deviations of Weight, Backfat, Length, and Percent Lean Cuts for All Animals in the Sample

Characteristic	Unit	Mean	Standard Deviations
Hot Carcass Weight	Pounds	168.1	26.42
Average Backfat[a]	Inches	1.62	.26
Backfat at First Rib	Inches	1.98	.32
Backfat at Fifth Rib	Inches	1.74	.29
Backfat at Last Rib	Inches	1.35	.25
Backfat at Last Lumbar Vertebra	Inches	1.52	.33
Length	Inches	30.14	1.49
Percent Lean Cuts[b]	Percent	51.13	2.94

[a]Mean of backfat measurements taken at the first and last ribs and at the last lumbar vertebra.

[b]Combined chilled weight of hams, loins, butts, and picnics, expressed as a percent of hot carcass weight.

Table 3. Means and Standard Deviations of Weight, Backfat, Length, and Percent Lean Cuts for U.S.D.A. Grade 1

Characteristic	Unit	Mean	Standard Deviations
Hot Carcass Weight	Pounds	162.5	25.65
Average Backfat[a]	Inches	1.37	.19
Backfat at First Rib	Inches	1.70	.21
Backfat at Fifth Rib	Inches	1.48	.21
Backfat at Last Rib	Inches	1.15	.22
Backfat at Last Lumbar Vertebra	Inches	1.23	.25
Length	Inches	30.45	1.49
Percent Lean Cuts[b]	Percent	54.75	1.48

[a]Mean of backfat measurements taken at the first and last ribs and at the last lumbar vertebra.

[b]Combined chilled weight of hams, loins, butts, and picnics, expressed as a percent of hot carcass weight.

Table 4. Means and Standard Deviations of Weight, Backfat, Length and Percent Lean Cuts for U.S.D.A. Grade 2

Characteristic	Unit	Mean	Standard Deviations
Hot Carcass Weight	Pounds	169.1	29.62
Average Backfat[a]	Inches	1.65	.16
Backfat at First Rib	Inches	2.03	.23
Backfat at Fifth Rib	Inches	1.77	.22
Backfat at Last Rib	Inches	1.36	.20
Backfat at Last Lumbar Vertebra	Inches	1.56	.22
Length	Inches	30.08	1.56
Percent Lean Cuts[b]	Percent	50.14	1.02

[a]Mean of backfat measurements taken at the first and last ribs and at the last lumbar vertebra.

[b]Combined chilled weight of hams, loins, butts, and picnics, expressed as a percent of hot carcass weight.

Table 5. Means and Standard Deviations of Weight, Backfat, Length, and Percent Lean Cuts for U.S.D.A. Grade 3

Characteristic	Unit	Mean	Standard Deviations
Hot Carcass Weight	Pounds	173.5	21.28
Average Backfat[a]	Inches	1.87	.15
Backfat at First Rib	Inches	2.25	.25
Backfat at Fifth Rib	Inches	2.00	.20
Backfat at Last Rib	Inches	1.55	.18
Backfat at Last Lumbar Vertebra	Inches	1.81	.24
Length	Inches	29.84	1.37
Percent Lean Cuts[b]	Percent	48.19	1.08

[a]Mean of backfat measurements taken at the first and last ribs and at the last lumbar vertebra.

[b]Combined chilled weight of hams, loins, butts, and picnics, expressed as a percent of hot carcass weight.

Table 6. Means and Standard Deviations of Wholesale Cuts for All Animals in the Sample

Wholesale Cuts		Mean Percentage	Standard Deviation
Loins	8-14	6.71	6.91
	14-17	7.89	8.51
	17-20	2.25	6.20
Hams	10-12	1.06	3.51
	12-14	2.41	5.15
	14-16	3.94	6.31
	16-18	5.18	7.70
	18-20	4.64	8.16
	20-25	2.17	6.38
	25 up	.08	1.12
Picnics	4-6	1.95	2.67
	6-8	4.21	3.63
	8 up	1.99	3.65
Butts	4-8	6.45	1.21
	8 up	.11	.73
Bellies	<7	.30	1.37
	7-9	1.74	3.32
	9-11	3.17	4.52
	11-13	4.28	5.67
	13-15	2.72	5.34
	15-17	1.05	3.60
	17-19	0.00	0.00
Spare Ribs	0-3	1.70	0.93
	3-5	1.84	1.43
Skinned Jowls		2.40	.49
Regular Trimmings		2.55	.65
50% Trimmings		1.91	.65
80% Trimmings		.73	.13
Neck Bone Trim		.15	.24
Neck Bones		1.33	.21
Ham Hocks		.74	.10
Picnic Hocks		.73	.15
Tails		.26	.58
Hind Feet		.88	.12
Front Feet		.69	.14
Skins		3.28	.49
Total Fat		13.62	3.58

Table 7. Means and Standard Deviations of Wholesale Cuts for U.S.D.A. Grade 1 Animals in the Sample

Wholesale Cuts		Mean Percentage	Standard Deviation
Loins	8-14	6.42	7.05
	14-17	7.88	8.45
	17-20	3.88	7.88
Hams	10-12	.85	3.02
	12-14	2.86	5.82
	14-16	2.97	5.81
	16-18	4.02	7.29
	18-20	7.24	9.89
	20-25	2.81	7.22
	25 up	0.00	0.00
Picnics	4-6	1.32	2.59
	6-8	4.41	4.02
	8 up	3.31	4.71
Butts	4-8	6.60	1.26
	8 up	.26	1.13
Bellies	<7	.79	2.28
	7-9	3.26	4.30
	9-11	3.46	4.82
	11-13	3.17	5.43
	13-15	1.26	4.05
	15-17	0.00	0.00
	17-19	0.00	0.00
Spare Ribs	0-3	1.64	.96
	3-5	2.03	1.50
Skinned Jowls		2.15	.23
Regular Trimmings		2.22	.58
50% Trimmings		2.27	.69
80% Trimmings		.74	.14
Neck Bone Trim		.15	.21
Neck Bones		1.53	.22
Ham Hocks		.78	.10
Picnic Hocks		.87	.15
Tails		.25	.46
Hind Feet		.93	.11
Front Feet		.70	.13
Skins		3.19	.55
Total Fat		10.56	2.28

Table 8. Means and Standard Deviations of Wholesale Cuts for U.S.D.A. Grade 2 Animals in the Sample

Wholesale Cuts		Mean Percentage	Standard Deviation
Loins	8-14	7.06	6.96
	14-17	7.26	8.43
	17-20	2.27	6.24
Hams	10-12	2.01	4.75
	12-14	2.02	4.35
	14-16	3.14	5.60
	16-18	5.05	8.21
	18-20	3.71	7.61
	20-25	3.06	7.58
	25 up	.21	1.79
Picnics	4-6	1.94	2.46
	6-8	4.41	3.22
	8 up	1.41	2.69
Butts	4-8	6.42	1.36
	8 up	.07	.57
Bellies	<7	.11	.64
	7-9	1.69	3.11
	9-11	2.99	4.30
	11-13	3.55	5.09
	13-15	3.78	5.92
	15-17	1.60	4.24
	17-19	0.00	0.00
Spare Ribs	0-3	1.75	1.03
	3-5	1.79	1.61
Skinned Jowls		2.47	.57
Regular Trimmings		2.50	.60
50% Trimmings		1.83	.68
80% Trimmings		.72	.13
Neck Bone Trim		.15	.28
Neck Bones		1.27	.19
Ham Hocks		.74	.12
Picnic Hocks		.69	.13
Tails		.27	.07
Hind Feet		.88	.13
Front Feet		.69	.18
Skins		3.40	.46
Total Fat		14.48	2.94

Table 9. Means and Standard Deviations of Wholesale Cuts for U.S.D.A. Grade 3 Animals in the Sample

Wholesale Cuts		Mean Percentage	Standard Deviation
Loins	8-14	6.55	6.79
	14-17	8.77	8.71
	17-20	.40	2.85
Hams	10-12	0.00	0.00
	12-14	2.44	5.42
	14-16	6.17	7.16
	16-18	6.67	7.24
	18-20	3.01	6.14
	20-25	.23	1.63
	25 up	0.00	0.00
Picnics	4-6	2.64	2.84
	6-8	3.71	3.74
	8 up	1.29	3.17
Butts	4-8	6.31	.93
	8 up	0.00	0.00
Bellies	<7	0.00	0.00
	7-9	.09	.62
	9-11	3.10	4.55
	11-13	6.52	6.03
	13-15	2.93	5.42
	15-17	1.47	4.30
	17-19	0.00	0.00
Spare Ribs	0-3	1.71	.74
	3-5	1.70	1.06
Skinned Jowls		2.59	.35
Regular Trimmings		2.98	.38
50% Trimmings		1.60	.43
80% Trimmings		.71	.10
Neck Bone Trim		.14	.17
Neck Bones		1.20	.13
Ham Hocks		.69	.08
Picnic Hocks		.63	.11
Tails		.25	.40
Hind Feet		.81	.09
Front Feet		.68	.08
Skins		3.21	.37
Total Fat		15.86	2.44

Variables Included

The gross margin differential (GMD) was used as the dependent variable in all equations for this objective.

The independent variables used in the analysis were: hot carcass weight in pounds, price in dollars per hundredweight of liveweight, and grade. Table 10 gives the means and standard deviations of the variables used in the analysis of this objective.

Table 10. Means and Standard Deviations of Variables Considered in Objective II

Variable	Unit	Mean	Standard Deviation
GMD	Dollars[a]	1.90	1.67
Hot carcass weight	Pounds	168.14	26.42
Liveweight price	Dollars[a]	18.26	2.02

[a]Per hundredweight.

In the equations analyzed in this and the remaining objectives (0,1) type dummy variables were used to quantify qualitative variables.[37]

A linear multiple regression equation was analyzed in Objective II. The equation was analyzed to study the association of various combinations of the variables listed above.

[37]Charles Sappington, "A Numerical Example of the Practical Use of Dummy Variables," Southern Journal of Agricultural Economics, II, No. 1 (December 1970), 197-201.

III. VARIABLE IDENTIFICATION FOR OBJECTIVE II

The coefficients calculated for the equations in the analysis for Objective II are presented below. The variables included in the equation for the analysis of this objective are identified as follows:

Dependent Variable

X_1 = gross margin differential in dollars per hundredweight.

Independent Variables

X_2 = hot carcass weight in pounds.

X_3 = price per hundredweight on a liveweight basis in dollars.

X_4 = one, if Grade 1 and zero otherwise.

X_5 = one, if Grade 2 and zero otherwise.

X_6 = one, if Grade 3 and zero otherwise.

$X_7 = X_2 \cdot X_4$ if Grade 1 and zero otherwise.

$X_8 = X_2 \cdot X_5$ if Grade 2 and zero otherwise.

$X_9 = X_2 \cdot X_6$ if Grade 3 and zero otherwise.

The equation for estimating X is:

$$X_1 = 17.257 - \underset{^{a}(.0055)^{***}}{.0370X_2} - \underset{(.0539)^{***}}{.5075X_3} - \underset{(1.1697)}{1.556X_5} - \underset{(1.5476)^{*}}{2.7259X_6} + \underset{(.0071)}{.0099X_8} + \underset{(.0091)^{*}}{.0174X_9}$$

---

[a]The figure below each coefficient is the standard error of the coefficient where:

* = significant at the .10 level.

** = significant at the .05 level.

*** = significant at the .01 level.

$R_2 = .6012$

$S_e = 1.0747$

This equation explained 60.12 percent of the variation in the GMD's for the original 180 animals included in the study. The standard error of estimate was found to be 1.0747 dollars.

The coefficients for hot carcass weight (X_2) and liveweight price (X_3) were both significant at the .01 level and had negative signs. Thus, the resulting effects on margins from increases in prices and from handling heavy animals is negative.

The coefficients of the intercept shifter variable for Grade 3 (X_6) was significant at the .10 level and had a negative sign, while the coefficient of the slope shifter variable for Grade 3 (X_9) was significant at the .10 level with a positive sign. Thus, the GMD's estimated for Grade 3 are lower than for Grade 1. But, as weights increase within this grade, the GMD's increase.

V. OBJECTIVE III

Due to the time period in which the data from the 180 animals used in the first two objectives and the sampling technique used the associations between procurement methods, seasons and GMD's could not be examined. The cut out data gathered in reaching Objective I were used to estimate the physical cut-out characteristics of a different sample of animals shown in Table 1, page 22.

Variables Included

The dependent variable used was the gross margin differential per hundredweight.

The independent variables considered were: hot carcass weight in pounds, liveweight price in dollars, method of procurement, grade, and season. Means and standard deviations of the variables used in the analysis for Objective III are found in Table 11.

Table 11. Means and Standard Deviations of Variables Considered in Objective III

Variable	Unit	Mean	Standard Deviation
GMD	Dollars[a]	2.57	1.53
Hot carcass weight	Pounds	155.57	13.21
Liveweight price	Dollars[a]	19.69	3.24

[a]Per hundredweight.

Three major procurement methods were entered as variables in the models: (1) direct liveweight purchases at the plant, (2) purchases from order buyers, and (3) purchases of animals on a carcass basis.

The seasons were divided as follows: January-March, April-June, July-September, and October-December.

There was no a priori reason to include slope shift variables for season or procurement method in the equations. Both slope and intercept change variables were allowed for grade.

Equation 1

This equation included GMD's as a function of hot carcass weights, liveweight prices, procurement methods (intercept changes), grades (allowing for both slope and intercept changes), seasons (intercept changes).

There was reason to suspect a problem of multicollinearity in the equation considered above; therefore, a second equation was fit to the data.

Equation 2

This equation included GMD's as a function of hot carcass weights, liveweight prices, procurement methods (intercept changes), grades (intercept changes), seasons (intercept changes).

V. VARIABLE IDENTIFICATION FOR OBJECTIVE III

The designation of variables for the regression equations in Objective III are given below.

Dependent Variable

X_1 = gross margin differential in dollars per hundredweight.

Independent Variables

X_2 = hot carcass weight in pounds.

X_3 = liveweight price per hundredweight in dollars.

X_4 = one, if direct liveweight purchase and zero otherwise.

X_5 = one, if order buyer and zero otherwise.

X_6 = one, if carcass purchase and zero otherwise.

X_7 = one, if Grade 1 and zero otherwise.

X_8 = one, if Grade 2 and zero otherwise.

X_9 = one, if Grade 3 and zero otherwise.

X_{10} = one, if January-March and zero otherwise.

X_{11} = one, if April-June and zero otherwise.

X_{12} = one, if July-September and zero otherwise.

X_{13} = one, if October-December and zero otherwise.

$X_{14} = X_2 \cdot X_7$ if Grade 1 and zero otherwise.

$X_{15} = X_2 \cdot X_8$ if Grade 2 and zero otherwise.

$X_{16} = X_2 \cdot X_9$ if Grade 3 and zero otherwise.

Equation 1

Equation 1 for estimating X_1 is:

$$X_1 = 9.5789 - \underset{^{a}(.0022)^{***}}{.0092X_2} - \underset{(.0069)^{***}}{.3164X_3} - \underset{(.0416)^{***}}{.6298X_5} - \underset{(.0415)^{***}}{.2728X_6} + \underset{(.4709)}{.0488X_8} + \underset{(.4849)^{**}}{1.0368X_9}$$

$$+ \underset{(.0548)^{***}}{.8309X_{11}} + \underset{(.0583)^{***}}{.6089X_{12}} + \underset{(.0478)^{***}}{.5337X_{13}} + \underset{(.0030)}{.0007X_{15}} + \underset{(.0031)}{.0010X_{16}}$$

The coefficients for hot carcass weight (X_2), and liveweight price (X_3) are statistically significant at the .01 level. The omitted variables to avoid matrix singularity were direct liveweight purchases (X_4), Grade 1 intercept (X_7), January-March (X_{10}), and Grade 1 slope change (X_{16}). The intercept changes for order buyers (X_5), carcass purchases (X_6), April-June (X_{11}), July-September (X_{12}), and October-December (X_{13}) were statistically significant at the .01 level and

[a]The figure below each coefficient is the standard error of the coefficient where:

* = significant at the .10 level.

** = significant at the .05 level.

*** = significant at the .01 level.

$R^2 = .6053.$

$S_e = .9617$

$F = 450.0$

variable Grade 3 intercept (X_9) was significant at the .05 level. Variables Grade 2 intercept changes (X_8), Grade 2 slope changes (X_{15}), and Grade 3 slope changes (X_{16}) were found to be insignificant at the .10 level.

The signs of both variables X_2 and X_3 are both negative, indicating a decrease in the gross margin differential due to both increases in hot carcass weight and liveweight prices.

When the effects of methods of procurement are considered, it can be seen that the intercepts for both order buyers (X_5) and carcass purchases (X_6) are significantly lower than that for direct purchases (X_4).

The intercept for animals purchased from order buyers was approximately .62 dollars a hundredweight less than the intercept for animals purchased by the direct liveweight purchase method. The intercept for animals purchased on a carcass basis had an intercept amounting to approximately .265 dollars a hundredweight lower. From the packers' standpoint, the procurement method providing him with the greatest GMD's is direct liveweight purchases. Another interpretation of these results would be that it could be advantageous to a producer to sell his animals to the packer on a carcass basis.

A check of the correlation matrix revealed that the correlations between intercept and slope change for grade were .9945 and .9948 for Grades 2 and 3, respectively. With correlations of the magnitude shown above, it is strongly suspected that problems of multicollinearity were present in equation 1.

A revised equation was estimated after removing the three highly correlated variables listed above.

Equation 2

Equation 2 for estimating X_1 is:

$$X_1 = \underset{}{9.4924} - \underset{^a(.0013)^{***}}{.0086X_2} - \underset{(.0069)^{***}}{.3165X_3} - \underset{(.0416)^{***}}{.6298X_5} - \underset{(.0414)^{***}}{.2728X_6} + \underset{(.0478)^{***}}{.1528X_8} + \underset{(.0422)^{***}}{1.1977X_9}$$

$$+ \underset{(.0548)^{***}}{.8311X_{11}} + \underset{(.0582)^{***}}{.6093X_{12}} + \underset{(.0478)^{***}}{.5337X_{13}}$$

The coefficients of all variables in equation 2 were found to be significant at the .01 level.

The coefficient of hot carcass weight (X_2) had a negative sign, indicating that increases in hot carcass weight are associated with decreases in the GMD.

The coefficient of liveweight price (X_3) also had a negative sign. Thus, increases in liveweight price were associated with decreases in GMD's.

Negative signs were also present for the coefficients of the intercept shifter variables for procurement methods. This would indicate that the company margins were lower for animals purchased from order buyers, and for animals purchased on a carcass basis.

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[a]The figure in parentheses below each coefficient is the standard error of the coefficient where:

*** = significant at the .01 level.

$R^2 = .6053$.

$S_e = .9615$.

$F = 550.3$.

The margins for Grade 2 animals and Grade 3 animals were significantly higher than the margins for Grade 1 animals.

The coefficients of the variables allowing for seasonal intercept changes all had positive signs, indicating that each of the other seasons had significantly higher gross margin intercepts than the season January-March.

With respect to R^2 and standard error of estimate, the two equations were almost identical. Equation 2 had more significant variables, probably due to the elimination of the problem of multicollinearity.

Coefficients for equations estimated for this objective show that GMD's are higher for the lighter and lower priced animals. Results indicate that a decrease of .008 dollars in the GMD is associated with each pound increase of hot carcass weight. Over the range of the weights considered this could amount to approximately .39 dollars per hundredweight difference in the GMD. The effect of a price increase would be a reduction of .31 dollars in the GMD for each dollar increase in liveweight price. Thus, unless the values added during processing (example--green bellies to bacon) are not higher for heavier hogs, the results indicate that a failure to take into account value differences between light weight and heavy weight animals may be a source of inaccuracy in the company pricing mechanism. The lower margins in times of price increases indicate that the packer in the time period covered absorbed part of price increases rather than passing it along to the consumer.

The results also suggest that it would be advantageous for producers selling to this firm to sell on a carcass basis rather than a liveweight basis, especially if one is producing Grade 1 animals. With regard to procurement methods, results suggested that the packer would benefit from buying more animals directly from producers. Over the long-run, however, this may not be so. Results of this type of practice could lead to either a shortage of supply of animals from loss of animals marketed in this manner by producers. It could also have the effect of causing producers to switch to selling animals on a carcass basis which in turn would lead to greater accuracy of pricing by the firm and a better allocation of resources in the entire system.

The highly significant coefficients and positive signs on the intercept change variables for Grade 2 (X_8) and Grade 3 (X_9) indicate that the packer would receive higher margins by purchasing lower grade animals under the assumed situation. However, since changes in values due to processing were not accounted for, it cannot be stated that this is definitely a source of inaccuracy.

VI. OBJECTIVE IV

Carcass buying models are often based on the effects that physical characteristics have on the wholesale values of different classes of animals. To study the association of physical characteristics and wholesale values several key physical characteristics and four sets of wholesale cut prices were used in examining the association between physical characteristics and wholesale values of animals. There were nine comparable equations examined for each of the wholesale cut price situations chosen. Several combinations of variables were examined in order to gain insight as to which variables or combination of variables would be of greatest value in developing a carcass buying program.

Variables Included

The wholesale values of the animals under different pricing situations for wholesale cuts were used as the dependent variables. The situations selected were:

(1) Wholesale value per hundredweight based on the mean prices of wholesale cuts calculated by randomly selecting two days a month from the days on which the gross margin differentials were calculated for Objective III.

(2) Wholesale value per hundredweight based on wholesale cut prices using the prices prevailing on the day when Peoria top liveweight price was the highest of all days that had animals entering the study.

(3) Wholesale value per hundredweight based on wholesale cut prices prevailing on the day when Peoria top liveweight price was the lowest of all of the days that had animals entering the study.

(4) Wholesale value of the animals per hundredweight based on the mean of the wholesale cut prices of all days where animals were included in the study.

The independent variables considered were: hot carcass weight, average backfat in inches, backfat in inches taken at the fifth rib, backfat in inches taken at the last lumbar vertebra, grade, and muscling.

Equation 1

Equation 1 assumed the variation in wholesale values to be a function of hot carcass weights and average backfat.

Equation 2

Equation 2 assumed the variation in wholesale values to be a function of hot carcass weights and single backfat measurements taken at the last lumbar vertebra.

Equation 3

A single backfat measurement taken at the fifth rib and hot carcass weight were the independent variables assumed for this equation.

Equation 4

This equation assumed that hot carcass weights, average backfat, grades (intercept changes), and muscling (intercept changes), as variables affecting the variation in wholesale values.

Equation 5

This is the same as equation 4 except that one backfat measurement taken at the last lumbar vertebra was used as an explanatory variable in place of average backfat.

Equation 6

One backfat measurement taken at the fifth rib replaced the variable of one backfat measurement taken at the last lumbar vertebra as an independent variable in the equation. All other variables remained the same as those for the two previous equations.

Equation 7

The independent variables used here included hot carcass weights and grades (intercept changes).

Equation 8

Equation 8 assumed muscling (intercept changes) and hot carcass weights as the explanatory variables.

Equation 9

The equation assumed the variation of the wholesale values to be a function of hot carcass weights, grade (intercept changes), and muscling (intercept changes).

VII. VARIABLE IDENTIFICATION FOR OBJECTIVE IV

The calculated coefficients of the models analyzed under Objective IV are presented in Tables 12-15. The variables included in all models are identified as shown below.

Dependent Variables

X_1 = wholesale value per hundredweight of hot carcass based on mean wholesale cut prices using two days in each month in the time period May 1970-April 1971.

X_2 = wholesale value per hundredweight of hot carcass based on wholesale cut prices using the prices prevailing on the day when Peoria top liveweight price was the highest of all days which had animals entering the study.

X_3 = wholesale value per hundredweight of hot carcass based on wholesale cut prices using prices prevailing on a sample day when Peoria top liveweight price was the lowest of all days which had animals entering the study.

Table 12. Calculated Coefficients for Models Using Wholesale Value Per Hundredweight of Hot Carcass Based on Mean Wholesale Cut Prices Using Two Days in Each Month in the Time Period May 1970-April 1971 as the Dependent Variable (Designated by Year)

Equation	Dependent Variable	b_o	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	R^2	Standard Error of Estimate	F-Ratio
1	Year	33.695	-.0154 (.0022)***	-.7057 (.2197)***	a	a	a	a	a	a	a	a	a	.3599	.6832	49.8
2	Year	33.467	-.0166 (.0020)***	a	a	-.4293 (.1653)***	a	a	a	a	a	a	a	.3475	.6898	47.2
3	Year	33.554	-.0157 (.0022)***	a	-.5102 (.1951)***	a a	a a	a a	a a	a a	a a	a a	a a	.3478	.6897	52.1
4	Year	33.941	-.0181 (.0024)***	-.2087 (.3525)	a	a	b	.1446 (.1873)	-.0230 (.2604)	b	-.5257 (.1958)***	-.7044 (.2509)***	-.6699 (.2916)***	.3967	.6729	16.2
5	Year	33.786	-.0190 (.0021)***	a	a	.0079 (.2283)	b	.1031 (.1809)	-.1072 (.2451)	b	-.5368 (.1964)***	-.7330 (.2514)***	-.6941 (.2913)***	.3955	.6735	16.1
6	Year	33.899	-.0185 (.0023)***	a	-.1242 (.2718)	a	b	.1343 (.1864)	-.0528 (.2483)	c	-.5385 (.1952)***	-.7282 (.2469)***	-.6815 (.2901)***	.3962	.6731	16.1
7	Year	33.116	-.0172 (.0020)***	a	a	a	b	-.1986 (.1210)	-.4385 (.1327)***	a	a	a	a	.3622	.6839	33.3
8	Year	33.782	-.0189 (.0019)***	a	a	a	a	a	a	b	-.5046 (.1858)***	-.6947 (.1772)***	-.7639 (.1981)***	.3878	.6720	27.7
9	Year	33.791	-.0189 (.0020)***	a	a	a	b	.1047 (.1744)	-.1036 (.2215)	b	-.5360 (.1947)***	-.7314 (.2463)***	-.6930 (.2884)***	.3955	.6716	18.9

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

[a]Deleted from the model. [b]Deleted from the model to avoid singularity.

Table 13. Calculated Coefficients for Models Using Wholesale Value Per Hundredweight of Hot Carcass, Based on Wholesale Cut Prices Prevailing on a Sample Day When Peoria Top Liveweight Price Was the Highest of All Days Included in the Sample as the Dependent Variable (Designated by High)

Equation	Dependent Variable	b_o	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	R^2	Standard Error of Estimate	F-Ratio
1	High	34.927	-.0118 (.0023)***	-1.065 (.2286)***	a	a	a	a	a	a	a	a	a	.3374	.7110	45.1
2	High	34.653	-.0138 (.0021)***	a	a	-.7300 (.1720)***	a	a	a	a	a	a	a	.3248	.7177	42.6
3	High	34.709	-.0128 (.0023)***	a	-.7660 (.2053)***	a	a	a	a	a	a	a	a	.3104	.7254	39.8
4	High	35.113	-.0165 (.0024)***	-.2873 (.3577)	a	a	b	.2746 (.1900)	.0144 (.2643)	b	-.5655 (.1987)***	-1.0019 (.2546)***	-.9269 (.2959)***	.4062	.6828	16.8
5	High	35.002	-.0171 (.0023)***	a	a	-.1435 (.2316)	b	.2487 (.1835)	-.0317 (.2486)	b	-.5660 (.1993)**	-1.0096 (.2550)***	-.9370 (.2955)***	.4062	.6828	16.7
6	High	35.036	-.0170 (.0023)***	a	-.1492 (.2760)	a	b	.2552 (.1893)	-.0355 (.2522)	b	-.5820 (.1982)***	-1.035 (.2507)***	-.0450 (.2946)***	.4050	.6835	16.7
7	High	34.045	-.0150 (.0020)***	a	a	a	b	-.2800 (.1255)***	-.6683 (.1377)***	a	a	a	a	.3441	.7094	30.8
8	High	34.858	-.0173 (.0020)***	a	a	a	a	a	a	b	-.5116 (.1906)***	-.9247 (.1817)***	-1.005 (.2031)***	.3849	.6890	27.4
9	High	34.907	-.0176 (.0020)***	a	a	a	b	.21965 (.17713)	-.09662 (.22499)	b	-.5797 (.1977)***	-1.0390 (.2501)***	-.9587 (.2929)***	.4040	.6821	19.6

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

[a]Deleted from the model. [b]Deleted from the model to avoid singularity.

Table 14. Calculated Coefficients for Models Using Wholesale Value Per Hundredweight of Hot Carcass Based on Wholesale Cut Prices Prevailing on a Sample Day When Peoria Top Liveweight Price Was the Lowest of All Days Included in the Sample as the Dependent Variable (Designated by Low)

Equation	Dependent Variable	b_o	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	R^2	Standard Error of Estimate	F-Ratio
1	Low	28.997	-.0141 (.0017)***	-.8557 (.1674)***	a	a	a	a	a	a	a	a	a	.4987	.5207	88.0
2	Low	28.767	-.0158 (.0016)***	a	a	-.5751 (.1265)***	a	a	a	a	a	a	a	.4849	.5278	83.3
3	Low	28.834	-.0149 (.0017)***	a	-.6288 (.1506)***	a	a	a	a	a	a	a	a	.4763	.5322	80.5
4	Low	29.197	-.0177 (.0018)***	-.2331 (.2598)	a	a	b	.0445 (.1381)	.0635 (.1920)	b	-.5448 (.1443)***	.7468 (.1850)***	-.7349 (.2149)***	.5580	.4960	31.0
5	Low	29.095	-.0182 (.0016)***	a	a	-.0997 (.1684)	a	.0200 (.1333)	-.1085 (.1807)	b	-.5468 (.1449)***	-.7565 (.1854)***	-.7457 (.2148)***	.5568	.4967	30.9
6	Low	29.148	-.0180 (.0017)***	a	-.1377 (.2005)	a	b	.0327 (.1375)	-.0973 (.1832)	b	-.5590 (.1440)***	-.7733 (.1821)***	-.7481 (.2140)***	.5571	.4965	30.9
7	Low	28.321	-.0167 (.0015)***	a	a	a	b	-.3291 (.0917)***	-.5304 (.1005)***	a	a	a	a	.5061	.5783	60.1
8	Low	29.066	-.0188 (.0014)***	a	a	a	a	a	a	b	-.5590 (.1371)***	-.8243 (.1307)***	-.8911 (.1461)***	.5509	.4957	53.7
9	Low	29.029	-.0185 (.0015)***	a	a	a	b	-.0001 (.1287)	-.1536 (.1635)	b	-.5563 (.1437)***	-.7769 (.1818)***	-.7607 (.2129)***	.5559	.4958	36.1

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

[a]Deleted from the model. [b]Deleted from the model to avoid singularity.

Table 15. Calculated Coefficients for Models Using Wholesale Value Per Hundredweight of Hot Carcass, Based on the Mean of the Wholesale Cut Prices of All Days Where Animals Were Included in the Study as the Dependent Variable (Designated by Average)

Equation	Dependent Variable	b_o	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	R^2	Standard Error of Estimate	F-Ratio
1	Average	33.680	-.0293 (.0018)***	-.7463 (.1840)***	a	a	a	a	a	a	a	a	a	.7061	.5793	212.7
2	Average	33.482	-.0308 (.0017)***	a	a	-.5035 (.1382)***	a	a	a	a	a	a	a	.7012	.5768	207.7
3	Average	33.572	-.02982 (.00182)***	a	-.5860 (.1634)***	a	a	a	a	a	a	a	a	.7006	.5775	207.1
4	Average	33.840	-.0317 (.0020)***	-.3842 (.2975)	a	a	b	.1409 (.1581)	.0427 (.2198)	b	-.3335 (.1653)**	-.5310 (.2118)**	-.5224 (.2461)**	.7185	.5680	62.7
5	Average	33.686	-.0325 (.0018)***	a	a	-.1848 (.1930)	b	.1048 (.1529)	-.0221 (.2071)	b	-.3349 (.1660)**	-.5428 (.2125)**	-.5370 (.2462)**	.7173	.5692	62.3
6	Average	33.816	-.0320 (.0019)***	a	-.2917 (.2294)	a	b	.1369 (.1573)	.0136 (.2096)	b	-.3583 (.1647)**	-.5731 (.2084)***	-.53809 (.2449)**	.7184	.5681	62.6
7	Average	33.069	-.0317 (.0016)***	a	a	a	b	-.2027 (.1020)**	-.4237 (.1119)**	a	a	a	a	.7030	.5767	138.9
8	Average	33.567	-.0331 (.0016)***	a	a	a	a	a	a	b	-.3329 (.1574)**	-.5691 (.1500)***	-.64374 (.1678)***	.7125	.5691	108.4
9	Average	33.564	-.0331 (.0017)***	a	a	a.	b	-.1059 (.1478)	-.3525 (.1877)*	b	-.3525 (.1649)**	-.5807 (.2087)**	-.5649 (.2444)**	.7158	.5691	72.6

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

[a]Deleted from the model. [b]Deleted from the model to avoid singularity.

X_4 = wholesale value per hundredweight of hot carcass based on the mean wholesale cut prices for all days which had animals in the study.

Independent Variables

X_5 = hot carcass weight in pounds.

X_6 = average backfat in inches.

X_7 = backfat in inches taken at the fifth rib.

X_8 = backfat in inches taken at the last lumbar vertebra.

X_9 = one, if Grade 1 and zero otherwise.

X_{10} = one, if Grade 2 and zero otherwise.

X_{11} = one, if Grade 3 and zero otherwise.

X_{12} = one, if very thick muscling and zero otherwise.

X_{13} = one, if thick muscling and zero otherwise.

X_{14} = one, if moderately thick muscling and zero otherwise.

X_{15} = one, if slightly thin muscling and zero otherwise.

The calculated coefficients and a discussion of the different models using various carcass characteristics as independent variables to explain the variation in the wholesale value of animals under the various pricing situations discussed in the previous section follows. Tables 12-15 show the estimated coefficients along with their standard errors and levels of significance. In all of the equations the F ratio of the regression was found to be significant at the .01 level, therefore this statistic will not be discussed in the text.

VIII. DISCUSSION OF OBJECTIVE IV RESULTS

Wholesale Cut Prices Based on Period May 1970-April 1971

The first three equations in Table 12 included hot carcass weights and backfat measurements as independent variables. All of the first three equations had similar results. The coefficients for hot carcass weights and the particular backfat measures used were significant at the .01 level. The estimated coefficients of all of the variables in the first three equations had negative signs. With respect to hot carcass weights, the equations indicate that a carcass buying model based on hot carcass weight and backfat would subtract approximately one and six tenths cents for each pound increase in hot carcass weight. A model with average backfat (the mean of three measures taken at the first rib, last rib, and last lumbar vertebra) and hot carcass weight would discount animals at the rate of about seven cents for each one tenth of an inch increase in backfat. Carcass buying models incorporating hot carcass weight and backfat measurements taken at the last lumbar vertebra would reduce the wholesale value per hundredweight by approximately four cents for every one tenth of an inch increase in backfat taken at this point. A model using backfat taken at the fifth rib and hot carcass weight would reduce the wholesale value of animals by approximately five cents for each one tenth inch increase in backfat taken at the fifth rib.

Equations 4 through 6 incorporated intercept changes for grades and muscling into the simpler models above. All of the equations were the same with the exception of using different measures of backfat. Adding the intercept change variables for grade and muscling resulted in increasing the R^2 and decreasing the standard errors of estimate of equations using similar backfat measures (discussed above). After including the intercept change variables for grade and muscling the coefficients of the variables for the various backfat measures were not found to be significant at the .10 level. It is suspect that the results of these equations are affected by the problem of multicollinearity. All of the muscling scores had coefficients which were statistically significant at the .01 level. Each possessed a negative sign indicating that wholesale values would decrease for animals with a lower muscling score.

Equation 7 considered grade and hot carcass weight as explanatory variables. The results of this equation suggest that carcass buying models incorporating systems of premiums and discounts based on the physical characteristics of hot carcass weight and grade would be as accurate as models based on carcass weight and backfat, assuming that animals were placed in the proper grade categories. The cost of gathering a visual grade observation as compared to making and recording backfat measurements would be lower for the cooperating concern; thus, from the results shown here, there would be no incentive to use a carcass buying model that would require the extra information achieved by the added information gained by taking backfat measurements.

Equation 8 used intercept change variables for muscling and hot carcass weight as independent variables. Results indicate that a carcass buying model based on these characteristics would deduct .0189 dollars per pound increase in hot carcass weight and the intercepts for thick, moderately thick, and slightly thin muscled animals would be

-.5046, -.6947, and -.7639 dollars less than animals with very thick muscling, respectively.

Equation 9 incorporated both grade and muscling intercept changes along with hot carcass weight as independent variables. The coefficients for the intercept change variables for each of the muscling scores were significant at the .01 level. The coefficients for intercept changes for Grades 2 and 3 were statistically different from Grade 1. The results of the model indicate that there would be no great advantage to incorporating both grade and muscling into carcass buying models.

Wholesale Values on Highest Liveweight Price Day

Table 13, page 49, shows the calculated coefficients for the same models as were shown in Table 12, page 48, the only change being the dependent variable.

In general, the relationships between the equations displayed in Table 12 and those displayed in this table were the same. The explanatory powers of the various carcass characteristics did not vary widely under the two pricing situations.

In all cases, as with the previous equations, the coefficients of hot carcass weight (X_2) were significant at the .01 level. All of the coefficients for this variable also had negative signs.

In all of the estimating equations where muscling scores were used as independent variables, the intercepts for thick, moderately thick, and slightly thin muscled animals were significantly lower than the intercept for animals with very thick muscling. This was the same relationship displayed under the previously discussed pricing situation.

Intercept values for Grades 2 and 3 were significantly lower than that for Grade 1 in equation 7. In all other cases where variables other than grade and hot carcass weight were involved the coefficients of the intercept changes for Grades 2 and 3 were not significantly different from that of Grade 1. It is suspected that this is due to multicollinearity since some of these variables are related by definition.

Wholesale Values on Lowest Liveweight Price Day

The same general relationships that prevailed in the two previous sets of models are found in Table 14, page 50. In all cases the signs, levels of significance, and number of significant variables were the same as in Table 13, page 49.

The degree of association between physical characteristics and wholesale values was considerably higher under this pricing situation than they were under the two previous sets of equations discussed. R^2's ranged between .4763 and .5559 for the equations in Table 14, whereas the ranges were .3475 to .3955 in Table 12, page 48, and .3104 to .4040 in Table 13.

Wholesale Values Using All Sample Days

Table 15, page 51, presents the calculated coefficients for the equations when the mean of the wholesale cut prices for all days with animals entering the study was used to determine wholesale value.

Generally the relationships of the equations were the same as before. The degree of association between the physical characteristics and wholesale values was higher for the mean pricing situation than it was for the two individual days chosen or for the average of the prevailing prices over another time period (Table 12).

A check of the first step of the linear regression equations (equivalent to a simple regression) revealed interesting results. The R^2 when hot carcass weight alone was taken into consideration under the different selected pricing situations upon which wholesale values were calculated was as follows: Table 12, page 48, .3226; Table 13, page 49, .2565; Table 14, page 50, .4248; and Table 15, page 51, .6788. The association between wholesale values and hot carcass weight alone was considered as a variable under all pricing situations discussed. The amount of reduction in wholesale value associated with each pound increase in hot carcass weight was as follows: Table 12, -.0183 dollars; Table 13, -.0166 dollars; Table 14, -.0180 dollars; and Table 15, -.0327 dollars. Therefore, the varying ability of the physical characteristics to explain variation in wholesale values per hundredweight of hot carcass can be largely attributed to the variability in price relationships of the wholesale cuts prevailing at the time of the period in question. Results suggest, in carcass buying models based on physical characteristics, the amount that the heavier weight animals should be discounted would vary depending on the prevailing pricing situation.

Summary of Equations for Objective IV

In comparable equations presented in Tables 12-15 the only change made was the dependent variable. In general, results of comparable equations were similar with respect to the signs of the respective variables, the number of significant variables, and the level of significance of the coefficients. All of the equations considered in this objective had F ratios significant at the .01 level. There was, however, a fairly wide range in results with respect to the degree of association between physical characteristics and wholesale values under the different pricing situations for wholesale cuts. The degree of association between hot carcass weights and wholesale values varied widely (as discussed above) when the dependent variable was changed. The magnitudes of the b coefficients for the variable hot carcass weight also varied widely. This indicates that there are variables other than physical characteristics (such as changing proportions of the prices of individual wholesale cuts) that could be considered when developing carcass buying models to establish systems of premiums and discounts for the various classes of animals. Results of the equations tested indicate that the systems of premiums and discounts for the various classes of hogs as shown in Appendix A would change as the relationships of the prices of wholesale cuts change. For example, results of equation 7 indicates that the difference in wholesale value per hundredweight of a Grade 1 animal with a hot carcass weight of 132 pounds and a Grade 1 animal with a hot carcass weight of 177 pounds would be 1.43 dollars of the pricing situation prevailing was the same as that depicted in Table 15, page 51. The differences for similar animals under the pricing situations were as those depicted in Tables 12, 13, and 14, pages 48-50, would be .77, .67, and .75, respectively. Another example using this same equation as an illustration is the relationship of the intercept shifter variables for Grades 2 and 3 with the intercepts for Grade 1 animals under the various pricing situations. When considering the coefficients for the intercept shifter variable for Grade 2 across all four situations of selected wholesale cut prices, the results were as follows: Table 12, -.1986; Table 13, -.2800; Table 14, -.3291; Table 15, -.2027. The comparable coefficients of intercept changes for Grade 3 as associated with Grade 1 over the four selected pricing situations were as follows: Table 12, page 48, -.4385; Table 13, page 49, -.6683; Table 14, page 50, -.5304; Table 15, page 51, -.4237. A carcass buying model which would be most equitable to all concerned would have to be based on more than physical characteristics if only one model were used, since the relationships are not consistent in explaining the variation in wholesale value per hundredweight of carcass. An alternative to including variables other than physical characteristics into carcass buying models could be to determine time periods or pricing situations when physical characteristics yielded similar results in their associations with wholesale values. For example, a firm may have a carcass buying model for the fall and one for the summer. Another example would be to have one for periods of low prices and another for a period of high prices. It was beyond the scope of this study to determine the exact relationships that existed in the ratios of the wholesale cut prices or degree of association between physical characteristics and wholesale values for different seasons.

Comparing the equations shown on each of the tables discussed suggests that even though there were fairly wide variations between some of the results found when different pricing situations for wholesale cuts were used, there were no real wide variations between the equations tested within each pricing situation of wholesale cuts considered. The results suggest that there would be no advantage to using more than one backfat measurement if one desired to build carcass buying models incorporating backfat measurements as a variable to establish systems of premiums and discounts between different classes of animals. Almost identical results were derived with respect to the first three equations in each of the four pricing situations discussed. This agrees with the results found by Hayenga in his study at Michigan State discussed in Chapter II, pages 16 and 17.

Results of the equations also indicate that carcass buying models which would be based on a visual grade or muscling score would be as accurate as models using backfat measurements. In all cases under all wholesale cut pricing situations discussed equations 7 and 8 yielded hot carcass weight explained as much or more of the variation in wholesale values as did equations using backfat measurements (equations 1-3). This could be advantageous from a cost of operation standpoint for most firms since visual observations given to animals could be taken and recorded with less expense than backfat measures.

The results also suggested that within each price situation there was no real advantage to include both grade and muscling in carcass buying models.

CHAPTER V

SUMMARY

I. REVIEW OF PROCEDURE

The objectives of this study were: (1) to estimate the cutout characteristics of U.S.D.A. Grades 1, 2, and 3 hogs at different weight intervals; (2) to determine the gross margin differentials among these animals and to identify variables affecting this margin; (3) to use cutout characteristics established in Objective I to calculate GMD's for a different sample of animals, taking into account differences that may be attributable to both season and procurement method; and (4) to determine relationships that may exist between physical characteristics and wholesale values per hundredweight of hot carcasses under different situations of wholesale cut prices.

The facilities and records of a large, federally inspected meat packing company were made available to this researcher and provided the primary data source. Data were gathered on 180 animals. Sixty of these animals were from U.S.D.A. Grade 1, while U.S.D.A. Grades 2 and 3 provided 70 and 50 animals, respectively. They fell into 18 categories of 10 animals each, based on liveweight and grade.

Wholesale values and costs of each of these animals were estimated and gross margin differentials per hundredweight calculated. Linear multiple regression equations using a stepwise regression program were used to identify variables affecting these GMD's.

Using the results of Objective I to provide estimates of the average physical characteristics, and company records, GMD's per hundredweight were calculated for a different sample of animals. This sample consisted of 90 animals from each grade, equally divided by source, for each month of the year running from May 1970 to April 1971. Linear multiple regression equations were used to identify factors affecting these GMD's.

Linear multiple regression equations were used also to test relationships among physical characteristics and wholesale values of animals based on calculated values per hundredweight based on different sets of wholesale cut prices.

II. REVIEW OF RESULTS

Analysis of the GMD's for the original sample of 180 animals showed the following results: (1) Increases in hot carcass weights were associated with lower GMD's. This could reflect inaccuracy in the concern's buying program. (2) Increases in liveweight prices of animals were associated with decreases in the GMD's. This suggests that all increases in live animal prices are not passed immediately on to the consumer. (3) The coefficient of the intercept change variable for Grade 3 was negative indicating that the concern received lower margins for Grade 3 animals than for Grade 1 animals. However, the coefficient of the slope change variable for Grade 3 was positive indicating that as weights increased within the grade, GMD's increased.

The analysis of the GMD's for the sample covering the time period May 1970-April 1971 revealed several of the same relationships that were present between the variables considered in the sample of the 180 animals analyzed. The coefficient of the variable for hot carcass weight was negative. This indicates a possible reflection of inaccuracy in the company's buying practices since there is a failure of liveweight prices to reflect wholesale value differences between lightweight and heavyweight animals. As was the case for the equations presented in Objective II, the association between increases in liveweight prices and GMD's was negative.

Animals procured from order buyers and also animals purchased on a carcass basis had significantly lower GMD's than animals purchased on a direct liveweight basis. From the standpoint of the firm, the logical action would be to increase procurement of animals through this channel. From the producer's standpoint the results indicate that it may be to his advantage to sell on a carcass basis. As previously pointed out in the long run these same relationships may not prevail.

The coefficients of the intercept shifters for seasons were all found to be significant at the .01 level and all of the seasons had higher intercepts than the period January-March.

The coefficients for the intercept shifter for Grades 2 and 3 were significant at the .01 level in both of the equations considered in Objective III. The signs of the coefficients were both positive in equation 2 where only intercept changes were considered for grade. This would indicate a possible reflection of inaccuracy in company buying programs.

The equations in Objective IV estimated the degree of association between physical characteristics and wholesale values of animals under different pricing situations for wholesale cuts.

The degree of association between physical characteristics and wholesale value of animals varied, depending on the pricing situation used to determine values. The degree of association between hot carcass weight and wholesale value varied widely under the various pricing situations for wholesale cuts. The magnitude of the b coefficients also varied widely for the variable hot carcass weight. This suggests that variables other than physical characteristics should be considered when constructing carcass buying models that would reflect the actual differences that are present for the various classes of animals.

Results of the equations indicate that there would be no advantage to including more than one backfat measurement in a carcass buying program if they were to be included. Equations estimated using one measure of backfat taken at either the fifth rib or at the last lumbar vertebra yielded results similar to those using average backfat as an explanatory variable in all of the pricing situations for wholesale cuts considered.

Assuming that the proper muscling score or grade would be given, results of the equations in each of the pricing situations for wholesale cuts indicate that carcass buying programs including grade or muscling as variables along with hot carcass weights would be as accurate as those using backfat measurements. This has implications in the operational cost in that information gained from visual observation may cost less than information gained from actual measurements. The results of the equations estimated that there would be no real advantage to incorporating both grade and muscling scores in carcass buying models.

III. CONCLUSIONS

There were several sources of potential inaccuracies in the buying practices of the firm pointed out in this study. First, a source of inaccuracy may be present due to a failure to properly discount the heavier weight of animals. Another potential source of inaccuracy may stem from a failure of the liveweight pricing system to reflect value differences between grades.

The GMD's received by the company could be affected by the methods of procurement used (this may be only for the short run).

Many carcass buying models are based on systems of premiums and discounts based on the associations present between physical characteristics and wholesale values. Results of the associations revealed in the equations suggest that hot carcass weight would be a very important variable to include in carcass buying models. Carcass buying models based on hot carcass weights and backfat measures would have no advantages over carcass buying models based on hot carcass weights and grade or over models using hot carcass weights and muscling scores. This is assuming that accurate grade and muscling scores would be given to animals. If backfat measures were to be used in carcass buying models, the results indicate that models constructed using one backfat measure taken at the fifth rib or at the last lumbar vertebra would have no appreciable disadvantage to models using average backfat as a variable. This is consistent with results of previous researchers. Results would lead one to conclude that there are variables other than physical characteristics which are associated with changes in wholesale value of animals.

IV. IMPLICATIONS FOR FUTURE RESEARCH

More research is needed to determine the associations between variables other than physical characteristics and wholesale values of hog carcasses. The relationships of the various wholesale cut prices under different pricing situations should be determined. Research in this area could be focused on the relationships of the wholesale cut prices at different seasons of the year, or the relationships of these wholesale cut prices under different situations of liveweight pricing. Once determined, these relationships should reflect themselves in the carcass buying programs of packers. For example, a packer could have one carcass buying program for each season of the year.

Research is needed in the area of costs and returns associated with the various classes of animals from the wholesale level to the retail level. A knowledge of these relationships would better enable firms to assess buying programs more effectively.

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APPENDICES

APPENDIX A

Table 16. Company Standards for Shrink and Dressing Percent[a]

Liveweight		171-190	191-210	211-230	231-250	251-270	271-290	291-330
USDA	Dressing Percent	68.5	69.5	70.0	70.5	71.0	71.5	
No.	Hot Carcass Weight	117-131	132-146	147-161	162-177	178-192	193-208	
1	Shrink	2.80	2.70	2.60	2.55	2.45	2.35	
USDA	Dressing Percent	68.5	69.5	70.0	70.5	71.0	71.5	71.5
No.	Hot Carcass Weight	117-131	132-146	147-161	162-177	178-192	193-207	208-222
2	Shrink	2.45	2.40	2.35	2.25	2.15	2.10	2.05
USDA	Dressing Percent		71.5	71.5	72.0	72.5	73.0	
No.	Hot Carcass Weight		133-150	151-165	166-181	182-196	197-212	
3	Shrink		2.10	2.05	2.00	1.95	1.90	

[a]Based on data gathered in test run from April 1965 through March 1969.

APPENDIX B

FORM FOR GATHERING ORIGINAL DATA

Grade ______________ Date ______________

Weight Range ______________

Carcass No.									
Buyer Number									
Sex									
Hot Weight									
Chilled Weight									
Backfat	1st								
	5th								
	Last								
	Last Lumbar								
Length	Left								
	Right								
Muscling									

SKD Jowls	
Jowl Butts	
Backs	
Reg. Trim	
50% Trim	
80% Trim	
NK Bone Trim	
Neck Bones	
Ham Hocks	
Picnic Hocks	
Tails	
Hind Feet	

Front Feet	
Skins	
Lard Fat	
Total Fat	

Loins	Left														
	Right														
Hams	Left														
	Right														
Picnics	Left														
	Right														
Butts	Left														
	Right														
Bellies	Left														
	Right														
Spare Ribs	Left														
	Right														
Bellies Thickness	Left														
	Right														

APPENDIX C

Table 17. Breakdown of Cuts Used for Computing Wholesale Values

Wholesale Cuts	Pounds	Wholesale Cuts
Loins	8-14	Skinned Jowls
	14-17	
	17-20	Regular Trimmings
Hams	10-12	50% Trimmings
	12-14	
	14-16	80% Trimmings
	16-18	
	18-20	Neck Bone Trim
	20-25	
	25 up	Neck Bones
Picnics	4-6	Ham Hocks
	6-8	
	8 up	Picnic Hocks
Butts	4-8	Tails
	8 up	
		Hind Feet
Bellies	<7	
	7-9	Front Feet
	9-11	
	11-13	Skins
	13-15	
	15-17	Total Fat
	17-19	
Spare Ribs	0-3	
	3-5	

APPENDIX D

Table 18. National Provisioner Daily Market Service Price Quotations Utilized for Computing Wholesale Values

Item	Price Used
8-14 Loins	Chicago Job Lot Fresh
14-17 Loins	Chicago Job Lot Fresh
17-20 Loins	Chicago Job Lot Fresh
10-12 Hams	Skinned Hams F.F.A. or Fresh 14/down
12-14 Hams	Skinned Hams F.F.A. or Fresh 14/down
14-16 Hams	Skinned Hams F.F.A. or Fresh 14/17
16-18 Hams	Skinned Hams F.F.A. or Fresh 14/17
18-20 Hams	Skinned Hams F.F.A. or Fresh 17/20
20-25 Hams	Skinned Hams F.F.A. or Fresh 20/26
25 up Hams	Skinned Hams F.F.A. or Fresh 26/30
4-6 Picnics	F.F.A. or Fresh 4/6
6-8 Picnics	F.F.A. or Fresh 6/8
8 up Picnics	F.F.A. or Fresh 8/12
4-8 Butts	Car Lot Fresh Boston Butts, 4/8 (Boxed)
8 up Butts	Car Lot Fresh Boston Butts, 8 up
<7 Bellies	Car Lot Fresh Regular Trimmings
7-9 Bellies	8-10 Bellies F.F.A. or Fresh divided by .90
9-11 Bellies	10-12 Bellies F.F.A. or Fresh divided by .90
11-13 Bellies	12-14 Bellies F.F.A. or Fresh divided by .90
13-15 Bellies	14-16 Bellies F.F.A. or Fresh divided by .90

Table 18 (continued)

Item	Price Used
15-17 Bellies	16-18 Bellies F.F.A. or Fresh divided by .90
17-19 Bellies	18-20 Bellies F.F.A. or Fresh divided by .90
0-3 Spare Ribs	Car Lot Frozen
3-5 Spare Ribs	Car Lot Frozen
Skinned Jowls	Car Lot Fresh
Regular Trimmings	Car Lot Fresh Regular Trimmings[a]
50% Trimmings	Car Lot Fresh 50% Lean
80% Trimmings	Car Lot Fresh Spl. 80% Lean
Neck Bone Trim	Car Lot Fresh Neck Bone Trimmings[b]
Neck Bones	Car Lot Fresh Neck Bones
Ham Hocks[c]	$9.00 per hundredweight
Pichic Hocks[d]	$10.00 per hundredweight
Tails	Car Lot Frozen
Hind Feet[e]	$2.00 per hundredweight
Front Feet	Car Lot Frozen, Feet Front, Toes On
Skins	Car Log Frozen Pig Skins (Gelatin)
Total Fat	P.S. and/or C.P. (loose multiplied by .66)

[a]When unquoted, the price of 50% Lean Trim less $2.00 per hundredweight was used.

[b]When unquoted, Job Lot Fresh less $1.00 per hundredweight was used.

[c]Company price used.

[d]Company price used.

[e]Company price used.

APPENDIX E

COOPERATING COMPANY'S PREMIUM HOG BUYING PROGRAM

The cooperating concern offers a premium for hogs, which after delivery to the plant, are bought on a dressed basis. The premium applies to barrow and gilt carcasses meeting the Revised-1968 U.S.D.A. Standards for U.S. No. 1 and U.S. No. 2. The four primal cuts from No. 1's and No. 2's should yield a minimum of 53 percent and 50 percent, respectively. A premium is paid for carcasses yielding more than their expected dressing percent and discounted when yielding less. The live base value is based upon the regular U.S. No. 3's weighing 191 to 215 pounds live. The premium for No. 1 carcasses is $1.50 above the live base price; No. 2 carcasses get a $0.75 premium above the base; No. 3 carcasses receive the base price, while No. 4's are discounted $0.75 below the base.

The following is an explanation, in table form, of the price being paid for all weights and grades of market hogs.

Table 19. Price Being Paid for all Units and Grades of Market Hogs

U.S. No. 1	0	(200) 137	+.75	(210) 146	+1.50	(245) 172	+1.25	(255) 180	+1.00	(270) 192	+.75																			
U.S. No. 2	-.50	(190) 130	+.25	(200) 139	+.75	(230) 161	+.50	(240) 168	+.25	(255) 180	0	(270) 192	-.25	(285) 204	-.50	(300) 215	-.75													
U.S. No. 3	-1.25	(180) 126	-.50	(190) 135	(Base Value) 0	(215) 154	-.25	(225) 161	-.50	(235) 169	-.75	(245) 176	-1.00	(255) 185	-1.25	(270) 196	-1.50	(285) 208	-1.75	(300) 219	-2.00	(320) 234	-2.25							
U.S. No. 4	-1.75	(175) 125	-1.25	(185) 133	-.75	(200) 145	-1.00	(210) 152	-1.25	(220) 160	-1.50	(230) 168	-1.75	(240) 175	-2.00	(255) 187	-2.25	(270) 198	-2.50	(285) 211	-2.75	(300) 222	-3.00	(315) 233	-3.25					

Note: ( ) Approximate Live Weight; ______ Hot Carcass Weight; ______ Premium or Discount Received from Live Base Value.

The following is an example of three producers with 20 hogs (No. 1 hogs--all the carcasses weighing 147 to 172 pounds) and how Dressing Percent affected the price which they received.

Table 20. Effect of Dressing Percent on Price Received for 20 U.S. No. 1 Hogs (All Carcasses Weighing 147 to 172 Pounds)

	Producer A	Producer B	Producer C
Liveweight	4,600 lbs.	4,600 lbs.	4,600 lbs.
Hot Carcass Weight	3,358 lbs.	3,220 lbs.	3,028 lbs.
Average Carcass Weight	168 lbs.	161 lbs.	154 lbs.
Dressing Percent	73.0	70.0	67.0
U.S.D.A. Grade	No. 1	No. 1	No. 1
Base Price	18.50	18.50	18.50
Premium or Discount for Weight and Grade	+1.50	+1.50	+1.50
Price per Hundredweight Live	20.00	20.00	20.00
Standard Dressing Percent	70.0	70.0	70.0
Price per Hundredweight Carcass	28.57	28.57	28.57
Total Value	$959.38	$919.95	$880.53

The Packers and Stockyards Division of the U.S.D.A. requires the producer to be paid on a basis of hot carcass weight; therefore, it is necessary to convert live value of each particular weight and grade to its carcass value.

The following example is an illustration of how the Weight-Grade Premium or Discount is determined and how it affects the value received.

Table 21. Determination of Weight-Grade Premium or Discount and Its Affect on Value Received

Grade	No. 1	No. 4
Carcass Weight	168	168
Base Value	18.50	18.50
Premium or Discount for Weight and Grade	+1.50	+1.50
Price per Hundredweight Live	20.00	17.00
Standard Dressing Percent	70.0	73.0
Price Per Hundredweight Carcass	28.57	23.29
Total Value of Carcass	$48.00	$39.13

(1) It is necessary to determine which weight range a graded carcass falls within and then add the premium to or subtract the discount from the live base value.

(2) Price per hundredweight live is divided by the standard dressing percent to get price per hundredweight carcass. (These standard dressing yields are based on extensive tests run on all grade and weight ranges.)

(3) Carcass price per hundred times hot carcass weight equals total value of the carcass.

Each producer's lot of hogs will be tattooed with an assigned number. These hogs will be slaughtered on the day or arrival or at the earliest possible time.

The hot carcass weight will be based on an entire carcass dressed packer type (split into two sides down back, jowls attached and head, ham facings, and leaf fat removed).

Each carcass will be graded using the U.S.D.A. Official Grade Standards for Barrow and Gilt Carcasses with the Company Grade for Shorts included. Shorts are made up of carcasses weighing less than 146 pounds.

This information along with the tattoo number, sex, and weight are punched on an IBM Card for each carcass. After processing the cards by the computer, the producer is paid the following business day after slaughter.

Along with the payment for the hogs, the producer will also be sent a report including the grade, total carcass weight, number of carcasses, and percent carcasses within each grade and for each weight range within that grade. Certification Information (length, loineye tracing and backfat) can be provided at a cost of $3.00 per head. A reason or reasons will be given for any condemnations.

The Company must know a day in advance of your planned shipment in order that plans for slaughtering your hogs can be made.

The Company cannot be responsible for condemnations directed by Federal Inspectors and/or Veterinarians, since the producer is being paid extra premiums.

With this system, several important advantages are possible:

(1) The producer is more accurately paid for his hogs, since we can more accurately determine differences in carcasses than in live hogs. A premium will be paid for hogs with higher yields and better grades. At the same time, this program penalizes those who meet the standards. This way the producers of high quality pork do not have to carry poorer producers.

(2) Producers have an incentive to produce better livestock and deliver it in an ideal condition for slaughter.

(3) It provides the producer with kill data which he can use to evaluate different type programs, different feeds, breed lines, feeding programs, etc.

(4) The producer is paid a higher price, since we do not have to allow for: Pregnant Gilts, any "Fill," Counterfeits, Bruises and Condemnations. Instead we can pay for what we receive. The producer can determine the weight range to feed his hogs in order to receive the most return.

All these advantages help to improve and promote better pork.

VITA

Warren Carl Couvillion, Sr., was born August 9, 1940, in Baton Rouge, Louisiana. He was reared in the town of Simmesport, Louisiana, and in 1958 he graduated from high school in that community. He then entered Louisiana State University where he graduated with a Bachelor of Science degree in Vocational Agricultural Education in June of 1962.

Upon completion of six months active duty in the United States Army Reserves, and two years as a vocational agricultural teacher in Avoyelles Parish, he moved to Wiggins, Mississippi. He worked for B and B Enterprises, Incorporated, and then as a teacher in the Stone County school system. In June, 1966 he returned to Louisiana State University where he completed the requirements for a Master of Science degree in the Department of Vocational Agricultural Education in May, 1967.

After one more year at Louisiana State University he became a graduate assistant in the Department of Agricultural Economics and Rural Sociology at the University of Tennessee.

In September, 1971 he joined the staff at Mississippi State University in the Department of Agricultural Economics as an assistant professor and assistant economist.

He is married to the former Marion Lucille Blass of Wiggins, Mississippi. They were married on February 8, 1964, and are the parents of two children, Warren Carl Couvillion, Jr., born February 19, 1965, and Courtney Anne Couvillion, born July 20, 1967.