A SIMPLIFIED SLAUGHTER HOG PRICING MODEL

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CHAPTER I

INTRODUCTION

In the last 40 years the average real income of the American family based on 1958 prices has increased greatly. In 1929 the average family earned only $1,236, but by 1969 this had increased to $2,507 [13]. Along with increased incomes, the tastes and preferences of Americans have changed. This has resulted in the substitution of meat for cereals and grains; indeed, meat and other animal products are the major items in the food budgets of most consumers. In 1960 the per capita consumption[1] of beef and pork was 124.5 pounds [65], accounting for 26.17 percent [67] of the consumer food dollar.[2] Per capita consumption of beef and pork had increased to 142.0 pounds [65] by 1969, when the American consumer spent 30.88 percent [68] of his food dollar for meat. Per capita pork consumption was essentially unchanged during this period, since the average American consumed 64.9 pounds in 1960 and 64.9 pounds [65] in 1969.

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[1]The per capita consumption of beef and pork is the sum of the retail cuts equivalents reported by the U.S.D.A. in Food Consumption: Prices and Expenditures.

[2]The percentage of the consumer food dollar spent on meat is taken from the annual average retail cost of the market basket of farm foods reported by the U.S.D.A. in The Marketing and Transportation Situation.

Problems of the Pork Industry

The meat industry is growing and the per capita consumption of certain major meats such as beef and poultry have increased in the last ten years. The fact that per capita pork consumption has failed to increase warrants concern by members of the pork industry.

One reason the per capita consumption of pork has failed to increase as rapidly as that of certain other meats is that pork is considered too fat by many consumers and medical authorities. Ikerd [31] reported in 1970 that consumers indicated that pork cuts are considered tasty and have an image of being healthful, practical and generally low in cost but that they consider pork to be too fat. In diets where cholesterol is of concern, pork is often excluded. Perhaps for these reasons many restaurants no longer include pork on their menu. Thus, the development of a more desirable product is an area of great concern to the pork industry.

In order to develop a more desirable product it is extremely important that consumers' tastes and preferences be reflected accurately to the producer. In a 1968 study Ikerd and Cramer [33] discovered that price signals are not accurately communicated to the pork producer. The fact that consumers consider pork to be too fat is not being accurately relayed from the packer to the producer. One reason for this is that consumers are concerned only with cuts of meat seen in the meat market. They do not know--nor do they care--whether these cuts come from a lean animal or from a fat animal that has been trimmed heavily. These characteristics are of interest to other segments of the marketing channel only because of their impact on profits. Both the packer and the retailer have the prerogative of trimming the fat away from the cut. If the packer does not show a distinct preference for leaner hogs through the pricing system, this will distort the information relayed to the producer. A need for greater expansion of the role of price incentives from the packer is clearly indicated.

The disadvantages of the current practice of buying on a live weight and grade system are well known. There is wide variation in the estimated value of the live hog and in the true value of the dressed carcass, within grades as well as between grades. These value differences between pork carcasses are often not reflected in a differential price to the producer. The tendency on the part of meatpackers is to generalize the prices they pay for slaughter animals instead of paying each producer the actual value for the product received. For the individual meatpacker the disparity between prices for individual animals or lots of animals and their actual value may disappear with the purchase of large numbers of animals. For the producer, however, an increase in the quality or the percentage of high value pork cuts per hog has little practical significance unless this is reflected by a higher price.

This is particularly a problem to the producer of high yielding animals. He receives less than carcass value while the producer of poor consumer value hogs may receive more than carcass value. This lack of precise identification of carcass merit has also meant that there has not been sufficient incentive for producers to improve the carcass yield capabilities of their product. The producer must share some of the blame for this, for if he is not willing to actively merchandise his product, the packer will pay only the average market price. He will not volunteer to pay a premium.

One major result of this is inaccuracy in the price signal mechanism in transmitting consumer desires to the producer. If the packer does not show a distinct preference for leaner hogs through the pricing system, this can and does distort the information relayed to the producer. Consumer preferences are not clearly understood by producers which leads to a misallocation of resources used to produce a product which does not maximize consumer satisfaction.

This problem is due in part to imperfect knowledge of carcass value relative to measurable live or carcass characteristics. The inability of buyers to easily and accurately determine carcass value on the basis of live characteristics can cause packers to ignore these characteristics and thus fail to reflect these characteristics by way of price signals. Buyers generally make their bids on the basis of estimated average weight and grade of the lot and the average expected yield of lean cuts less some discount for bruise and disease loss based on the experience of the buyer. This pricing based primarily on live weight also leads to the wasteful practice of filling prior to selling.

Another factor is the intensely competitive nature and low profit margins present in the meat packing industry. In 1969, net earnings in meat packing were 0.9 percent of sales [2]. A small error in the pricing of either the raw material or the finished product could mean a large change in profits or even cause a loss. Consequently, meatpackers tend to be conservative in their evaluation of the profit yield potential of live animals. Firms in the industry are secretive concerning the methods used in deriving hog values. As a result many methods are used leading to the confusion of both meatpackers and hog producers. This reflects both the nature of competition in the industry and the desire to purchase raw materials at favorable prices. It may also indicate the fact that it is difficult to estimate the yield of higher value cuts coming from each animal. If the slaughter hog market is to relay more accurate price signals, however, the packer must accurately estimate product and by-product yield of slaughter hogs and price them accordingly.

Objectives of the Study

This study is designed to enhance the efficiency and competitive position of the single firm meatpacker as he competes with the larger, multi-firm meatpacker in the procurement of slaughter hogs. Large firms have access to highly sophisticated management and control techniques which are not available to the smaller packer due to the lack of finances and often to the inability to use these techniques. So far as producers are concerned, these techniques are neither known nor readily understood.

Often the smaller packer--to which this study is primarily directed--competes on the basis of personal service and superior product quality. With regard to raw material procurement, many small packers' strategies have been to purchase only superior meat type animals. A basic problem this study is designed to investigate is what price can small packers afford to pay when competing for this superior animal.

More specifically this study is designed to improve the communication from the consumer to the producer through:

(1) Developing a model that may be used as a guide in determining the price buyers can pay for hogs as yieldability and wholesale prices of the primal cuts vary, and

(2) Reviewing pricing techniques used by slaughter hog buyers in Oklahoma.

Although some meatpackers use elaborate formulas for purchasing hogs, there is an interest within the meat packing industry in obtaining additional information concerning the relationships between the value of the hog and its yieldability in the lean cuts[3] of ham, loin, and shoulder coupled with the wholesale prices of these cuts. This suggests the need for a simple yet accurate standard method buyers may use in evaluating slaughter hogs on the basis of quantity and quality. This would improve the market function of relaying to the producer the type of product desired.

This leads to the hypothesis that if equations which will accurately predict the yield of high value cuts can be constructed, then a more realistic method for pricing slaughter hogs can be developed. This requires that the variables used by the model be objective. The equations must also have a high degree of statistical validity. Stevens [60] listed additional characteristics of an ideal method of carcass evaluation as follows: accuracy, minimization of time and slowing of the packers' operation, measurement of economically important cuts, and final evaluation with a minimum of computation. Rosendale [54] contends also that a carcass evaluation method should be nondestructive to the product. A model meeting these criteria would allow hog pricing to be based on the merits of the individual animal or carcass and would provide specific price signals to producers indicating the type of market

[3]Lean cuts are the ham, loin, boston butt, and picnic. Many authors combine the boston butt and picnic so that the lean cuts are the ham, loin and shoulder. Primal cuts refer to the lean cuts plus the belly.

hogs that consumers find most desirable.

Procedures

Primary data on the evaluation of 192 live hog and pork carcasses were collected at slaughter and packing plants in Oklahoma. All measurements were taken by OSU Agricultural Economics Department personnel. An effort was made to obtain a wide range of backfat thickness and muscling for the different weights of hogs which would be consistent with the type of hog normally purchased for the cooperating packers' operations. Complete producer shipments were used so that average lot pricing could be evaluated. The sample represented six sources of hogs and five distinguishable breeds or crosses. Live weight ranged from 174.5 to 258.5 pounds and average backfat ranged from .96 to 1.8 inches. There were 96 USDA #1 hogs, 87 #2 hogs, and nine #3 hogs in the sample.

The live hog data and the kill floor data were collected at the slaughter plant on the first day of each producer shipment evaluation. Live data were collected in the packing house pens two or three hours prior to slaughter. Hot carcasses were weighed with the leaf fat remaining. The carcasses were chilled overnight and were reweighed the following day. Carcass backfat thickness was also measured at this time.

Cutout data were obtained by placing personnel in the packers' assembly lines. Throughout the collection of the cutout data an effort was made to measure those variables which require little time and effort and yet which accurately predict the lean cuts, either collectively or separately. The variables measured on each individual hog were recorded in the Hog Data Sheet included in Appendix A. Grader estimates for live animal and carcass characteristics were also recorded. From the model developed, the major variations in the value of a hog was measured in relation to variance in the weight of the primal cuts.

The technique of multiple regression was used to isolate the relationships. The significance of the regression equations for practical work lies in the fact that they constitute an objective means for estimating the value of one variable when the value of other related variables are known. If, for example, we know that the expected relationship between the percent primal cuts of hog carcass weight and the carcass weight and grade, the regression equation can be used to estimate the quantity of primal cuts any given hog may have.

Current slaughter hog purchasing procedures were reviewed through visiting several meat packers to observe direct buying techniques and through visiting numerous hog buyers. Questionnaires were also mailed to the principal Oklahoma hog buyers.

The remaining chapters are organized as follows. Chapter II presents a review of literature which is related to this study and from which the requirements and limitations of a hog pricing model were developed. Chapter III presents the results of interviews at several packing and slaughtering plants and the responses to questionnaires indicating the advantages and disadvantages of the current methods of purchasing slaughter hogs in Oklahoma.

The theoretical framework for a pricing model is constructed in Chapter IV. Chapter V is included to provide reviewers with detailed information regarding the characteristics of the sample and the specific procedures used to measure these variables. Four hog pricing models are developed and presented in Chapter VI. Chapter VI also included relationships suggested by other investigators and their accuracy when used with this sample. The study is summarized and potential applications of the results are suggested in Chapter VII.

CHAPTER II

REVIEW OF LITERATURE

For many years researchers have investigated the problems involved in developing the type of hog which will best meet the desires of consumers. New methods of feeding, breeding, management, and control designed to increase the efficiency of the producer are developed and improved continuously. In the past decade there has been tremendous progress in furnishing consumers the leaner pork they desire, much of this without price incentives. The United States Department of Agriculture [66] conducted a survey of 50 meat packers to determine the percentage of hogs slaughtered by grade in 1967-68 which they compared to a 1960-61 slaughter hog breakdown. The study revealed that 50 percent of slaughter gilts and barrows in 1967-68 graded U.S. #1, an increase of 17 percent over the 1960-61 period. U.S. #2 slaughter hogs decreased from 38 to 34 percent and #3 hogs decreased from 26 to 12 percent. The remainder included medium and cull grades.

Genetic Potential in Swine Production

Although improvements in swine in the last decade have been dramatic, additional improvements may well be retarded without price incentives. Much of the research conducted by the government and other agencies has led to phenomenal improvements that have functioned to reduce the cost of producing quality slaughter animals. With improvements in the pricing mechanism, the potential for leaner hogs is greater yet. In 1968 Gray, et al. [25], using a total of 1,828 Poland China hogs over five generations found that by selecting for low backfat thickness there was a 20 percent decrease in backfat thickness. The heritability estimate[1] for intrasire regression of the mean of offspring on the dam was 0.56 with a standard deviation of .09.

Hetzer and Harvey [28] reported in 1969 the results of selection for backfat thickness in ten generations of Durocs and eight generations of Yorkshire. The procedure was to collect two lines from each breed; one high in backfat and one low in backfat. After ten generations the high and low backfat lines differed by 68 percent of the initial mean in the Duroc and 44 percent after eight generations in the Yorkshire. The same year Jensen, Criag, and Robison [34] using data collected over a period of two years on five breeds, calculated heritability estimates of 0.67 for average backfat, 0.40 for percent lean cut, and 0.58 for flavor from nested variance and covariance analysis.

While these reports are not exhaustive of genetic research, they do indicate that it is genetically possible to produce leaner, high yielding hogs. This approach to the hog problem involves a producer investment in improved breeding stock and careful selection for the desired quality. The commercial producer, however, cannot pay premium prices for breeding stock unless he is reimbursed through increased prices reflecting the improvement in quality.

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[1]A heritability estimate is the fraction of the differences between observed individuals attributable to genetic causes.

Consumer Desires

A major reason for the lack of differential prices paid for carcass merit is the difficulty in determining the yield of high value cuts from the live animal and the determination of values arrived from the various yields. It is also necessary to ascertain what consumers want. In 1964, Emerson, et al. [19], investigated consumer acceptability of pork cuts and any effect slaughter weight had on acceptance. They reported that slaughter weight had little or no effect on marbling and as slaughter weight increased the percent protein in ham and other lean cuts decreased. A taste panel indicated a preference for large lean pork chops. The lean pork chops from the largest weight group (190-200 pounds) were preferred above the lean pork chops from the lower weight hogs. No preference was observed for hams and bacon taken from the heavier hogs versus those taken from lighter hogs.

Varney, et al. [71], reported in 1961 the results of two groups of 30 Hampshire barrows, slaughtered at weights of 159 and 215 pounds live weight. They found that on a live weight basis the light hogs were worth 0.91 dollars per hundredweight more than the heavy hogs and were worth 1.90 dollars per hundredweight more on the dressed weight basis. The heavier hogs were higher in percent of lard stock on both the live weight and carcass weight basis and were lower in percent of lean and primal cuts. Both of these studies are in accord with Ikerd [31] who determined that one of the primary problems of consumer acceptance of pork today is that pork is fatter than desired.

Relationships in Live Hog Evaluation

Most of the hogs produced in the United States are marketed on a live weight and grade basis. In order for the meat packer or buyer to make rational purchases it is necessary that he have some knowledge of the live animal characteristics which indicate carcass value differences. Also the commercial producer must make decisions as to the timing of marketing and breeding stock replacement based on live animal characteristics.

Ahlschwede, et al. [3], found that when hogs were slaughtered at 91 kilograms the measurements of leg length, leg circumference, heart girth, loin width, and live weight at 140 days of age accounted for 22, 7, 16, 10, and 14 percent of the variation in percent lean cuts, respectively.

Most researchers have found that sex and breed are important for predicting the lean cuts on a live animal and carcass basis. Bruner and Swiger [9] studied 2,508 pigs from the Duroc, Hampshire, Landrace, Poland China, Spotted Swine, and Yorkshire breeds. All pigs were fed the same diet. They reported that:

(1) Barrows gained faster than gilts but used more feed per unit of gain than did gilts;

(2) Barrows had shorter carcasses and more backfat than did gilts;

(3) Poland and Hampshire pigs had less backfat, higher percent lean cuts, larger longisimis dorsi areas and slightly lower rates of gain than did the other four breeds;

(4) Duroc had the lowest feed requirement of all breeds;

(5) Yorkshire barrows had the greatest backfat.

That barrows have more backfat than gilts of the same weight is affirmed by most studies in the United States. In England, Cuthbertson and Pease [15] also found that to be true. Likewise a Canadian study by

Doorenenbal [16] reported gilts were leaner than barrows. Further, gilts had less internal fat than did barrows.

It has been established that the percent of high value cuts is related to the amount of backfat of a hog. Several methods of measuring the backfat on a live animal have been developed. Hazel and Kline [26] in 1952 described a "probing" technique for measuring backfat thickness on a live hog. This involved inserting a metal ruler in an incision made along the back of the animal. They found that the average of four backfat measurements from a live hog was a more accurate indicator of leanness than a similar average of carcass backfat measurements. The correlation coefficient between the average of four carcass backfat measurements and the percentage primal cuts of carcass weight was -0.45 while the average of the four live hog backfat measurements had a correlation with percent primal cuts of -0.499. This method was repeated in 1956 by Holland and Hazel [30] who also used an ice pick probe to measure the depth of lean at each backfat location in order to evaluate the use of muscle thickness in estimating high value cuts. They reported, however, that the average of three backfat probes was the most accurate indicator of percent lean cuts among the live animal measurements. The correlation coefficient between percent lean cuts and the average of backfat probes was -0.78. The body circumference at the middle of the hog explained 36 percent of the variation in percent lean cuts.

Robison, et al. [53], in 1960 confirmed the value of backfat probes for predicting carcass merit. They developed a regression equation to predict percent lean cuts with width behind the shoulder and backfat depth at the loin as independent variables. The associated multiple correlation coefficient was 0.69.

It should be noted that many of the methods developed for predicting carcass merit from live hog measurements are not generally applicable to the meat packer or to the commercial hog producer. The time and labor required to take the various measurements for large numbers of animals are often prohibitive. For this reason most hogs sold on a live weight basis are subjectively evaluated by both the buyer and seller. The market price for the various weights and grades of slaughter hogs may be known but negotiations are based on the estimated quality and weight of the animals offered. In 1954 Clifton, et. al. [12], considered the problems of determining the wholesale "cut-out" value of hogs and measuring the differences in the prices which buyers pay for live hogs in each of the classes. The value of each carcass was derived by using prices quoted in the National Provisioner multiplied by the weights of the corresponding cuts and by-products. The average dollar value per hundredweight for Choice 1, Choice 2, and Choice 3 carcasses, respectively, were 20.95, 20.66, and 20.30. These value differences were due primarily to variation in the yield of four lean cuts associated with each grade. They reported that while the average Choice 1 hog was worth about 65 cents per hundredweight more than the average Choice 3 hog and 29 cents more than the Choice 2 hog, the differences between average prices by grade actually paid by Chicago buyers had an F-ratio of 0.8183 which was not statistically significant at the 25 percent level.

Naive, Cox and Wiley [44] used 23 buyers in a study designed to investigate the ability of buyers to estimate carcass quality from live hogs. They reported that the buyers, when estimating grades of hogs within lots, estimated the correct grades of 77.4 percent of the hogs. The accuracy of the lot grades for the individual buyer varied, however, from 28.9 to 96.0 percent. The ability of buyers to estimate dressing percentage ranged from 32.5 to 85.0 percent correct with an average of 68.0 percent. Sixteen buyers, when they estimated the grade of each hog in a sample lot of ten hogs, averaged 54.0 percent correct placement.

Engleman, Dowell and Olson [20] using the actual cutout value as a standard, compared the relative accuracy of pricing 32 lots of hogs by seven separate methods. The average pricing error per hundred pounds live weight over all 32 lots of hogs was:

(1) $0.36 when using average live hog weight per hog;

(2) $0.33 when using the individual live weight of each hog;

(3) $0.35 when using both live weight and estimated carcass grade and yield of each hog;

(4) $0.30 when using live weight and adjusted estimates of yield and carcass grade of each hog;

(5) $0.28 when using live weight and live grade of each hog;

(6) $0.26 when using live weight and live grade with perfect grading assumed;

(7) $0.15 when using actual carcass weight and grade.

These findings indicate that pricing hogs on a live weight basis is the least accurate. The market structure is not flexible enough for the price system to indicate to producers the demand for meatier hogs. This has stimulated some interest in buying on carcass weights and grades.

Relationships in Hog Carcass Evaluation

In any investigation to determine relationships of the various carcass measurements to carcass value, certain considerations related to the accuracy of the measurement should be reviewed. Stiffler and Kropf [61] reported that the loin is the most difficult wholesale cut to standardize because five cutting errors are possible: carcass split, scribe length, interior and posterior cutting location, and external fat trim. Standardizing the fat trim on the ham is also difficult.

Lasley and Kline [37] using 220 barrows found that the ham, loin, and picnic from the left side averaged .85 pounds greater than the right side. Although the right side had larger boston butts, the left side yielded .375 pounds of lean cuts more than the right. They concluded there was no evidence of bilateral asymmetry, but that biased values are obtained when either the right or the left side is not consistently appraised or averaged. Failure to divide the carcass into equal halves is partly responsible for these differences. A study of Bowman, et al. [7], concurred that a definite pattern exists in the errors associated with splitting the carcass, dividing the sides into ham, middle and shoulder, and subsequently separating each wholesale unit into fat, lean, and bone. They found that the greatest splitting errors were made in the shoulder and the smallest in the ham.

It should be noted by any reviewer that many of the procedures developed and the relationships which are measured refer to the lean cuts of the hog. Gaarder [23] found that the principal criterion of carcass value is the weight of the lean cuts. He reported that key indicators of the lean cuts are average backfat, carcass weight, and length. In this study the variation in the percent lean cuts explains 95 percent of the variation in the carcass value after carcass weight was considered. The lean cuts amounted to 60-70 percent of the total value of the carcass.

Pearson, et al. [47], stated that the high correlations of primal cuts ($r = 0.96$) and lean cuts ($r = 0.92$) to carcass value show that both measures are closely indicative of monetary value. While researchers agree that the lean cuts are the principal components of carcass value it would be impractical to weigh the hams, loins, and shoulders of each animal. Therefore, many studies have been conducted to establish the relationships of lean cut yield to other carcass measurements.

Many different methods have been and are being used to evaluate pork carcasses. Generally, the simplest methods present problems in accuracy. Also, the complete breakdown of a carcass presents a time and cost disadvantage, even though it is the most accurate procedure. Stevens [60] has listed some of the methods most commonly employed in carcass evaluation as follows:

(1) Dressing percent.

(2) U.S. Department of Agriculture grade or backfat measurements.

(3) The ham as a percent of weight.

(4) Ham-loin index.[2]

(5) Ham plus loin as a percent of carcass weight.

(6) Lean-cut yield as a percent of carcass weight.

Whether one should employ the weight of the carcass, the weight of the live animal, or the adjusted live weight depends upon the costs of the errors involved and ease of measurement. Whatever the method used, the cutting errors between plants and even the cutting errors within plants will influence the results obtained.

Numerous studies have established the relationship of backfat to

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[2]The ham-loin index is a combination of the loineye area and the percent ham. The percent ham of adjusted live weight is computed and the amount exceeding ten is multiplied by ten. This is added to the loineye area in square inches which has been multiplied by ten.

carcass merit. However, Stevens [60] cautions that backfat thickness is easily altered by changing the feed intake of the pig (referring to show pigs that have been limit fed to increase lean cut yield or decrease in fat percent). Therefore, unless pigs have had access to self-feeding, as is customary in a commercial swine operation, the results could be misleading. He reported the correlation coefficients for percent lean cuts of live weight to backfat thickness measured at selected locations were: shoulder, -0.30; last rib, -0.45; last lumbar, -0.49; and average backfat, -0.48. These results are near those reported by most researchers. Rosendale [54] reported that the correlation coefficients between the backfat measurement taken at the first rib, last rib, and last lumbar, and the percent lean cuts of chilled carcass were -0.38, -0.44, and -0.54, respectively. The correlation coefficients between the dollar values per hundredweight of carcass and the various backfat measurements were: first rib (r = -0.34), last rib (r = -0.43), and last lumbar (r = -0.51). The correlations between the dollar value per live hundredweight and the backfat measurements listed above were -0.34, -0.42, and -0.51, respectively.

Pearson, et al. [47], stated that a single measurement of backfat thickness taken at the last lumbar vertebra was considerably more closely related to carcass value than measurements taken at the first, second, or last rib. The measurements taken at the last lumbar vertebra were nearly as correlated to carcass value (r = -0.71) as was average backfat thickness (r = -0.72). In an earlier study, Pearson, et al. [46], reported that the fat-lean ratio in the cross section of the loin taken at the last rib should be used as a measurement of carcass leanness. The correlation coefficients between the fat-lean ratio and the percent lean cuts or the percent primals on either a live or carcass weight basis range from -0.60 to -0.62.

Cross, Carpenter and Palmer [14] found correlation to exist between average backfat thickness and the:

(1) Percent fat of carcass weight (r = 0.74),

(2) Percent lean of carcass weight (r = -0.62),

(3) Percent bone of carcass weight (r = -0.81),

(4) Percent four lean cuts of carcass weight (r = -0.76).

This is in agreement with Doornenball [16] who determined the correlation between chemical fat in total backfat trim and in total fat in the left side was 0.67 for barrows and 0.61 for gilts.

Investigating other methods for estimating carcass composition Doornenball, et al. [17], found the ultrasonically determined lean-fat ratio in the thirteenth rib was correlated with the percent protein of carcass (r = 0.27), and with the percent fat (r = 0.28). The correlation coefficient for carcass length, average backfat, and specific gravity with percent fat of carcass were 0.30, 0.69, and -0.93, respectively. The ratio of the lean to fat taken at the tenth rib area had a correlation of 0.80 with percent of protein and -0.86 with percent of fat.

Skelley and Handlin [56] reported a correlation between the percent four lean cuts of live weight and:

(1) Dressing percent (r = 0.12),

(2) Carcass length (r = 0.41),

(3) Carcass grade (r = -0.57),

(4) Carcass backfat (r = -0.61)

(5) Loin eye area (r = 0.72),

(6) Ham-loin index (r = 0.82).

The percents of ham and loin of live weight also showed very high correlations with the above factors, including the percent four lean cuts. They, therefore, concluded that the percent of ham and loin may be used in place of the percent of the four lean cuts. Their data indicated that the lean cut yield of pork carcasses increases steadily as backfat decreases. These results are in general agreement with Stevens [60] who reported finding correlations between lean cuts as a percent of live weight and: ham-loin index ($r = 0.82$), carcass length ($r = -.16$), average backfat ($r = -0.78$), loin eye area ($r = 0.54$), dressing percent ($r = 0.23$), and percent lean cuts of carcass weight ($r = 0.78$).

Zobrisky, et al. [73], in a study to evaluate the lean cuts as a criterion for estimating live hog value, reported that the correlation coefficients between the total lean cuts and the loin, ham, and shoulder were 0.74, 0.73, and 0.70, respectively. This implies that any of the lean cuts could be used in a regression equation to estimate the lean cut yield.

CHAPTER III

REVIEW OF TECHNIQUES AND PROCEDURES USED FOR PURCHASING SLAUGHTER HOGS IN OKLAHOMA

The type of market outlet used by commercial hog farmers is influenced by many factors such as the distance to market, the number of animals to be sold and the prices received for slaughter hogs at various outlets. In 1969, 18.9 percent of all slaughter hogs in the United States were purchased at terminal markets, with almost as many (13.7 percent) bought at auctions. The remaining 67.4 percent were purchased by country buyers or directly by slaughtering plants. Regardless of the type of outlet used by the commercial producers, 95.7 percent of all slaughter hogs were bought on a live weight basis [69].

Live Animal Purchasing Procedures

Prior to World War II hogs were generally priced according to average live weight. While some differential was paid for different weight groups, there was little price recognition of variation in lean cut yield within weight groups. In the 1950's objective grade standards were adopted and soon most hogs were bought and sold on average weight and grade basis. Currently, hogs which are sold live are priced according to average weight and grade along with estimated dressing percentage.

The questionnaire shown in Appendix A was sent to 15 major Oklahoma slaughter hog buyers to determine the principal methods of purchasing slaughter hogs, and the characteristics of both the hogs and the market upon which price offers were based. The eight respondents were responsible for an annual purchase of 960,000 animals of which 97.5 percent were purchased on a live weight basis. All of the respondents replied that when pricing a pen of slaughter hogs with some variation in both weight and grade, they primarily consider the average weight and grade along with the estimated dressing percentage.

The maximum price a buyer can bid is generally set by the packer. This price is primarily influenced by the supply of slaughter animals in the area and the current wholesale prices of the primal cuts. The respondents indicated that the wholesale price of fresh loins is the most important primal cut price.

All buyers prefer to use a USDA market quotation as a guide when making a bid. The quotations most often cited were from the Oklahoma City, Omaha, and Kansas City markets.

Most lots of hogs brought to market vary widely, not only in the yield of high value cuts, but also in their weight and grade. This tends to reduce the usefulness of grade standards when buying hogs and three of the eight respondents indicated that the USDA grading system is not useful to them. This may reflect a natural tendency on the part of most buyers to discount mixed lots due to the uncertainty of the actual yield of high value cuts obtained. Respondents indicated that when pricing a pen of hogs of similar weight but of mixed grades, the average grade of the lot is normally used as a basis. The presence of a few low grading hogs in the lot, however, does encourage a lower bid price. Lots with variation in both weight and grade are priced on buyer estimates of average weight, grade and dressing percentage.

Table I indicates the live hog characteristics considered most important by the responding buyers when determining their buying price.

TABLE I

FREQUENCY OF RESPONSES FOR IMPORTANCE OF LIVE HOG CHARACTERISTICS ON BID PRICE

Live Hog Characteristic	Rank of Importance								
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.
Live Weight	5		1	1					
Est. Percent Lean Cuts	3	3							
Fill		2	1	1	1	1			
Dressing Percentage		1	4	1					
Backfat		2		2	1				
Cleanliness			1		1		2	1	
Carcass Length						2			
Breed							1	2	
Sex									3

The actual live weight was the most important single factor used as a basis for price bids. Undoubtedly many variables are mentally weighed when making an offer; however, the respondents indicated the three most important are live weight, estimated percent lean cuts and fill. The sex of the lot is not considered important when bidding for animals, but four buyers did indicate a preference for Yorkshire-Hampshire crosses, Polands, and Yorkshires. Two respondents consider the Tamworth and Landrace breeds least desirable. However, the sex, breed and carcass length were less important to the respondents than any other live animal characteristic in determining the bid price.

Responses to a question asking buyers to indicate the manner in which they believe most slaughter hogs in Oklahoma will be sold within the next ten years are shown in Table II.

TABLE II

ESTIMATED PERCENT OF SLAUGHTER HOG TRANSACTIONS THROUGH VARIOUS MARKET AGENCIES IN OKLAHOMA IN THE NEXT TEN YEARS

Market Agency	Respondent							
	1	2	3	4	5	6	7	8
Direct (All Methods)					33			
Live Wt. and Grade			33			50		
Carcass Grade & Yield	100		33				100	100
Forward Contract Buying			33					
Terminal		100		50	33	50		
Auction				50	33			

Opinions are mixed regarding the dominant method of slaughter hog purchasing in the future. Six of the eight respondents indicated that they expect a third or more of all slaughter hogs to be purchased by direct methods within the next ten years. Four of these buyers felt that all slaughter hogs will be purchased directly and of these four buyers, three indicated that all hogs will be directly purchased on a carcass grade and yield basis. If buyer opinions are indicative of industry plans then the future will hold increased direct purchasing by carcass grade and yield in Oklahoma.

Personnel in a few of the larger firms in the Oklahoma area which were currently buying on a grade and yield basis were interviewed. Generally, the producer delivered directly to the packer and retained title to the animals until they were killed and evaluated. In the event any animal was condemmed the carcass was the property of the producer although the plant would purchase condemmed carcasses at reduced prices.

Upon arrival at the packer holding pens the live animals were weighed and tattooed. Carcass grade and yield animals were slaughtered the day following delivery. Each hot carcass was weighed and backfat measurements were taken by a packer employee. Some plants had a grader assign a grade on each carcass based upon the visual observation of such characteristics as length, average backfat, fullness of loin, thickness and depth of hams, and overall carcass quality.

Usually payments were made from a base value which represented the bid for an average hog, plus a yield factor applied to the lot on the average, and plus a grade factor. Analysis sheets were included with payment checks which indicate individual carcass weight, yields, and grade or backfat so that the producer could check the calculations and compare the amount of payment with the current market price. This analysis sheet also provided information valuable to the producer in evaluating his hog breeding and feeding program.

The disadvantages of the current practice of buying on a live weight and grade system are well known, and generally, a system of carcass merit purchasing will meet these disadvantages. An alternative to a carcass system which could also be considered would require a change in the procedure of producers when selling live animals. The questionnaire revealed that hog buyers, when confronted with lots which have some variation in both weight and grade, have a natural tendency to discount their bid due to the uncertainty of the actual yield of high value cuts obtained. Most lots of hogs brought to market vary widely, not only in the yield of high value cuts, but also in weight and grade. All buyers indicated that pricing would be simpler and more accurate and higher prices would be offered if animals were sorted by weight. Most buyers stated they could also make generally higher bids if slaughter hogs were sorted by grade prior to marketing. When producers bring hogs to market in lots which are not uniform they cannot expect to receive a price which represents the true value of the carcass. If animals were sorted by weight and grade (backfat) before the producer tries to sell them, however, pricing can much more nearly approach actual value.

CHAPTER IV

THEORETICAL CONSTRUCTION FOR A SLAUGHTER HOG PRICING MODEL

An economic system is traditionally defined on the basis of what it does. Such a system, as defined by Leftwich [38], performs the following functions:

(1) Determines what is to be produced.

(2) Determines how production is to be organized.

(3) Determines how the products are to be distributed.

(4) Determines how goods are rationed over the short run.

(5) Determines how the productive capacity of the economy is to be maintained and expanded.

The different types of economic systems are defined by the methods by which they perform the above functions. Price plays a key role in regulating the free market or enterprise economy. This type of economic system is characterized by a great deal of individual freedom. Within the limits set by law, consumers are free to spend their income on anything they wish. Assuming pure competition enterpreneurs are free to enter into or leave the business of their choice and resources are free to seek employment whenever and wherever they are able.

Consumers may spend their income for a large variety of products. By offering higher prices for those items which they desire greatly and lower prices for those items yielding less satisfaction (assuming similar supply schedules) the consumers cast their "dollar votes" for the basket of goods which will maximize their satisfaction or utility. These desires are thus communicated to the entrepreneur via the effect that prices have on profits. Because entrepreneurs are motivated by the desire for profits, they will devote their productive facilities to those commodities most profitable to them.

When the tastes and preferences of consumers change, they modify the way in which they spend their income. This changes the structure of prices within the system. In this way the market price represents the standard of value which provides the information necessary for wise managerial decisions. In the case of pork, if consumers want less fat and more lean, the price system would be expected to reflect this desire through higher prices for lean cuts. As the relative profitability of producing the two items changes, producers will shift toward production of the more profitable item and away from the production of the less profitable one. There is a constant channeling of resources away from the production of items which consumers want least and to production of items which consumers want most. Thus, consumers in purchasing those products which they prefer, determine what products are to be available and in what quantities.

Most agricultural commodities produced by the farm firm go through many intermediate steps before being sold in the final form to the ultimate consumer. A simplified marketing channel for slaughter hogs is shown in Figure 1.

Slaughter hogs produced on farms are generally transferred into the hands of a relatively few meat packers. There each animal is converted into the various cuts and products and then dispersed through the wholesale and retail channels to the final consumer.

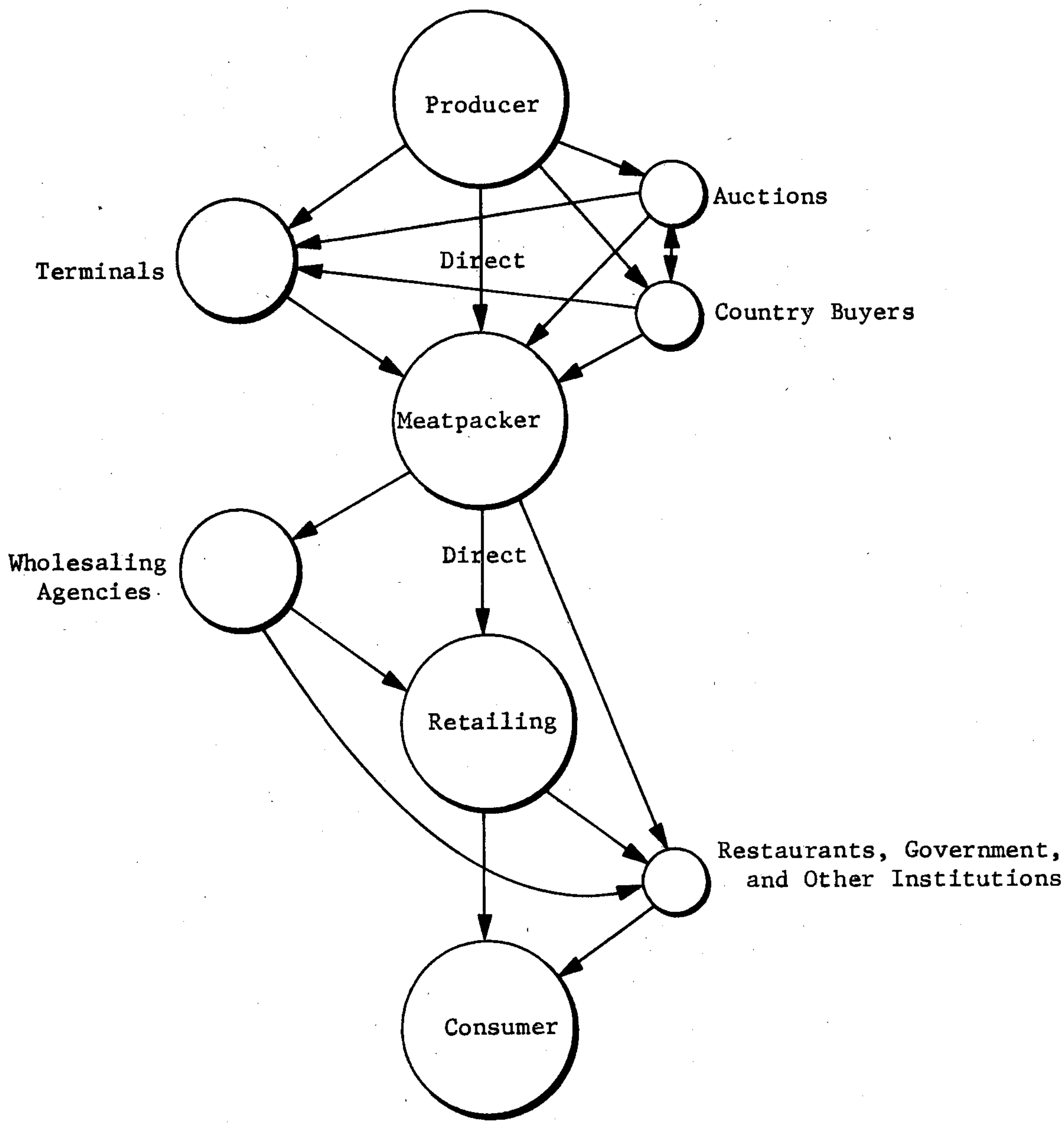


Figure 1. A Simplified Marketing Channel for Slaughter Hogs

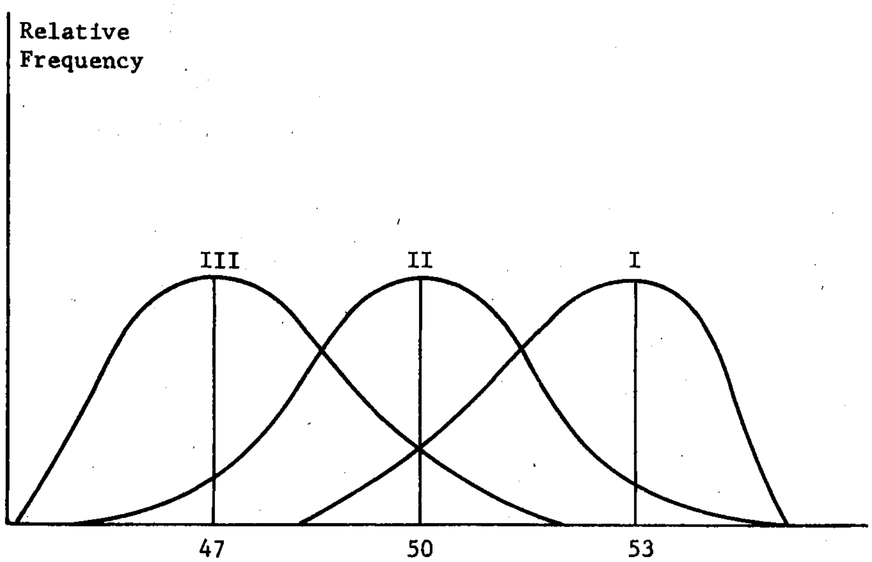
From a single hog many different edible products are obtained. These have a wide range of value both to the consuming public and to the various agencies within the marketing channel. In the processing, many of these products lose their identity with the original animal. It is the function of the price system to reflect the quantities and qualities of the final products which the consumers most desire. These messages must be transmitted through the various agencies before it ultimately reaches the farmer. In this process the signals may often be distorted and inaccurate when they do reach the farmer. In summary, Purcell [48] has stated:

> The message, the price signal has a long and hazardous course to run before it reaches the producer. Many value-related attributes of the product are never identified during exchange processes and are not priced. Even if a premium or discount is carried through the system, the producer has the task of distinguishing such a signal from a random price fluctuation.

When this happens the farmer may be unable to make optimum decisions simply because the price system is not telling him what the desired product is.

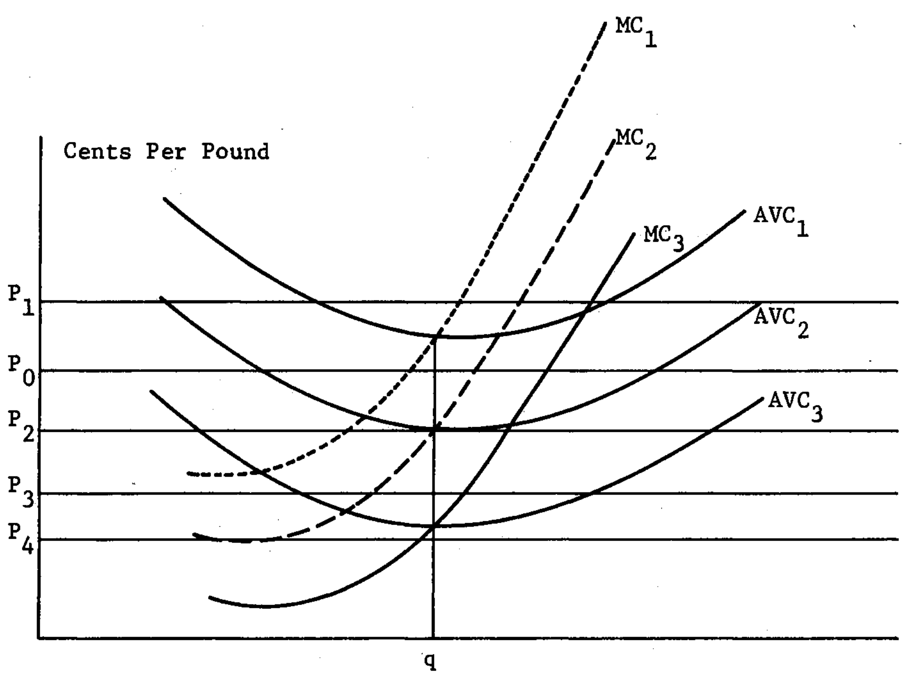
If the market system fails to properly indicate to producers via price signals the specific product desired by consumers, the result may be higher than necessary consumer food costs and lower than necessary incomes for pork producers.

The results of price misinformation to the individual producer are illustrated in Figure 2. The probability distributions shown in Figure 2a indicate the distribution of different grades of slaughter hogs resulting from three separate and successively more intensive management systems. The distribution labeled I, for example, indicates the range of hogs with the indicated percent lean cuts resulting from a management



Distribution of Hogs - Percent Lean Cuts

Figure 2a



Quantity of Hogs

Figure 2b

Figure 2. Quality Distribution and Production Cost of Hogs Under Three Separate Management Systems

system designed to produce primarily grade U.S. #1 slaughter hogs. The expected modal yield of percent lean cuts is 53 percent of carcass weight, which is designated as U. S. #1 slaughter hogs [70]. For this management system, as well as the other two, a range of outcomes (represented by percent lean cuts) will occur for any lot of hogs produced. Thus, for management system I, the expected mode of any lot will be 53 percent lean cuts, but some of the individual animals may only grade a low #2 or high #3 while others will grade a high #1.

It is reasonable to assume that the producer has at least three cost structures corresponding roughly to the three grades of market hogs: U. S. #1, #2, and #3. The operation which produces some animals of all three grades might have the cost structure of the #2 grade. An increase in grade, represented by an increased percent lean cuts of carcass weight, could increase cost because it requires increased managerial ability and increased investment in breeding stock. It might also require changing or improving the physical facilities and perhaps require a more expensive feed ration. These assumptions are somewhat substantiated by observing that in actual production of slaughter hogs, a price differential for improved quality must be paid in order to encourage increased production of superior animals.

The average variable cost curves shown in Figure 2b represent the possible cost curves for three different management systems (three different grades of slaughter hogs). The producer's supply curve for each product is that portion of the marginal cost curve above the corresponding average variable cost curve. For the individual producer in pure competition, the demand curve for his product is a horizontal line at the price quoted by the packer.

When packers practice average lot pricing and offer, for example, price P_0 for the producer's pen of slaughter hogs, it is apparent from the diagram that the operation which produces uniform pens of slaughter hogs more cheaply will be the operation which the producer will select. If, as in Figure 2, an operation to produce uniform lots of grade 1 hogs is not profitable but operations to produce grade 2 or some combination of all three grades are, then there is no economic incentive for the producer to structure his operation for the production of superior slaughter hogs.

Also, if the packer offers differential prices based on the expected yield of the high value cuts but fails to correctly estimate the actual value difference between grades then his bid prices might be P_1 for grade 1, P_0 for grade 2, and P_3 for grade 3. In this instance the operation to produce grade 1 hogs is profitable. However, it is not much more profitable than the operation to produce grade 3 hogs and both operations are less profitable than a plant designed to produce primarily grade 2 slaughter hogs.

A hog pricing model, therefore, must accurately predict the value differences between hogs if it is to be useful. The packer then must accurately relay these value differences to producers through differential prices if producers are to know consumer desires. Such a set of differential prices might appear as price P_1 for grade 1, P_2 for grade 2, and P_4 for grade 3. Therefore, $P_1 - P_4$ is the value difference between grade 1 and grade 3 hogs and $P_1 - P_2$ is the value difference between grade 1 and grade 2 hogs. Given the assumed cost structures these prices would provide inducement to producers for the operation of plants geared to a more efficient utilization of resources in the production of higher quality hogs.

The failure to pay the true value difference between hogs causes producers of plants represented by AVC_1 to have lower incomes than is equitable. The continued marketing of overly fat pork cuts which must be heavily trimmed is a waste of resources. If the combination of trimming cost and the cost of lower yields is higher than a needed differential for higher quality hogs then the consumer's pork cost will be higher than necessary.

A Theoretical Pricing Model

The price path, from a demand orientation, is the reverse of the marketing channel shown in Figure 1. Consumers purchasing pork products at their local market create demand, and this along with supply determines the retail price for pork. The price the packer receives is derived from this retail price. The packer receives the retail price less the retail margin which will include among others the cost of transporting pork products from the packer to the retailer, and the cost of refrigerating, displaying and holding the various products until they are purchased by consumers. This process of derived prices is repeated at each level of the price path. The producer, for example, if he sells directly to the packer, receives the retail price less the retail margin and the packer margin. The packer margin among other costs, includes charges to labor, management, plant, borrowed capital and equity.

The problem of determining how much to pay for raw materials and predicting the value of the finished products is perhaps greatest at the packer level. In the short run the cost for labor, plant, management, and interest are fixed to the packer. The prices of the raw materials (slaughter hogs), however, vary daily. From each slaughter hog the packer manufactures numerous products whose prices also vary in the short run. Figure 3 illustrates several of these for various parts of a hog carcass. The packer, then, is faced with the problem of short run fluctuations in product and raw material prices.

If we define the very short run as that length of time in which a slaughter hog may be purchased, brought to the plant, processed and the various products sold, it can be assumed that product prices are constant. With product prices fixed, the packer need only make decisions concerning the prices paid for raw materials to make a profit.

Making rational decisions regarding raw material procurement requires information concerning the expected yields of the various products derived from each animal or class of animals. If the packer knows in the very short run how much he will receive for his product and also knows his fixed and operating costs, then he need only determine the quantity of the different products which each class of slaughter hogs will yield in order to establish how much he can pay for his raw materials and still make any target profit.

Thirty-eight of the 45 major retail edible products listed in Figure 3 are derived from the primal cuts. We can further simplify the raw material price decision by assuming the yields of the nonprimal cuts are fixed proportions of the remainder of the carcass. Figure 3 shows, for example, that the fatback, lard, sausage, jowl bacon, pigs feet and spare ribs comprise the remainder of the carcass. All other edible products are derived from the primal cuts.

The profit function for the packer may be written

$$\pi = P_{y_{ik}} Y_{ij} + Z_n - (P_{H_n} H_n + C_r)$$

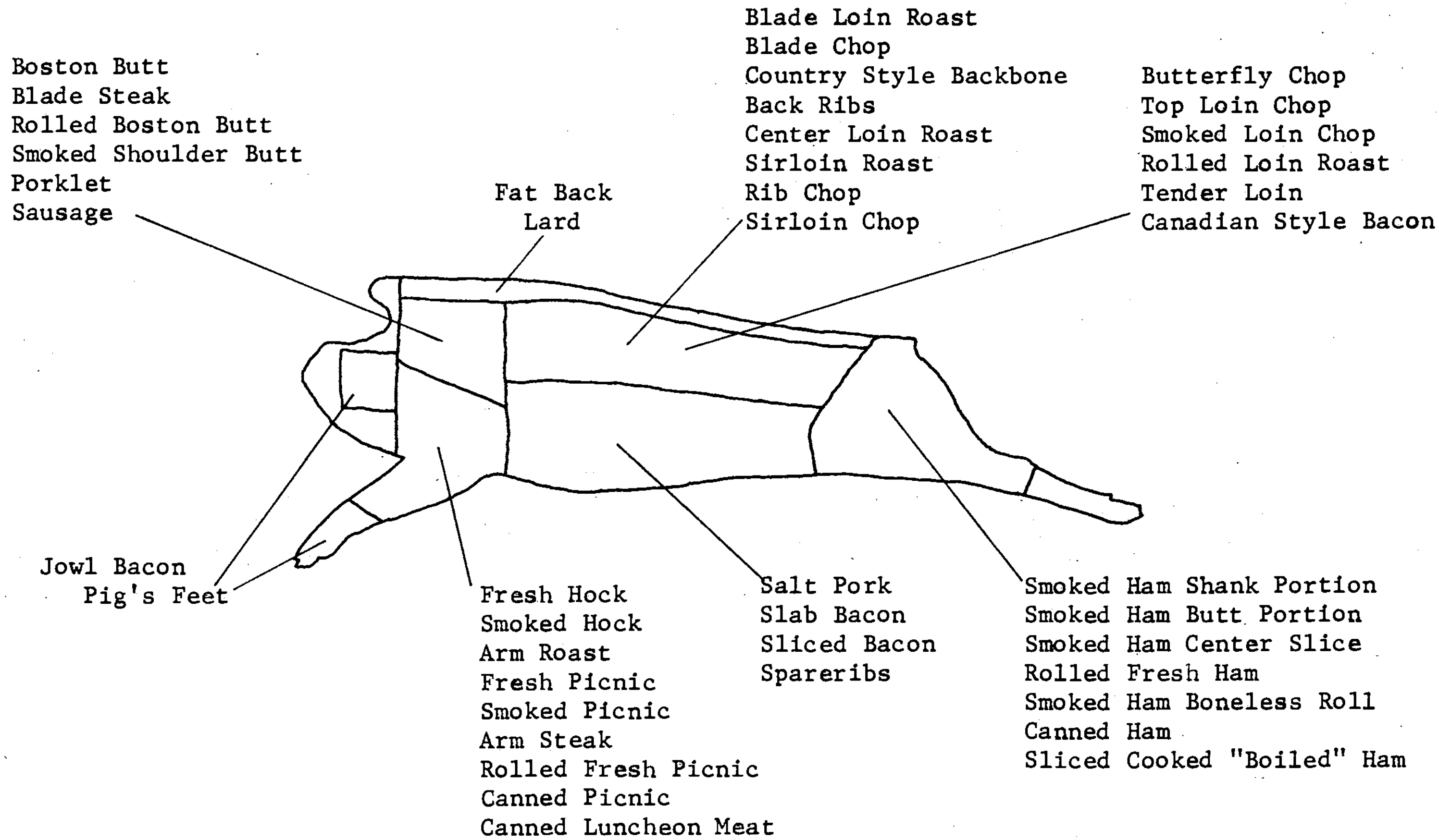


Figure 3. Possible Retail Cuts From A Slaughter Hog Carcass[a]

[a]This information is presented in R. L. Henrickson, Meat Technology, Oklahoma State University, Stillwater, Oklahoma, pp. 41.

where

Y_{ij} is the yield in pounds of the i^{th} wholesale product from the j^{th} primal cut,

$P_{y_{ik}}$ is the price per pound for the i^{th} wholesale product in the k^{th} weight class,

Z_n is the value of the nonprimal byproducts (edible and nonedible) from the n^{th} carcass weight-grade class,

H_n is the weight, in pounds, of the slaughter hog in the n^{th} weight-grade class,

P_{H_n} is the purchase price per pound for slaughter hogs of the n^{th} weight-grade class, and

C_r is the average total cost per slaughter hog excluding procurement cost for the r^{th} size of plant.

In the very short run we can assume that $P_{y_{ik}}$ and C_r are known. Developing expectations for Y_{ij} based on H_n will allow the firm to determine the raw material price (P_{H_n}) which will maximize profit or meet some target level of profit in the very short run. A simple information flow diagram with prices and expected yields of primal cuts from various sizes and grades of market hogs and the use of this information is shown in Figure 4.

Numerous measurable observations on either live animals or carcasses are available and have been proposed. Whatever the choice of measurable variables, the expected weights and known prices of the primal cuts give the firm the expected wholesale value of the carcass which may be treated as known. For any weight-grade class of market hogs only P_{H_n} is unknown. The development of a model to predict the expected weights of

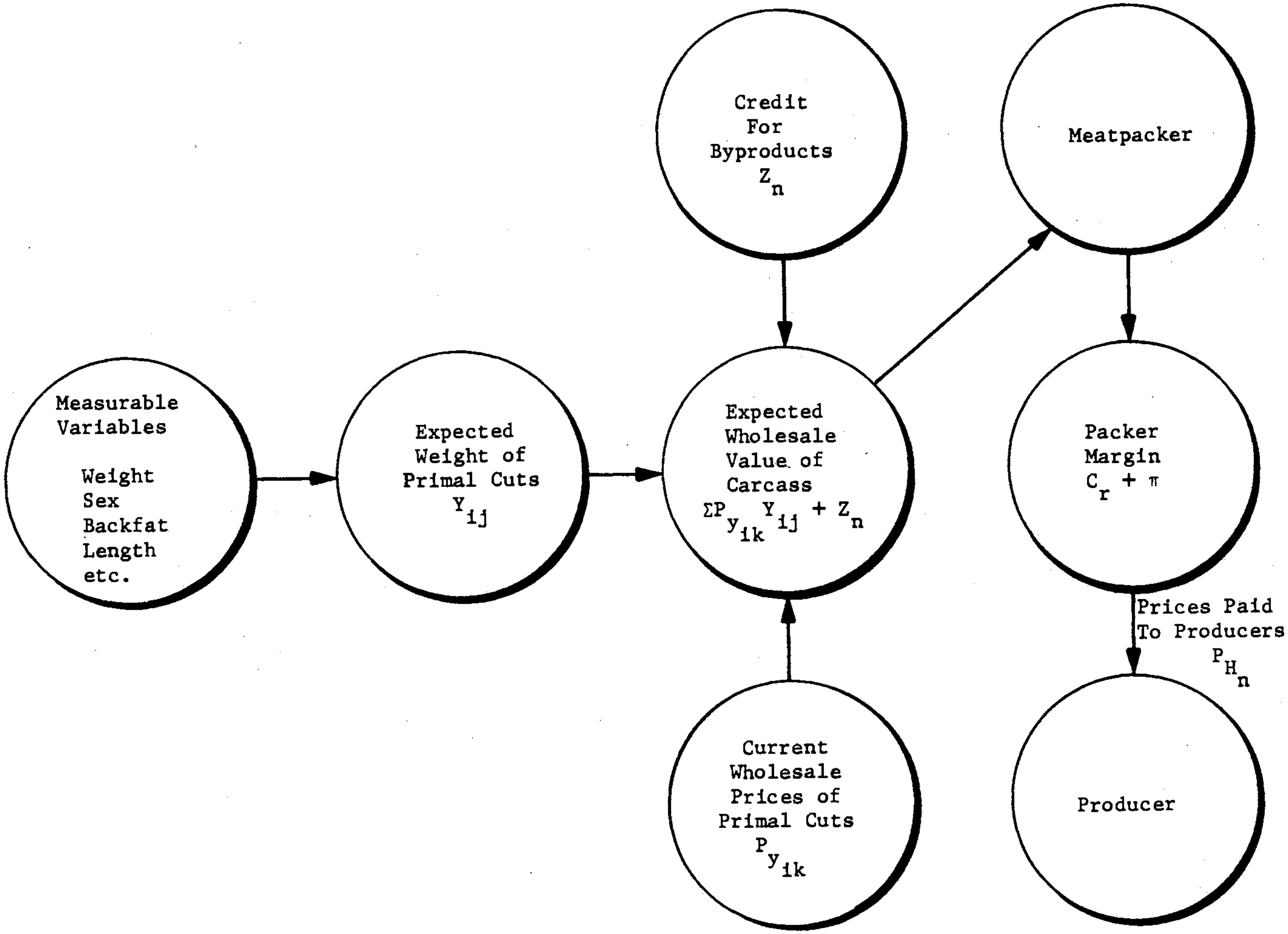


Figure 4. A Simplified Information Flow Diagram for Using a Slaughter Hog Pricing Model

the primal cuts provides the packer with the information needed for wise managerial decisions. The packer by making his price bid a function of measurable live or carcass observations, given wholesale prices, relays the consumer price signal accurately to the producer.

CHAPTER V

SLAUGHTER HOG SAMPLE CHARACTERISTICS

The data for the pricing model were collected from 192 market weight barrows and gilts processed by two commercial slaughtering and packing plants in Oklahoma from August through September, 1970. The information collected on each hog was recorded on the data sheet shown in Appendix A. The personnel collecting data were integrated into the assembly lines so that line speeds were not reduced. This was necessary to assure that carcasses would be split and cut up in exactly the same fashion as those in the normal, day-to-day operation of these plants.

The lots which were evaluated represent the major sources of supply to the plants. Three direct producer shipments and three terminal market purchases were included.

Data Collection

Live Hog Data

Live animals were purchased one day prior to slaughter. The animals were held overnight in the packer holding pens. Live animals were graded two or three hours before slaughter. The hog buyer for the plant estimated carcass yield, backfat thickness, body length, carcass grade and percent lean cuts. These data were used to evaluate the ability of an experienced buyer to estimate the characteristics of a live hog which are related to carcass merit. At this time, live weight was measured to the nearest one-half pound and identification of the individual animal throughout the packer lines was assured by tattooing each hip and shoulder. The breed of each animal was recorded as designated by the company buyer. These breeds were Yorkshire, Hampshire, Red Cross, White Cross, and Black Cross.

Killing Floor Data

Hot carcass weight was measured immediately after slaughter. The head was removed but the feet, leaf fat and kidneys were attached. Carcasses were split after weighing and hung in a cooler for 24 hours. Gut weights were taken following state inspection.

Chilled Carcass Data

The day following slaughter, carcass halves were identified and sorted so that individual carcasses could be weighed. Extreme care was taken not only to match correct halves, but also to adjust for the various sizes and types of overhead hooks which are used by each plant. Backfat measurements and carcass length were obtained as the chilled carcass hung on the rail. Backfat was measured to the nearest one-tenth inch in the packer holding locker following weighing. Few carcasses were evenly split and in many instances a large flap of backfat was present on one carcass half while the corresponding half would have little fat. To adjust for this, measurements at each location were made on both carcass halves, perpendicular to the body line, and then averaged. Backfat was measured opposite the first thorac, last thorac, and last lumbar vertebrae.

Carcass length was the average of both sides, measured from the anterior edge of the aitch bone to the anterior edge of the first rib.

Cutting Floor Data

Measurements of the five primal cuts and the spare ribs were taken on the cutting floor. The cuts of meat from both carcass halves were weighed to the nearest one-tenth pound. Measurements of other miscellaneous cuts were not taken in order that packer operations would not be interrupted.

The carcass was cut in the following method. The ham was separated from the body at the fifth sacral vertebra about two inches in front of the pubic bone, and the hind foot was removed at the hock. The skin and fat from the upper two-thirds of the ham were then removed leaving only a one-fourth to one-eighth inch covering of fat over the skinned portion. The ham was then weighed, skinned with the bone in.

Shoulders were weighed with the upper two-thirds skinned in the same manner as the ham. It was not feasible to separate shoulders into the boston butt and picnic due to identification problems and interfering with packer operations. This did not present a problem in the analysis, however, because prices are also reported for whole shoulders.

Loins were trimmed to a one-fourth to one-eighth inch fat covering before weighing.

The Sample

The frequencies of observation of barrows and gilts in increments of one-tenth backfat and ten pound live weight classes are shown in Table III. The range of live weight was 174.5 pounds to 258.5 pounds and average live weight was 217.5 pounds. Mean lumbar backfat was

TABLE III

FREQUENCY OF OBSERVATION BY LIVEWEIGHT, BACKFAT, AND SEX OF SLAUGHTER HOG SAMPLE

		Live Weight in Pounds									
Lumbar Backfat in Inches	Sex	170 to 179.9	180 to 189.9	190 to 199.9	200 to 209.9	210 to 219.9	220 to 229.9	230 to 239.9	240 to 249.9	250 to 259.9	Total
1.84 to 1.75	B[a]			1			1	1		1	4
	G[b]										0
1.74 to 1.65	B				1	1	1	1		1	5
	G										0
1.64 to 1.55	B			3	1	1	5	3	1	1	15
	G						1	3	1		5
1.54 to 1.45	B		1	3	1	6	7	4	2		24
	G				1	2	5	3			11
1.44 to 1.35	B		2	3	5	10	6	6			32
	G			1	3	10	4	1	6		25
1.34 to 1.25	B	1	1	2	5	3	6		2	1	21
	G			2	5	6	3	1	1		18
1.24 to 1.15	B		1	3	3	6					13
	G			1	4	2	1	2			10
1.14 to 1.05	B		1	1							2
	G				3	2	1				6
1.04 to .95	B										0
	G										0
.94 to .85	B	1									1
	G										0
Total	B	2	6	16	16	27	26	15	5	4	117
	G			4	16	22	15	10	8		75

[a]Barrows

[b]Gilts

1.275 inches. The sample contained 117 barrows and 75 gilts. Table III may be interpreted as a scatter diagram by cells of lumbar backfat and live weight. Generally as live weight increased, lumbar backfat increased. This was consistent with the expected physical relationship.

Each carcass was assigned a grade based on the thickness of the average backfat and the weight of the carcass as reported in the February 1970 USDA's Swine and Pork Grades [70]. The percentage of each grade in the sample is shown in Table IV. Although the sample contained more number 2's and fewer number 3's than reported in the larger samples shown in Table IV, the percent of U.S. No. 1 hogs is similar to the 1967-68 survey and probably is not totally unlike the national population of slaughter hogs.

The grades which represent the relationship between backfat and carcass weight were distributed across most weight ranges as shown in Table V. As live weight increased there was a tendency for the average grade to decrease. In general, heavier animals did not grade as well as lighter animals. In this sample the percent of hogs in each live weight class grading U.S. No. 1 was equal to or greater than 50 percent for animals weighing less than 220 pounds. The percent of U.S. No. 1's decreased for animals weighing more than 220 pounds. Six of the nine slaughter hogs grading U.S. No. 3 had live weight of more than 220 pounds.

The frequency of observation of the breeds, carcass weights and lots are shown in Table VI. The range of carcass weight was 124 to 205 pounds. The carcass weight was distributed normally about the mean carcass weight (166 pounds). The breeds represented in the sample may not be representative of the population in Oklahoma. Sixty-four percent of

TABLE IV

DISTRIBUTION OF GRADES OF SLAUGHTER HOG SAMPLE

Grade	Number in Sample	Percent of Sample	1967-68[a] Percent	1960-61[a] Percent
U.S. No. 1	96	50.0%	49.9	33.4
U.S. No. 2	87	45.3%	35.4	38.6
U.S. No. 3	9	4.7%	11.9	25.9

[a]These percentages represent two samples of slaughter hogs (57,000 and 45,000) which are reported in Improvements in Grades of Hogs Slaughtered from 1960-61 to 1967-68, USDA/ERS/Marketing Division, May, 1969 [66].

TABLE V

FREQUENCY OF GRADE BY WEIGHT CLASS OF SLAUGHTER HOG SAMPLE

	Live Weights in Pounds								
Grade	170 to 179.9	180 to 189.9	190 to 199.9	200 to 209.9	210 to 219.9	220 to 229.9	230 to 239.9	240 to 249.9	250 to 259.9
U.S. No. 1	2	3	11	23	28	17	4	6	1
U.S. No. 2		3	9	8	19	22	19	6	2
U.S. No. 3			1		2	2	2	1	1

the sample were either Yorkshire or White Crosses.

Lots 3, 4, and 5 were terminal market purchases. The remaining lots were direct producer shipments. All lots consigned to the packer in the slaughter holding pens on Monday and Thursday of each week were accepted for the sample.

The means, standard deviations, and standard errors of the mean for several of the characteristics of the sample are shown in Table VII. The average live weight for the sample was 217.5 pounds. The average carcass had 33.7 pounds of ham, 25.2 pounds of loin, 28.4 pounds of shoulder and 22.6 pounds of belly. The weight of the lean cuts was the total of the ham, loin, and shoulder weights. Total primal weight was the weight of the lean cuts plus the belly.

The average dressing percent of 76.23 percent may be biased upward because animals were often held over night without feed before live animal evaluation was made.

TABLE VI

FREQUENCY DISTRIBUTION OF BREED, WARM CARCASS WEIGHT, AND LOT OF SLAUGHTER HOG SAMPLE

Variable	Number In Sample	Variable	Number In Sample
Breed		Warm Carcass Weight in Pounds	
Yorkshire	89	120-139.9	7
Red Cross	25	140-149.9	22
White Cross	34	150-159.9	35
Hampshire	26	160-169.9	58
Black Cross	18	170-179.9	41
		180-189.9	18
		190-210.0	11
Lot No.			
1	23		
2	72		
3	20		
4	10		
5	9		
6	58		

TABLE VII

MEAN, STANDARD DEVIATION, AND STANDARD ERROR OF MEAN FOR VARIOUS CHARACTERISTICS OF SLAUGHTER HOG SAMPLE

Variable[a]	Mean	Standard Deviation	Standard Error of Mean
Live Weight	217.449	16.430	1.186
Warm Carcass Weight	165.882	14.764	1.065
Chilled Carcass Weight	160.719	13.870	1.001
Adj. Live Weight	220.218	17.445	1.259
Gut Weight	17.251	2.833	0.204
Carcass Shrink in Cooler	5.164	2.281	0.165
Dressing Percent	76.228	1.925	0.139
Body Length	30.574	0.798	0.058
Average Backfat	1.427	0.151	0.011
First Rib	1.809	0.188	0.014
Last Rib	1.196	0.179	0.013
Last Lumbar	1.275	0.195	0.014
Ham Weight	33.654	3.411	0.246
Loin Weight	25.194	2.507	0.181
Shoulder Weight	28.373	2.654	0.192
Belly Weight	22.574	2.455	0.177
Spare Ribs Weight	5.440	0.556	0.040
Percent Ham of Warm Carcass	20.308	1.319	0.095
Total Lean Cuts Weight	87.221	7.973	0.575
Percent LC of Warm Carcass	52.650	2.915	0.210
Percent LC of Live Weight	40.128	2.360	0.170
Total Primals Weight	109.796	9.408	0.679
Estimated Dressing Percent	73.482	2.645	0.191
Estimated Backfat	1.444	0.158	0.011
Estimated Length	30.357	0.789	0.057
Estimated Percent LC of Live Weight	39.490	1.681	0.121

[a]Weight is measured in pounds. Backfat and length are measured in inches.

CHAPTER VI

DEVELOPMENT OF A HOG PRICING MODEL

It is the purpose of this chapter to present the developments of alternative slaughter hog pricing models. A preliminary analysis designed to isolate easily measured variables which are related to carcass value as suggested by previous research will be discussed first. Certain of these variables will then be selected to develop regression models to estimate the weight of primal cuts of individual hogs on (1) live weight basis, (2) adjusted live weight basis, (3) carcass weight basis, and (4) carcass and ham weight basis. Finally the regression models will be combined with prices of the primal cuts to obtain estimated values of these primal cuts. The reviewer should remember from Chapter II that other studies have found that variation in the yield of lean cuts accounted for 92 to 95 percent of the variation in total carcass value (Gaarder [23], Pearson, et al. [47]) and that the lean cuts alone constitute 60-70 (Gaarder [23]) to 65-75 (Clifton, Jessen, and Jacobs [12]) percent of the value of the carcass.

The models will be tested by comparing the estimated values with actual values calculated from the actual weights of primal cuts along with their respective prices.

Preliminary Analysis

The review of literature revealed many variables which have been found to be related to the value of hog carcasses or which may be useful for construction of a pricing model. Those most frequently reported are backfat, length, weight, the lean cut yield and the primal yield. Undoubtedly there are others which also are related to carcass value

Carcass Backfat

Simple correlations for backfat with many of the major live hog and carcass characteristics are shown in Table VIII. As would be expected the correlations between the three individual backfat measurements and average backfat is high (0.7056 with first rib, 0.8507 with last rib, and 0.8689 with last lumbar). The measurement taken at the last lumbar vertebra is more closely related to the average than either the first rib or the last rib measurement.

There is almost no correlation between backfat and carcass length in market weight slaughter hogs. However, average backfat explains 16 percent of the variation in live weight and 15.4 percent of the variation in carcass weight. The correlations between backfat and lean cut weights were very low, but backfat accounted for 24 percent of the variation in belly weight.

The various backfat measurements had positive correlations with the percent ham of live weight and the percent primals of live and carcass weight but negative correlations with the percent ham of carcass weight and the percent lean cuts of live or carcass weight. The last lumbar backfat measurement had higher correlations with these percentages than did the first rib or the last rib backfat measurements and superior to or as high as average backfat. This would imply that one backfat measurement taken at the last lumbar vertebra would be appropriate for for carcass evaluation procedures or for pricing models. This agrees

TABLE VIII

CORRELATIONS BETWEEN BACKFAT MEASUREMENTS AND SELECTED SAMPLE CHARACTERISTICS[a]

	Carcass Backfat			
Carcass Trait[b]	First Rib	Last Rib	Last Lumbar	Average
First Rib Backfat	1.000	0.3424	0.3644	0.7056
Last Rib Backfat	0.3424	1.000	0.7345	0.8507
Last Lumbar Backfat	0.3644	0.7345	1.000	0.8689
Average Backfat	0.7056	0.8507	0.8689	1.000
Carcass Length	0.0292	0.0554	0.0163	0.0409
Live Weight	0.3184	0.3503	0.3046	0.4004
Carcass Weight	0.3323	0.3448	0.2779	0.3926
Yield	0.2224	0.1699	0.0754	0.1914
Shrink	0.0417	-0.0701	-0.1721	-0.0841
Lean Cut Weight	0.1245	0.0153	-0.0779	0.0242
Percent Lean Cuts of Live Weight	-0.2182	-0.4247	-0.5073	-0.4751
Percent Lean Cuts of Carcass Weight	-0.3317	-0.5302	-0.5759	-0.5931
Primal Weight	0.1982	0.1299	0.0352	0.1484
Percent Primal of Carcass Weight	0.3254	0.5023	0.5570	0.5713
Percent Primal of Live Weight	0.1608	0.3529	0.4584	0.4021
Ham Weight	0.1209	0.0248	-0.0772	0.0267
Percent Ham of Carcass Weight	-0.2712	-0.4333	-0.5002	-0.4975
Percent Ham of Live Weight	0.1761	0.3465	0.4426	0.3992
Loin Weight	0.0571	-0.0316	-0.1358	-0.0469
Shoulder Weight	0.1647	0.0440	-0.0065	0.0838
Belly Weight	0.3554	0.4480	0.3878	0.4899

[a] $r \geq |0.14077|$ significant at .05 level.
$r \geq |0.18369|$ significant at .01 level.

[b] Weight is measured in pounds.
Backfat and length are measured in inches.

with Stevens [60] and Pearson, et al. [47].

Carcass Length

Carcass length is positively associated with observations describing the actual size of the live animal or carcass as shown in Table IX. Generally, larger animals tend to have larger hams, loins, shoulders and bellies and also tend to be longer than lighter weight slaughter hogs. Carcass length, however, is not highly related to measures of meatiness as expressed by such variables as percent lean cuts of carcass or live weight.

Carcass Yield

Carcass yield[1] is often an important variable when calculating the value of the cuts obtained from a live hog. The actual weight of the carcass is highly associated with the yield of the primal cuts. Carcass weight is used in the pricing formulas developed by Ikerd and Cramer [32] and the Canadian System [10]. Correlations between carcass yield and various other carcass traits may be seen in Table IX. Carcass yield is highly correlated with measures of actual weight of ham ($r = 0.4498$), loin ($r = 0.5363$), lean cuts ($r = 0.5046$) and primals ($r = 0.5350$). This would imply that the amount of fill which influences actual yield in the live animal is a very important factor in determining the price a buyer can bid on a live weight basis. This also indicates, as expected,

[1] Carcass yield is also denoted as dressing percentage by some authors. Carcass yield is calculated by the following formula:

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

TABLE IX

SIMPLE CORRELATIONS BETWEEN CARCASS LENGTH AND YIELD AND SELECTED SAMPLE CHARACTERISTICS[a]

Carcass Trait[b]	Carcass Length	Carcass Yield
Carcass Length	1.000	0.2091
Live Weight	0.5355	0.4158
Carcass Weight	0.5153	0.6372
Yield	0.2091	1.000
Shrink	0.2142	0.6158
Lean Cut Weight	0.5046	0.5687
Percent Lean Cuts of Live Weight	0.0975	0.3492
Percent Lean Cuts of Carcass Weight	0.0110	-0.0847
Primals Weight	0.5350	0.5921
Percent Primals of Live Weight	-0.1274	-0.4538
Percent Primals of Carcass Weight	-0.0037	0.1516
Ham Weight	0.4498	0.5338
Percent Ham of Live Weight	-0.0698	-0.3363
Percent Ham of Carcass Weight	-0.0024	-0.0409
Loin Weight	0.5363	0.5132
Shoulder Weight	0.4311	0.5375
Belly Weight	0.4114	0.4222

[a] $r \geq |0.14077|$ significant at .05 level.

$r \geq |0.183691|$ significant at .01 level.

[b] Weight is measured in pounds.
Length is measured in inches.

that adjusted live weight and carcass weight measures should do a better job of predicting the yield of primal cuts than will live weight measures. The correlation of 0.4158 between carcass yield and live weight indicates that larger animals had higher dressing percentages than did smaller animals in the sample. Carcass yield had the following correlations with the common measures of meatiness: percent ham of live weight (r = 0.3363), percent lean cuts of live weight (r = 0.3492), and percent primals of live weight (r = 0.4538). These correlations indicate the value of carcass yield in predicting meatiness on a live weight basis. The correlations with the corresponding measures of meatiness on a carcass weight basis are low as was expected. Carcass yield or dressing percent can be concluded to have little association with relative measures of carcass quality.

Carcass Weight

The relationship between carcass weight and many of the other sample characteristics may be seen in Table X.

Carcass weight has a correlation of 0.9655 with live weight. Carcass weight has a higher correlation with shoulder weight (r = 0.7985) and belly weight (r = 0.8197) than with the generally leaner ham (r = 0.7704) and loin (r = 0.6808). The negative correlation of carcass weight with U.S. No. 1 grade slaughter hogs (-0.2466) implies that as carcass weight increases the proportion of No. 1 hogs decreases in the sample. The correlations with U.S. No. 2 and U.S. No. 3 grade hogs is 0.2037 and 0.1035, respectively.

TABLE X

CORRELATIONS BETWEEN CARCASS WEIGHT AND SELECTED SAMPLE CHARACTERISTICS[a]

Sample Trait[b]	Carcass Weight
Live Weight	0.9655
Cooler Shrink	0.4569
Lean Cut Weight	0.8095
Percent Lean Cuts of Live Weight	0.0199
Percent Lean Cuts of Carcass Weight	-0.2703
Primal Weight	0.8999
Percent Primal of Carcass Weight	0.3041
Percent Primal of Live Weight	-0.1016
Ham Weight	0.7704
Percent Ham of Carcass Weight	-0.1703
Percent Ham of Live Weight	-0.0703
Loin Weight	0.6808
Shoulder Weight	0.7985
Belly Weight	0.8197
Gut Weight	0.1079
U.S. #1 Grade	-0.2466
U.S. #2 Grade	0.2037
U.S. #3 Grade	0.1035
Barrow	-0.1388
Gilt	0.1388

[a] $r \geq |0.14077|$ significant at .05 level.
$r \geq |0.18369|$ significant at .01 level.

[b] Weight is measured in pounds.

Lean Cuts Yield

Correlations for lean cuts and ham yield are shown in Table XI. Ham weight has higher correlations with lean cut weight and primal weight than any other single measurement. Ham weight accounted for 93 percent of the variation in total lean cut weight and 88 percent of the variation in total primal weight. Thus, of the variables measured, ham is the best single indicator of variation in lean cut or primal yields implying it may be useful in a predicting relationship.

Ham weight explained 72 percent of the variation in shoulder weight, 65 percent of the variation in loin weight, but only 21 percent of the variation in belly weight. It is reasonable that ham has higher correlations with meatier cuts than it does with fat cuts.

Both ham and lean cut weights tend to increase as body size increases. The correlations for live weight with ham weight and with lean cut weight are 0.729 and 0.764, respectively. The corresponding correlations for carcass weight are 0.770 and 0.809.

The percent ham or lean cuts of either live weight or carcass weight decreases as weight increases. This implies that beyond some range the rate of gain of lean cuts decreases while the rate of bone, offal and internal fat deposit increases. This is in agreement with Adams [1] who has written "...as slaughter weight increased percentage of lean cuts decreased due to the rate of fat deposition being greater than that of lean at heavier weights."

It is apparent from Table XI that the measures of comparative muscling or meatiness are not as highly correlated with carcass value as are the actual weights of the ham or lean cuts. The percent lean cuts of carcass weight account for only 9.2 percent of the variation in lean

TABLE XI

CORRELATIONS BETWEEN HIGH VALUE CUTS AND SELECTED SAMPLE CHARACTERISTICS

Variable[b]	Ham Weight	Percent Ham of Warm Carcass	Total Lean Cuts Weight	Percent LC[c] of WC[d]	Percent LC of Live Weight
Ham Weight	1.000	0.494	0.964	0.345	0.555
Loin Weight	0.804	0.315	0.895	0.381	0.579
Shoulder Weight	0.850	0.222	0.920	0.231	0.450
Belly Weight	0.458	-0.408	0.483	-0.515	-0.304
Spare Ribs Weight	0.571	0.125	0.640	0.160	0.297
Total Lean Cuts Weight	0.963	0.384	1.000	0.344	0.569
Primals Weight	0.936	0.219	0.974	0.157	0.403
Warm Carcass Weight	0.770	-0.170	0.809	-0.270	0.020
Live Weight	0.729	-0.188	0.764	-0.291	-0.094
Chilled Carcass Weight	0.644	-0.213	0.745	-0.310	-0.064
Adjusted Live Weight	0.783	-0.126	0.822	-0.220	0.014
Gut Weight	-0.153	-0.188	0.764	-0.291	-0.094
Cooler Shrink	0.460	0.092	0.516	0.118	0.374
Yield	0.533	-0.041	0.569	-0.085	0.349
Body Length	0.450	-0.002	0.505	0.011	0.098
Percent Ham of Warm Carcass Weight	0.494	1.000	0.384	0.902	0.831
Percent Ham of Chilled Carcass Weight	0.538	0.982	0.442	0.897	0.871
Percent LC of Warm Carcass Weight	0.344	0.902	0.344	1.000	0.904
Percent LC of Chilled Carcass Weight	0.397	0.874	0.408	0.976	0.934
Percent LC of Live Weight	0.555	0.831	0.569	0.904	1.000
Percent LC of Adjusted Live Weight	0.496	0.863	0.502	0.938	0.978
Average Backfat	0.027	-0.497	0.024	-0.593	-0.475
First Rib Backfat	0.121	-0.271	0.125	-0.332	-0.218
Last Rib Backfat	0.025	-0.433	0.015	-0.530	-0.425
Last Lumbar Backfat	-0.077	-0.500	-0.078	-0.576	-0.507
Estimated Yield	0.368	0.301	0.418	0.372	0.496
Estimated Backfat	0.196	-0.419	-0.189	-0.444	-0.477
Estimated Length	0.331	-0.082	0.388	-0.061	0.029
Estimated Grade	-0.169	-0.203	-0.186	-0.239	-0.269
Estimated Percent LC of Live Weight	0.031	0.159	0.031	0.183	0.181
Avg. BF x Live Weight[e]	0.378	-0.438	0.394	-0.554	-0.377
Avg. BF x WC	0.437	-0.416	0.457	-0.532	-0.299
Avg. BF x CC[f]	0.411	-0.426	0.426	-0.546	-0.330
Lum. BF x WC[g]	0.286	-0.466	0.304	-0.568	-0.387
Lum. BF x CC	0.263	-0.471	0.278	-0.576	-0.410
Lum. BF x Live Weight	0.226	-0.479	0.240	-0.580	-0.449
Length x WC	0.765	-0.145	0.811	-0.228	0.040
Length x Live Weight	0.725	-0.154	0.769	-0.236	-0.050
Breed	0.217	0.511	0.206	0.548	0.538
Yorkshire	-0.273	-0.534	-0.263	-0.568	-0.577
Red Cross	0.410	0.148	0.399	0.088	0.223
White Cross	-0.347	0.123	-0.341	0.214	0.066
Hampshire	0.266	0.312	0.277	0.336	0.358
Black Cross	0.135	0.216	0.112	0.120	0.223
Sex	0.313	0.292	0.304	0.264	0.306
Barrow	-0.313	-0.287	-0.304	-0.264	-0.306
Gilt	0.313	0.287	0.304	0.264	0.306
Grade	-0.065	-0.439	-0.054	-0.486	-0.406
Grade 1	0.060	0.342	0.054	0.437	0.351
Grade 2	-0.055	-0.294	-0.043	-0.361	-0.280
Ham Value[h]	0.9788	0.4708	0.9491	0.3290	0.5454
Loin Value	0.6696	0.1991	0.7545	0.2523	0.4376
Shoulder Value	0.8497	0.2217	0.9199	0.2311	0.4498
Belly Value	0.4154	-0.3251	0.4478	-0.3972	-0.2152
Total Lean Cuts Value	0.8971	0.3173	0.9488	0.3032	0.5287
Primals Value	0.8880	0.2255	0.9408	0.1992	0.4370

[a] $r \geq |0.14077|$ significant at .05 level. $r \geq |0.18369|$ significant at .01 level.

[b] Weight is measured in pounds; backfat and length are measured in inches.

[c] LC = Lean Cuts.

[d] WC = Warm Carcass Weight.

[e] Avg. BF x Live Weight = Average Backfat times Live Weight.

[f] Avg. BF x CC = Average Backfat times Chilled Carcass Weight.

[g] Lum. BF x WC = Lumbar Backfat times Warm Carcass Weight.

[h] The value of the wholesale cuts were computed using The National Provisioner, July 24, 1971 [41] price quotes.

cut value and four percent of the variation in primal value, but lean cuts weight explains 90 percent of the variation in lean cut value and 88.5 percent of the variation in primal value.

Calculating the actual wholesale value of individual hog carcasses and using these actual value differences to develop a pricing model, is a technique inherent in the Canadian carcass valuation system [10]. The Canadian use of fixed index numbers assumes that relative carcass values remain proportional. Such a technique is not realistic for a pricing model in the United States because there exist price variations within and between the various pork cuts. Lighter weight cuts are usually worth more per pound than are heavier weights, but such price differentials change from period to period. For example, the National Provisioner prices for carlot pork list the prices for skinned hams shown in Table XII for January 22, 1971 [41] and August 20, 1971 [43]. The range for January of five cents and for August of 5.5 cents is similar. However, the price differential for hams under 14 pounds and those in the 17-20 pound range on January 22 is 2.75 cents while in August this differential is .25 cents. There is a wide variation in the price differential between reported weights. This implies that to be useful, a slaughter hog pricing model should predict only the yield of salable cuts coming from individual animals in order that the relative value differences between the various weights and grades of slaughter hogs may be accurately reflected as wholesale prices change.

Regression Analysis

The multiple regression procedure used 146 variables in various combinations to predict values for 36 dependent variables which included

TABLE XII

NATIONAL PROVISIONER HAM PRICES: CHICAGO PRICE ZONE, JANUARY 22, 1971 AND AUGUST 20, 1971

Skinned Hams, f.f.a.[a] of Fresh	January 22, 1971	August 20, 1971
	Cents Per Pound	
14/dn	36	40
14/17	34	39 3/4
17/20	33 1/4	39 3/4
20/26	32 1/2	38
26/30	31	34 1/2

[a]The initials f.f.a. are defined as "Fresh Freezer Accumulation shall mean hams which may be fresh, partially frozen or solidly frozen which have been accumulating for a period not exceeding 15 days." Chicago Mercantile Exchange, Chicago Mercantile Exchange Year Book 1970-71, Market News Department, Chicago Mercantile Exchange, 1971.

different forms of the weights of ham, loin, shoulder, belly, total lean cuts, and total primals.

Development of a Pricing Model

The development of a slaughter hog pricing model requires the estimation of weights of salable cuts which may be valued using current market prices. To be useful, equations from which a pricing model is built must explain a large percent of the variation in the value of the hog carcass and should have a relatively small standard error of the estimate.

Percents of cuts as dependent variables in the pricing models were not used. Even if the percent ham (of carcass or live weight) were accurately predicted, the prediction must be converted to the actual weight of ham before the value of the ham could be calculated. Predicting the percentage yields of lean cuts and of primals have an additional disadvantage. When only these aggregates are known there is still no way to derive their value. Aggregate prices cannot be determined because price relationships for individual cuts vary widely as was discussed earlier, and because the proportion of the individual cuts in the aggregate figure may not be constant.

Four separate pricing models have been constructed based on live weight, adjusted live weight, carcass weight, and carcass weight plus the ham weight measure. Each model will be presented and explained separately. Only a selected number of regressions in the development of each model will be discussed. A selected sample of the numerous other equations which were fitted and is included in Appendix B. Prices are applied and the performance of each model evaluated in the final section.

Model I

Model I uses live weight as a basic independent variable and may be useful as a guide for live animal purchase or evaluation by estimating the last lumbar backfat thickness or by measuring the backfat with a probe or sonoray. Such a procedure would also be a useful management tool for purebred and commercial swine producers. The equations predicting weights of the individual primal cuts considered most appropriate for constructing a model using live weight are shown in Table XIII. The equations were selected because of logical and statistical significance of relationships, accuracy, and ease of usage.

All of the coefficients shown in this table are significant at the 0.005 level. Equations one through four are used to construct the predicting model.[2] The four equation system requires only two measurements, the live weight and the last lumbar backfat measurement. The variable "gilt" is a dummy variable and the regression coefficient estimate should be considered a constant which adjusts the weight of the cut(s) when the animal is a gilt.

The sex variable was omitted from the regressions involving shoulder and belly weights as the regression estimates for sex were not significantly different from zero at the 90 percent level. It is apparent from Table XIII that gilts with the same backfat and live weight as barrows yield 2.3856 pounds more lean cuts on the average than do barrows.

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[2]Equations five and six are not used in the model, but are included to illustrate that errors are in part compensating. The standard error of the estimate for the regression on total lean cuts weight is 4.3287 pounds. In the regression on total primals weight the standard error of the estimator is reduced to 4.1003. The independent variables explain about 81 percent of the variation in the weight of the primal cuts.

TABLE XIII

MODEL I: REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS USING LIVE WEIGHT, BACKFAT AND SEX[a]

		Constant	Live Weight	Gilt	Log (Lumbar Backfat x Live Weight)	R^2	Standard Error of Estimate
(1)	Ham Weight	26.4097 (4.4152)[b]	0.1952 (0.0119)	1.1425 (0.3085	-14.6319 (2.3181)	0.6551	2.0189
(2)	Loin Weight	25.4743 (3.7351)	0.1332 (0.0101)	0.8136 (0.2610)	-12.1349 (1.9611)	0.5433	1.7079
(3)	Shoulder Weight	19.1995 (3.4484)	0.1564 (0.0092)		-10.1946 (1.7923)	0.6406	1.5998
(4)	Belly Weight	-13.5536 (2.9061)	0.1056 (0.0077)		5.4060 (1.5104)	0.7015	1.3482
(5)	Total Lean Cuts Weight	70.0467 (9.4666)	0.4809 (0.0256)	2.3856 (0.6615)	-36.2543 (4.9703)	0.7099	4.3287
(6)	Total Primal Cuts Weight	57.1381 (8.9670)	0.5889 (0.0242)	2.1184 (0.6266)	-31.2881 (4.7081)	0.8130	4.1003

[a]Weight is measured in pounds.
Backfat is measured in inches.

[b]Standard errors appear in parenthesis below the estimates.

Barrows tend to have heavier bellies than do gilts so that the difference in primal cuts is only 2.1184.

Using Model I, predictions of individual primal cut weights were obtained for one-tenth inch backfat and ten pound carcass weight increments as shown in Table XIV for gilts. This table may be made appropriate for barrows by subtracting 1.1425 pounds from the estimate of ham and 0.8136 pounds from the estimate of loin in each weight-backfat cell. The table provides a convenient list of the expected yield of primal cuts[3] from any live slaughter hog which may be used by buyers or producers to evaluate the merits of individual animals or the average of pens of animals prior to slaughter.

Summing the individual lean cuts or primal weights found in the table and dividing by the appropriate live weight will give the percent of lean cuts or primals. The wholesale prices which the firm believes to be relevant for the primal cuts can be used to determine the primals value from any market weight barrow or gilt. The firm can divide the value of primals by the corresponding live hundredweight to obtain the value of the primals per hundredweight. This information is useful to indicate the value difference per hundredweight between grades (backfat and weight) and weights of market weight slaughter hogs. Also, such information can be used by packers or their buyers to select the most valuable live weight and backfat class of slaughter hogs given any set of wholesale prices. This would allow the packer to optimize raw materials procurement for existing wholesale prices or expected future

[3]Table XIV lists the total weight of the ham, loin, shoulder, and belly for live market weight hogs. Thus, for example, ham weight of 30.73 pounds for a 170 pound gilt with 0.7 inches lumbar backfat represents <u>two</u> 15 pound hams.

TABLE XIV

PREDICTED WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS FOR GILTS USING MODEL I EQUATIONS

LUMBAR BACKFAT		LIVE WEIGHT													
		160.	170.	180.	190.	200.	210.	220.	230.	240.	250.	260.	270.	280.	290.
		---POUNDS---													
0.7	H[a]	28.80	30.37	31.96	33.56	35.19	36.83	38.49	40.16	41.84	43.53	45.23	46.95	48.67	50.40
	L[b]	22.73	23.74	24.77	25.82	26.88	27.96	29.05	30.14	31.25	32.37	33.49	34.63	35.77	36.91
	S[c]	23.33	24.63	25.94	27.26	28.60	29.95	31.31	32.67	34.05	35.43	36.82	38.22	39.62	41.03
	B[d]	14.42	15.62	16.81	17.99	19.17	20.34	21.50	22.66	23.82	24.97	26.12	27.26	28.41	29.54
0.8	H	27.95	29.52	31.11	32.71	34.34	35.98	37.64	39.31	40.99	42.68	44.39	46.10	47.82	49.55
	L	22.03	23.04	24.07	25.12	26.18	27.25	28.34	29.44	30.55	31.66	32.79	33.92	35.06	36.21
	S	22.74	24.04	25.35	26.67	28.01	29.36	30.71	32.08	33.46	34.84	36.23	37.63	39.03	40.44
	B	14.73	15.93	17.12	18.31	19.48	20.65	21.82	22.98	24.13	25.29	26.43	27.58	28.72	29.86
0.9	H	27.20	28.77	30.36	31.97	33.59	35.23	36.89	38.56	40.24	41.93	43.64	45.35	47.07	48.80
	L	21.41	22.42	23.45	24.50	25.56	26.63	27.72	28.82	29.93	31.04	32.17	33.30	34.44	35.59
	S	22.22	23.51	24.83	26.15	27.49	28.84	30.19	31.56	32.94	34.32	35.71	37.11	38.51	39.92
	B	15.01	16.21	17.40	18.58	19.76	20.93	22.09	23.25	24.41	25.56	26.71	27.85	29.00	30.13
1.0	H	26.53	28.10	29.69	31.30	32.92	34.57	36.22	37.89	39.57	41.27	42.97	44.68	46.40	48.13
	L	20.85	21.86	22.90	23.94	25.00	26.08	27.17	28.26	29.37	30.49	31.61	32.75	33.89	35.03
	S	21.75	23.05	24.36	25.68	27.02	28.37	29.73	31.09	32.47	33.85	35.24	36.64	38.04	39.45
	B	15.26	16.46	17.65	18.83	20.01	21.18	22.34	23.50	24.66	25.81	26.96	28.10	29.24	30.38
1.1	H	25.93	27.49	29.08	30.69	32.32	33.96	35.62	37.29	38.97	40.66	42.36	44.07	45.80	47.52
	L	20.35	21.36	22.39	23.44	24.50	25.58	26.66	27.76	28.87	29.99	31.11	32.24	33.38	34.53
	S	21.33	22.63	23.94	25.26	26.60	27.95	29.30	30.67	32.05	33.43	34.82	36.22	37.62	39.03
	B	15.48	16.68	17.87	19.05	20.23	21.40	22.56	23.73	24.88	26.03	27.18	28.33	29.47	30.61
1.2	H	25.37	26.94	28.53	30.14	31.76	33.41	35.06	36.73	38.41	40.11	41.81	43.52	45.24	46.97
	L	19.89	20.90	21.93	22.98	24.04	25.12	26.20	27.30	28.41	29.53	30.65	31.79	32.93	34.07
	S	20.95	22.24	23.55	24.88	26.21	27.56	28.92	30.29	31.66	33.05	34.44	35.83	37.24	38.64
	B	15.69	16.88	18.07	19.26	20.43	21.60	22.77	23.93	25.09	26.24	27.39	28.53	29.67	30.81
1.3	H	24.87	26.43	28.02	29.63	31.26	32.90	34.55	36.22	37.91	39.60	41.30	43.01	44.73	46.46
	L	19.47	20.48	21.51	22.56	23.62	24.70	25.78	26.88	27.99	29.11	30.23	31.36	32.50	33.65
	S	20.59	21.89	23.20	24.52	25.86	27.21	28.57	29.93	31.31	32.69	34.08	35.48	36.88	38.29
	B	15.87	17.07	18.26	19.44	20.62	21.79	22.96	24.12	25.27	26.43	27.57	28.72	29.86	31.00
1.4	H	24.39	25.96	27.55	29.16	30.78	32.43	34.08	35.75	37.43	39.13	40.83	42.54	44.26	45.99
	L	19.08	20.09	21.12	22.17	23.23	24.31	25.39	26.49	27.60	28.71	29.84	30.97	32.11	33.26
	S	20.26	21.56	22.87	24.19	25.53	26.88	28.24	29.60	30.98	32.36	33.75	35.15	36.55	37.96
	B	16.05	17.25	18.44	19.62	20.80	21.97	23.13	24.29	25.45	26.60	27.75	28.89	30.03	31.17
1.5	H	23.96	25.52	27.11	28.72	30.35	31.99	33.64	35.31	37.00	38.69	40.39	42.10	43.82	45.55
	L	18.72	19.73	20.76	21.81	22.87	23.94	25.03	26.13	27.23	28.35	29.48	30.61	31.75	32.90
	S	19.96	21.25	22.56	23.89	25.23	26.57	27.93	29.30	30.67	32.06	33.45	34.85	36.25	37.66
	B	16.21	17.41	18.60	19.78	20.96	22.13	23.29	24.45	25.61	26.76	27.91	29.05	30.20	31.33

TABLE XIV (Continued)

	H	23.55	25.11	26.70	28.31	29.94	31.58	33.23	34.90	36.59	38.28	39.98	41.69	43.41	45.14
1.6	L	18.38	19.39	20.42	21.47	22.53	23.60	24.69	25.79	26.89	28.01	29.14	30.27	31.41	32.56
	S	19.67	20.97	22.28	23.60	24.94	26.29	27.65	29.01	30.39	31.77	33.16	34.56	35.96	37.37
	B	16.36	17.56	18.75	19.93	21.11	22.28	23.44	24.60	25.76	26.91	28.06	29.21	30.35	31.49
	H	23.16	24.73	26.32	27.93	29.55	31.19	32.85	34.52	36.20	37.89	39.60	41.31	43.03	44.76
1.7	L	18.06	19.07	20.10	21.15	22.21	23.28	24.37	25.47	26.57	27.69	28.82	29.95	31.09	32.24
	S	19.40	20.70	22.01	23.33	24.67	26.02	27.38	28.74	30.12	31.50	32.89	34.29	35.69	37.10
	B	16.50	17.70	18.89	20.07	21.25	22.42	23.59	24.75	25.90	27.06	28.20	29.35	30.49	31.63
	H	22.80	24.36	25.95	27.56	29.19	30.83	32.49	34.16	35.84	37.53	39.23	40.94	42.67	44.39
1.8	L	17.75	18.77	19.80	20.84	21.91	22.98	24.07	25.17	26.27	27.39	28.52	29.65	30.79	31.94
	S	19.15	20.45	21.76	23.08	24.42	25.77	27.12	28.49	29.87	31.25	32.64	34.04	35.44	36.85
	B	16.64	17.84	19.03	20.21	21.39	22.56	23.72	24.88	26.04	27.19	28.34	29.48	30.62	31.76
	H	22.45	24.02	25.61	27.22	28.84	30.49	32.14	33.81	35.49	37.19	38.89	40.60	42.32	44.05
1.9	L	17.47	18.48	19.51	20.56	21.62	22.70	23.78	24.88	25.99	27.11	28.23	29.36	30.50	31.65
	S	18.91	20.21	21.52	22.84	24.18	25.53	26.89	28.25	29.63	31.01	32.40	33.80	35.20	36.61
	B	16.76	17.96	19.15	20.34	21.51	22.68	23.85	25.01	26.16	27.32	28.46	29.61	30.75	31.89
	H	22.13	23.70	25.28	26.89	28.52	30.16	31.82	33.49	35.17	36.86	38.96	40.28	42.00	43.73
2.0	L	17.20	18.21	19.24	20.29	21.35	22.43	23.51	24.61	25.72	26.83	27.96	29.09	30.23	31.38
	S	18.68	19.98	21.29	27.62	23.95	25.30	26.66	28.03	29.40	30.78	32.17	33.57	34.97	36.38
	B	16.88	18.08	19.27	20.46	21.63	22.80	23.97	25.13	26.28	27.44	28.58	29.73	30.87	32.01
	H	21.82	23.39	24.97	26.58	28.21	29.85	31.51	33.18	34.86	36.55	38.25	39.97	41.69	43.42
2.1	L	16.94	17.95	18.99	20.03	21.09	22.17	23.26	24.35	25.46	26.58	27.70	28.84	29.98	31.12
	S	18.47	19.76	21.07	22.40	23.74	25.08	26.44	27.81	29.18	30.57	31.96	33.36	34.76	36.17
	B	17.00	18.20	19.39	20.57	21.75	22.92	24.08	25.24	26.40	27.55	28.70	29.84	30.99	32.12
	H	21.52	23.09	24.68	26.29	27.91	29.55	31.21	32.88	34.56	36.25	37.96	39.67	41.39	43.12
2.2	L	16.70	17.71	18.74	19.79	20.85	21.92	23.01	24.11	25.22	26.33	27.46	28.59	29.73	30.88
	S	18.26	19.56	20.87	22.19	23.53	24.88	26.24	27.60	28.98	30.36	31.75	33.15	34.55	35.96
	B	17.11	18.31	19.50	20.68	21.86	23.03	24.19	25.35	26.51	27.66	28.81	29.95	31.09	32.23
	H	21.24	22.81	24.40	26.00	27.63	29.27	30.93	32.60	34.28	35.97	37.68	39.39	41.11	42.84
2.3	L	16.46	17.47	18.51	19.55	20.61	21.69	22.78	23.87	24.98	26.10	27.22	28.36	29.50	30.64
	S	18.07	19.36	20.67	22.00	23.33	24.68	26.04	27.41	28.78	30.17	31.56	32.95	34.36	35.76
	B	17.21	18.41	19.60	20.78	21.96	23.13	24.30	25.46	26.61	27.76	28.91	30.06	31.20	32.34
	H	20.97	22.54	24.13	25.73	27.36	29.00	30.66	32.33	34.01	35.70	37.40	39.12	40.84	42.57
2.4	L	16.24	17.25	18.28	19.33	20.39	21.46	22.55	23.65	24.76	25.87	27.00	28.13	29.27	30.42
	S	17.98	19.17	20.48	21.81	23.14	24.49	25.85	27.22	28.59	29.98	31.37	32.76	34.17	35.58
	B	17.31	18.51	19.70	20.88	22.06	23.23	24.40	25.56	26.71	27.86	29.01	30.16	31.30	32.44
	H	20.71	22.28	23.87	25.47	27.10	28.74	30.40	32.07	33.75	35.44	37.15	38.86	40.58	42.31
2.5	L	16.02	17.04	18.07	19.11	20.17	21.25	22.34	23.43	24.54	25.66	26.78	27.92	29.06	30.20
	S	17.70	18.99	20.30	21.63	22.96	24.31	25.67	27.04	28.41	29.80	31.19	32.58	33.99	35.39
	B	17.41	18.61	19.80	20.98	22.16	23.33	24.49	25.65	26.81	27.96	29.11	30.25	31.39	32.53

[a]Ham Weight = 26.4097 (Constant) + 0.1952 (Live Weight) + 1.1425 (Gilt) - 14.6319 (Log [Lumbar Backfat x Live Weight]).

[b]Loin Weight = 25.4743 (Constant) + 0.1332 (Live Weight) + 0.8136 (Gilt) - 12.1349 (Log [Lumbar Backfat x Live Weight]).

[c]Shoulder Weight = 19.1995 (Constant) + 0.1564 (Live Weight) - 10.1946 (Log [Lumbar Backfat x Live Weight]).

[d]Belly Weight = -13.5536 (Constant) + 0.1056 (Live Weight) + 5.4060 (Log [Lumbar Backfat x Live Weight]).

prices.

In the tabular form the model may be used with only a desk calculator for the purchase of slaughter hogs on an individual live weight system. Granting credit for by-products allows the packer to calculate total green cut value for any animal. If average total cost is known, breakeven analysis would be possible. Recomputations would only be necessary when the product prices faced by the firm change.

If the firm has access to a computer, only the equations in Table XIII, along with wholesale prices, are needed and calculations may be made on a continuous basis rather than ten pound increments. The use of a high speed computer would allow the operator to introduce price changes daily.

Model II

A second pricing model was developed to predict the weights of the individual primal cuts based on the adjusted live weight.[4] The adjusted live weight model is considered more accurate for live animal transactions because it accounts for differences in fill.

The equations developed for Model II are shown in Table XV. The equations predicting total primals weight had an R^2 of 0.88 and standard error of the estimate of 3.24 (Model I had an R^2 of 0.81 and standard error of the estimate of 4.10).

Model II requires the measurements of live weight and last lumbar backfat thickness plus the gut weight from each animal. Thus Model II,

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[4]Adjusted live weight was calculated using the formula: (Live weight minus gut weight) times 1.10.

TABLE XV

MODEL II: REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS USING ADJUSTED LIVE WEIGHT[a]

		Constant	Adjusted Live Weight	Gilt	Log (Lumbar Backfat x Adjusted Live Weight)	R^2	Standard Error of Estimate
(1)	Ham Weight	24.8951 (3.9586)[b]	0.1912 (0.0099)	1.0810 (0.2757)	-13.8319 (2.0449)	0.7246	1.8042
(2)	Loin Weight	24.3155 (3.4249	0.1330 (0.0086)	0.7598 (0.2385)	-11.7520 (1.7692)	0.6185	1.5609
(3)	Shoulder Weight	17.9148 (3.1537)	0.1510 (0.0078)		-9.3385 (1.6136)	0.7017	1.4574
(4)	Belly Weight	-14.2359 (2.9608)	0.0945 (0.0073)		6.5483 (1.5149)	0.6926	1.3683
(5)	Lean Cut Weight	66.2005 (8.0932)	0.4719 (0.0203)	2.2304 (0.5636)	-35.3045 (4.1806)	0.7894	3.6885
(6)	Total Primals Weight	52.5869 (7.1111)	0.5687 (0.0178)	1.9684 (0.4952)	-28.1721 (3.6733)	0.8832	3.2409

[a]Weight is measured in pounds.
Backfat is measured in inches.

[b]Standard errors appear in parenthesis below the estimates.

although more accurate, may not be practical for some packers. However, it is included in this study because of the frequent use of adjusted live weight in swine carcass competitions.

The equations composing Model II have been calculated for one-tenth inch lumbar backfat and ten pound carcass weight increments. The predicted cut-out weights of the ham, loin, shoulder, and belly for gilts are shown in Table XVI. This table may be used and interpreted in the same fashion as the table for Model I. It may be of interest to packers as a transition model if producers desire to be paid on a live weight basis but the packer requires greater accuracy than Model I provides.

Model III

Model III requires the measurement of individual carcass weight and last lumbar backfat, both of which may be taken on the kill line without slowing line speeds. Equations one through four listed in Table XVII make up the model. Equations five and six are included for ease of discussion.

The coefficients included in these equations are significant at the 0.005 percent level. As would be expected, Model III equations have higher coefficients of determination and lower standard errors of the estimate than do the equations for Model I. When compared to Model II using adjusted live weight, Model III equations have slightly lower R^2 and higher standard errors for the ham, loin, and shoulder. The Model III equation for belly weight has a R^2 of 0.6988 compared with 0.6926 for Model II.

Model III, however, does have certain advantages. The individual weight and backfat measurements necessary for Model III require little

TABLE XVI

PREDICTED WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS FOR GILTS USING MODEL II EQUATIONS

LUMBAR BACKFAT		ADJUSTED LIVE WEIGHT													
		160.	170.	180.	190.	200.	210.	220.	230.	240.	250.	260.	270.	280.	290.
		---POUNDS---													
0.7	H[a]	28.22	29.77	31.34	32.93	34.53	36.15	37.78	39.43	41.08	42.75	44.43	46.11	47.80	49.51
	L[b]	22.26	23.28	24.31	25.37	26.43	27.51	28.61	29.71	30.82	31.94	33.07	34.20	35.35	36.50
	S[c]	22.94	24.20	25.46	26.77	28.07	29.39	30.71	32.04	33.37	34.72	36.07	37.43	38.79	40.16
	B[d]	14.30	15.42	16.53	17.63	18.72	19.80	20.88	21.95	23.02	24.08	25.13	26.19	27.23	28.28
0.8	H	27.42	28.97	30.54	32.12	33.73	35.35	36.98	38.62	40.28	41.95	43.62	45.31	47.00	48.70
	L	21.57	22.59	23.63	24.68	25.75	26.83	27.92	29.03	30.14	31.26	32.39	33.52	34.67	35.82
	S	22.40	23.66	24.94	26.23	27.53	28.84	30.17	31.49	32.83	34.18	35.53	36.88	38.25	39.61
	B	14.68	15.80	16.91	18.01	19.10	20.18	21.26	22.33	23.40	24.46	25.51	26.57	27.61	28.66
0.9	H	26.71	28.26	29.83	31.42	33.02	34.64	36.27	37.92	39.57	41.24	42.92	44.60	46.30	48.00
	L	20.97	21.99	23.03	24.09	25.15	26.23	27.32	28.42	29.54	30.66	31.79	32.92	34.07	35.22
	S	21.92	23.18	24.46	25.75	27.05	28.37	29.69	31.02	32.35	33.70	35.05	36.41	37.77	39.14
	B	15.02	16.13	17.24	18.34	19.43	20.52	21.59	22.66	23.73	24.79	25.85	26.90	27.95	28.99
1.0	H	26.08	27.63	29.20	30.78	32.39	34.01	35.64	37.28	38.94	40.61	42.28	43.97	45.66	47.36
	L	20.44	21.46	22.49	23.55	24.61	25.69	26.78	27.89	29.00	30.12	31.25	32.38	33.53	34.68
	S	21.49	22.76	24.03	25.32	26.63	27.94	29.26	30.59	31.93	33.27	34.62	35.98	37.34	38.71
	B	15.32	16.43	17.54	18.64	19.73	20.81	21.89	22.96	24.03	25.09	26.15	27.20	28.25	29.29
1.1	H	25.51	27.06	28.62	30.21	31.81	33.43	35.07	36.71	38.37	40.03	41.71	43.40	45.09	46.79
	L	19.95	20.97	22.01	23.06	24.13	25.21	26.30	27.40	28.51	29.63	30.76	31.90	33.04	34.19
	S	21.11	22.37	23.65	24.94	26.24	27.55	28.87	30.20	31.54	32.89	34.24	35.59	36.96	38.32
	B	15.59	16.71	17.81	18.91	20.00	21.09	22.16	23.23	24.30	25.36	26.42	27.47	28.52	29.56
1.2	H	24.98	26.53	28.10	29.69	31.29	32.91	34.54	36.19	37.84	39.51	41.19	42.87	44.57	46.27
	L	19.51	20.53	21.56	22.62	23.68	24.76	25.85	26.96	28.07	29.19	30.32	31.45	32.60	33.75
	S	20.75	22.02	23.29	24.59	25.89	27.20	28.52	29.85	31.19	32.53	33.88	35.24	36.60	37.97
	B	15.84	16.95	18.06	19.16	20.25	21.33	22.41	23.48	24.55	25.61	26.67	27.72	28.77	29.81
1.3	H	24.50	26.05	27.62	29.21	30.81	32.43	34.06	35.71	37.36	39.03	40.71	42.39	44.09	45.79
	L	19.10	20.12	21.15	22.21	23.27	24.35	25.45	26.55	27.66	28.78	29.91	31.05	32.19	33.34
	S	20.43	21.69	22.97	24.26	25.56	26.87	28.20	29.53	30.86	32.21	33.56	34.92	36.28	37.65
	B	16.06	17.18	18.29	19.39	20.48	21.56	22.64	23.71	24.78	25.84	26.89	27.95	28.99	30.04
1.4	H	24.06	25.61	27.18	28.76	30.37	31.99	33.62	35.26	36.92	38.59	40.26	41.95	43.64	45.34
	L	18.72	19.74	20.78	21.83	22.90	23.98	25.07	26.17	27.28	28.40	29.53	30.67	31.81	32.96
	S	20.13	21.39	22.67	23.96	25.26	26.57	27.90	29.23	30.56	31.91	33.26	34.61	35.98	37.35
	B	16.27	17.39	18.50	19.60	20.69	21.77	22.85	23.92	24.99	26.05	27.10	28.16	29.20	30.25
1.5	H	23.64	25.19	26.76	28.35	29.95	31.57	33.20	34.85	36.50	38.17	39.85	41.53	43.23	44.93
	L	18.37	19.39	20.42	21.48	22.54	23.62	24.72	25.82	26.93	28.05	29.18	30.32	31.46	32.61
	S	19.85	21.11	22.39	23.68	24.98	26.29	27.62	28.95	30.28	31.63	32.98	34.34	35.70	37.07
	B	16.47	17.59	18.69	19.79	20.88	21.97	23.05	24.12	25.18	26.24	27.30	28.35	29.40	30.45

TABLE XVI (Continued)

	H	23.26	24.80	26.37	27.96	29.56	31.18	32.82	34.46	36.12	37.78	39.46	41.15	42.84	44.54
1.6	L	18.04	19.06	20.09	21.15	22.21	23.29	24.39	25.49	26.60	27.72	28.85	29.99	31.13	32.28
	S	19.59	20.85	22.13	23.42	24.72	26.03	27.35	28.68	30.02	31.37	32.72	34.07	35.44	36.80
	B	16.65	17.77	18.88	19.98	21.07	22.15	23.23	24.30	25.37	26.43	27.48	28.54	29.58	30.63
	H	22.89	24.44	26.01	27.60	29.20	30.82	32.45	34.10	35.75	37.42	39.10	40.78	42.47	44.18
1.7	L	17.73	18.75	19.78	20.84	21.90	22.98	24.08	25.18	26.29	27.41	28.54	29.68	30.82	31.97
	S	19.34	20.60	21.88	23.17	24.47	25.79	27.11	28.44	29.78	31.12	32.47	33.83	35.19	36.56
	B	16.83	17.94	19.05	20.15	21.24	22.32	23.40	24.47	25.54	26.60	27.66	28.71	29.76	30.80
	H	22.55	24.10	25.67	27.25	28.86	30.48	32.11	33.75	35.41	37.08	38.75	40.44	42.13	43.83
1.8	L	17.44	18.46	19.49	20.55	21.61	22.69	23.78	24.89	26.00	27.12	28.25	29.38	30.53	31.68
	S	19.11	20.37	21.65	22.94	24.24	25.55	26.88	28.21	29.54	30.89	32.24	33.60	34.96	36.33
	B	16.99	18.11	19.21	20.31	21.40	22.49	23.56	24.64	25.70	26.76	27.82	28.87	29.92	30.96
	H	22.22	23.77	25.34	26.93	28.53	30.15	31.78	33.43	35.08	36.75	38.43	40.11	41.81	43.51
1.9	L	17.16	18.18	19.22	20.27	21.34	22.42	23.51	24.61	25.72	26.84	27.97	29.11	30.25	31.40
	S	18.89	20.15	21.43	22.72	24.02	25.34	26.66	27.99	29.32	30.67	32.02	33.38	34.74	36.11
	B	17.14	18.26	19.37	20.47	21.56	22.64	23.72	24.79	25.85	26.92	27.97	29.02	30.07	31.12
	H	21.92	23.46	25.03	26.62	28.22	29.84	31.48	33.12	34.78	36.44	38.12	39.80	41.50	43.20
2.0	L	16.90	17.92	18.96	20.01	21.08	22.16	23.25	24.35	25.46	26.58	27.71	28.85	29.99	31.14
	S	18.68	19.94	21.22	22.51	23.82	25.13	26.45	27.78	29.12	30.46	31.81	33.17	34.53	35.90
	B	17.29	18.41	19.51	20.61	21.70	22.79	23.86	24.93	26.00	27.06	28.12	29.17	30.22	31.26
	H	21.62	23.17	24.74	26.33	27.93	29.55	31.18	32.83	34.48	36.15	37.83	39.51	41.21	42.91
2.1	L	16.65	17.67	18.71	19.76	20.83	21.91	23.00	24.10	25.21	26.33	27.46	28.60	29.74	30.89
	S	18.48	19.75	21.02	22.32	23.62	24.93	26.25	27.58	28.92	30.26	31.61	32.97	34.33	35.70
	B	17.43	18.54	19.65	20.75	21.84	22.92	24.00	25.07	26.14	27.20	28.26	29.31	30.36	31.40
	H	21.34	22.89	24.46	26.05	27.65	29.27	30.90	32.55	34.20	35.87	37.55	39.23	40.93	42.63
2.2	L	16.41	17.43	18.47	19.52	20.59	21.67	22.76	23.86	24.97	26.10	27.22	28.36	29.50	30.65
	S	18.29	19.56	20.84	22.13	23.43	24.74	26.06	27.39	28.73	30.07	31.42	32.78	34.14	35.51
	B	17.56	18.68	19.78	20.88	21.97	23.06	24.13	25.21	26.27	27.33	28.39	29.44	30.49	31.54
	H	21.08	22.62	24.19	25.78	27.38	29.00	30.64	32.28	33.94	35.60	37.28	38.97	40.66	42.36
2.3	L	16.19	17.20	18.24	19.29	20.36	21.44	22.53	23.64	24.75	25.87	27.00	28.13	29.28	30.43
	S	18.11	19.38	20.66	21.95	23.25	24.56	25.88	27.21	28.55	29.89	31.24	32.60	33.96	35.33
	B	17.69	18.80	19.91	21.01	22.10	23.18	24.26	25.33	26.40	27.46	28.52	29.57	30.62	31.66
	H	20.82	22.37	23.94	25.52	27.13	28.75	30.38	32.02	33.68	35.35	37.02	38.71	40.40	42.10
2.4	L	15.97	16.99	18.02	19.08	20.14	21.22	22.32	23.42	24.53	25.65	26.78	27.92	29.06	30.21
	S	17.94	19.21	20.48	21.77	23.08	24.39	25.71	27.04	28.38	29.72	31.07	32.43	33.79	35.16
	B	17.81	18.92	20.03	21.13	22.22	23.30	24.38	25.45	26.52	27.58	28.64	29.69	30.74	31.78
	H	20.58	22.12	23.69	25.28	26.88	28.50	30.13	31.78	33.44	35.10	36.78	38.46	40.16	41.86
2.5	L	15.76	16.78	17.82	18.87	19.94	21.02	22.11	23.21	24.32	25.44	26.57	27.71	28.85	30.00
	S	17.78	19.04	20.32	21.61	22.91	24.22	25.54	26.87	28.21	29.56	30.91	32.26	33.63	34.99
	B	17.92	19.04	20.15	21.25	22.34	23.42	24.50	25.57	26.64	27.70	28.75	29.81	30.85	31.90

[a]Ham Weight = 24.8951 (Constant) + 0.1912 (Adjusted Live Weight) + 1.0810 (Gilt) - 13.8319 (Log [Lumbar Backfat x Adjusted Live Weight]).

[b]Loin Weight = 24.3155 (Constant) + 0.1330 (Adjusted Live Weight) + 0.7598 (Gilt) - 11.7520 (Log [Lumbar Backfat x Adjusted Live Weight]).

[c]Shoulder Weight = 17.9148 (Constant) + 0.1510 (Adjusted Live Weight) - 9.3385 (Log [Lumbar Backfat x Adjusted Live Weight]).

[d]Belly Weight = -14.2359 (Constant) + 0.0945 (Adjusted Live Weight) + 6.5483 (Log [Lumbar Backfat x Adjusted Live Weight]).

TABLE XVII

MODEL III: REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS USING CARCASS WEIGHT[a]

	Constant	Warm Carcass Weight	Gilt	Log (Lumbar Backfat x Warm Carcass Weight)	R^2	Standard Error of Estimate
(1) Ham Weight	28.0704 (3.8166)[b]	0.2288 (0.0126)	1.0558 (0.2848)	-14.1425 (2.1154)	0.7066	1.8620
(2) Loin Weight	26.1317 (3.2779)	0.1591 (0.0108)	0.7470 (0.2446)	-11.9143 (1.8168)	0.5996	1.5992
(3) Shoulder Weight	20.6179 (2.9821)	0.1817 (0.0097)		-9.6459 (1.6382)	0.6938	1.4767
(4) Belly Weight	-10.2971 (2.7350)	0.1120 (0.0089)		6.1636 (1.5025)	0.6988	1.3543
(5) Total Lean Cuts Weight	73.9916 (7.8759)	0.5656 (6.0260)	2.1643 (0.5877)	-34.1244 (4.3654)	0.7714	3.8425
(6) Total Primal Cuts Weight	64.3827 (7.0302)	0.6809 (0.0232)	1.8640 (0.5246)	-29.4413 (3.8966)	0.8692	3.4298

[a]Weight is measured in pounds.
Backfat is measured in inches.

[b]Standard errors appear in parenthesis below the estimates.

time or change in the packer assembly lines which may not be true for Model II. Model I is dependent upon accurate estimation of backfat if mechanical measurement is not possible.

The equations in Table XVII were used to calculate the weights of primal cuts for the various weight and backfat classes as shown in Table XVIII. This latter table contains the predicted cut-out of the ham, loin, shoulder, and belly for gilts. The weights may be adjusted for barrows by subtracting 1.0558 pounds from the ham weight and 0.7470 pounds from the loin weight. The equations used in developing the table or the table itself may be used by the firm as described for Model I.

Additional tables are presented here, using Model III, to better depict the relationships of total lean cut yield as carcass weight and backfat vary. The expected lean cuts for gilts using equation five from Table XVII have been evaluated for ten pound carcass weight and one-tenth inch lumbar backfat increments and presented in Table XIX. This shows that total lean cuts increase as the weight of slaughter gilts increases. Additional backfat for any carcass weight results in a decrease in lean cut yield. From this table the predicted percent lean cuts of carcass weight were calculated. The carcass weight and backfat combinations which yield 50 percent lean cuts are shown in Figure 5. It is obvious that increasing body weight does not result in proportional increases in lean cut yield. Smaller hogs at any backfat thickness have greater percent lean cuts than do heavier animals with equal backfat thickness. It follows then, that the bone, guts, offal, and miscellaneous cuts increase at rapid rates as carcass weight increases from 110 to 200 pounds. It appears from this sample that carcass or live weight grades, if they represent expected lean cut yield, should allow lighter

TABLE XVIII

PREDICTED WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS FOR GILTS USING MODEL III EQUATIONS

LUMBAR BACKFAT		CARCASS WEIGHT													
		110.	120.	130.	140.	150.	160.	170.	180.	190.	200.	210.	220.	230.	240.
		---POUNDS---													
0.7	H[a]	27.61	29.37	31.16	33.00	34.86	36.75	38.67	40.61	42.56	44.53	46.52	48.53	50.54	52.57
	L[b]	21.89	23.03	24.21	25.42	26.65	27.90	29.18	30.47	31.79	33.11	34.45	35.80	37.16	38.53
	S[c]	22.40	23.85	25.33	26.83	28.36	29.91	31.47	33.05	34.64	36.24	37.85	39.47	41.10	42.74
	B[d]	13.65	15.00	16.34	17.66	18.96	20.25	21.54	22.81	24.07	25.33	26.58	27.83	29.06	30.30
0.8	H	26.79	28.55	30.34	32.18	34.04	35.93	37.85	39.79	41.74	43.71	45.70	47.70	49.72	51.75
	L	21.20	22.34	23.52	24.72	25.96	27.21	28.49	29.78	31.09	32.42	33.76	35.11	36.47	37.84
	S	21.84	23.29	24.77	26.28	27.80	29.35	30.91	32.49	34.08	35.68	37.29	38.91	40.54	42.18
	B	14.01	15.36	16.70	18.01	19.32	20.61	21.89	23.17	24.43	25.69	26.94	28.18	29.42	30.66
0.9	H	26.07	27.82	29.62	31.45	33.32	35.21	37.13	39.06	41.02	42.99	44.98	46.98	49.00	51.02
	L	20.59	21.73	22.91	24.11	25.35	26.60	27.88	29.17	30.48	31.81	33.15	34.50	35.86	37.23
	S	21.34	22.80	24.28	25.78	27.31	28.85	30.42	31.99	33.58	35.18	36.80	38.42	40.05	41.68
	B	14.32	15.68	17.01	18.33	19.63	20.93	22.21	23.48	24.75	26.00	27.25	28.50	29.74	30.97
1.0	H	25.42	27.18	28.97	30.81	32.67	34.56	36.48	38.41	40.37	42.34	44.33	46.33	48.35	50.38
	L	20.05	21.19	22.36	23.57	24.80	26.06	27.34	28.63	29.94	31.26	32.60	33.95	35.31	36.68
	S	20.90	22.35	23.84	25.34	26.87	28.41	29.98	31.55	33.14	34.74	36.35	37.98	39.61	41.24
	B	14.61	15.96	17.29	18.61	19.92	21.21	22.49	23.76	25.03	26.29	27.54	28.78	30.02	31.25
1.1	H	24.84	26.59	28.39	30.22	32.09	33.98	35.89	37.83	39.79	41.76	43.75	45.75	47.76	49.79
	L	19.55	20.69	21.87	23.08	24.31	25.57	26.84	28.14	29.45	30.77	32.11	33.46	34.82	36.19
	S	20.50	21.96	23.44	24.94	26.47	28.01	29.58	31.15	32.74	34.34	35.95	37.58	39.21	40.84
	B	14.86	16.21	17.55	18.87	20.17	21.46	22.75	24.02	25.28	26.54	27.79	29.04	30.27	31.51
1.2	H	24.30	26.06	27.85	29.69	31.55	33.44	35.36	37.30	39.25	41.22	43.21	45.21	47.23	49.26
	L	19.10	20.24	21.42	22.63	23.86	25.12	26.39	27.69	29.00	30.32	31.66	33.01	34.37	35.74
	S	20.14	21.59	23.07	24.58	26.10	27.65	29.21	30.79	32.38	33.98	35.59	37.21	38.84	40.48
	B	15.09	16.45	17.78	19.10	20.40	21.70	22.98	24.25	25.52	26.77	28.02	29.27	30.51	31.74
1.3	H	23.81	25.57	27.36	29.20	31.06	32.95	34.87	36.80	38.76	40.73	42.72	44.72	46.74	48.76
	L	18.69	19.83	21.01	22.21	23.45	24.70	25.98	27.27	28.58	29.91	31.26	32.59	33.95	35.32
	S	19.80	21.26	22.74	24.24	25.77	27.31	28.88	30.45	32.04	33.64	35.26	36.88	38.51	40.14
	B	15.31	16.66	17.99	19.31	20.62	21.91	23.19	24.47	25.73	26.99	28.24	29.48	30.72	31.96
1.4	H	23.36	25.11	26.91	28.74	30.60	32.50	34.41	36.35	38.30	40.28	42.27	44.27	46.28	48.31
	L	18.31	19.45	20.62	21.83	23.06	24.32	25.59	26.89	28.20	29.52	30.86	32.21	33.57	34.94
	S	19.49	20.95	22.43	23.93	25.46	27.00	28.57	30.14	31.73	33.33	34.94	36.57	38.20	39.83
	B	15.51	16.86	18.19	19.51	20.82	22.11	23.39	24.66	25.93	27.19	28.44	29.68	30.92	32.15
1.5	H	22.93	24.69	26.48	28.32	30.18	32.07	33.99	35.92	37.88	39.85	41.84	43.84	45.86	47.89
	L	17.95	19.09	20.27	21.47	22.70	23.96	25.24	26.53	27.84	29.17	30.50	31.85	33.21	34.58
	S	19.20	20.66	22.14	23.64	25.17	26.71	28.28	29.85	31.44	33.04	34.66	36.28	37.91	39.54
	B	15.69	17.04	18.38	19.70	21.00	22.29	23.58	24.85	26.11	27.37	28.62	29.87	31.11	32.34

TABLE XVIII (Continued)

	H	22.54	24.29	26.09	27.92	29.78	31.68	33.59	35.53	37.48	39.46	41.45	43.45	45.46	47.49
1.6	L	17.62	18.76	19.93	21.14	22.37	23.63	24.90	26.20	27.51	28.83	30.17	31.52	32.88	34.25
	S	18.93	20.39	21.87	23.37	24.90	26.44	28.01	29.58	31.17	32.77	34.39	36.01	37.64	39.27
	B	15.86	17.22	18.55	19.87	21.17	22.47	23.75	25.02	26.29	27.54	28.79	30.04	31.28	32.51
	H	22.16	23.92	25.71	27.55	29.41	31.30	33.22	35.16	37.11	39.08	41.07	43.08	45.09	47.12
1.7	L	17.30	18.44	19.62	20.82	22.06	23.31	24.59	25.88	27.19	28.52	29.86	31.21	32.57	33.94
	S	18.68	20.13	21.61	23.12	24.64	26.19	27.75	29.33	30.92	32.52	34.13	35.75	37.38	39.02
	B	16.03	17.38	18.71	20.03	21.34	22.63	23.91	25.18	26.45	27.71	28.96	30.20	31.44	32.67
	H	21.81	23.57	25.36	27.20	29.06	30.95	32.87	34.80	36.76	38.73	40.72	42.72	44.74	46.77
1.8	L	17.01	18.15	19.32	20.53	21.76	23.02	24.29	25.59	26.90	28.22	29.56	30.91	32.27	33.64
	S	18.44	19.89	21.37	22.88	24.41	25.95	27.51	29.09	30.68	32.28	33.89	35.51	37.14	38.78
	B	16.18	17.53	18.87	20.18	21.49	22.78	24.06	25.34	26.60	27.86	29.11	30.35	31.59	32.83
	H	21.48	23.24	25.03	26.86	28.73	30.62	32.54	34.47	36.43	38.40	40.39	42.39	44.41	46.43
1.9	L	16.73	17.87	19.04	20.25	21.48	22.74	24.01	25.31	26.62	27.94	29.28	30.63	31.99	33.36
	S	18.21	19.67	21.15	22.65	24.18	25.72	27.29	28.86	30.45	32.05	33.67	35.29	36.92	38.55
	B	16.32	17.68	19.01	20.33	21.63	22.93	24.21	25.48	26.75	28.00	29.25	30.50	31.74	32.97
	H	21.17	22.92	24.72	26.55	28.41	30.31	32.22	34.16	36.11	38.09	40.07	42.08	44.09	46.12
2.0	L	16.46	17.60	18.78	19.98	21.22	22.47	23.75	25.04	26.35	27.68	29.02	30.36	31.72	33.09
	S	18.00	19.45	20.93	22.44	23.96	25.51	27.07	28.65	30.24	31.84	33.45	35.07	36.70	38.34
	B	16.46	17.81	19.15	20.47	21.77	23.06	24.35	25.62	26.88	28.14	29.39	30.64	31.88	33.11
	H	20.87	22.62	24.42	26.25	28.11	30.01	31.92	33.86	35.81	37.79	39.78	41.78	43.79	45.82
2.1	L	16.21	17.35	18.52	19.73	20.96	22.22	23.50	24.79	26.10	27.43	28.76	30.11	31.47	32.84
	S	17.79	19.25	20.73	22.23	23.76	25.31	26.87	28.44	30.03	31.63	33.25	34.87	36.50	38.13
	B	16.59	17.94	19.28	20.60	21.90	23.19	24.48	25.75	27.01	28.27	29.52	30.77	32.01	33.24
	H	20.58	22.33	24.13	25.96	27.83	29.72	31.64	33.57	35.53	37.50	39.49	41.49	43.51	45.53
2.2	L	15.97	17.11	18.28	19.49	20.72	21.98	23.26	24.55	25.86	27.18	28.52	29.87	31.23	32.60
	S	17.60	19.05	20.53	22.04	23.56	25.11	26.67	28.25	29.84	31.44	33.05	34.67	36.30	37.94
	B	16.72	18.07	19.40	20.72	22.03	23.32	24.60	25.87	27.14	28.40	29.65	30.89	32.13	33.36
	H	20.31	22.06	23.86	25.69	27.55	29.45	31.36	33.30	35.26	37.23	39.22	41.22	43.23	45.26
2.3	L	15.74	16.88	18.05	19.26	20.49	21.75	23.03	24.32	25.63	26.95	28.29	29.64	31.00	32.37
	S	17.41	18.87	20.35	21.85	23.38	24.92	26.49	28.06	29.65	31.25	32.87	34.49	36.12	37.75
	B	16.83	18.19	19.52	20.84	22.15	23.44	24.72	25.99	27.26	28.52	29.77	31.01	32.25	33.48
	H	20.05	21.80	23.60	25.43	27.29	29.19	31.10	33.04	34.99	36.97	38.95	40.96	42.97	45.00
2.4	L	15.52	16.66	17.83	19.04	20.27	21.53	22.81	24.10	25.41	26.73	28.07	29.42	30.78	32.15
	S	17.24	18.69	20.17	21.67	23.20	24.75	26.31	27.88	29.47	31.08	32.69	34.31	35.94	37.58
	B	16.95	18.30	19.64	20.95	22.26	23.55	24.83	26.11	27.37	28.63	29.88	31.12	32.36	33.60
	H	19.80	21.55	23.35	25.18	27.04	28.93	30.85	32.79	34.74	36.72	38.70	40.71	42.72	44.75
2.5	L	15.31	16.45	17.62	18.83	20.06	21.32	22.59	23.89	25.20	26.52	27.86	29.21	30.57	31.94
	S	17.06	18.52	20.00	21.50	23.03	24.57	26.14	27.71	29.30	30.90	32.52	34.14	35.77	37.40
	B	17.06	18.41	19.75	21.06	22.37	23.66	24.94	26.22	27.48	28.74	29.99	31.23	32.47	33.71

[a] Ham Weight = 28.0704 (Constant) + 0.2288 (Warm Carcass Weight) + 1.0558 (Gilt) − 14.1425 (Log [Lumbar Backfat x Warm Carcass Weight]).

[b] Loin Weight = 26.1317 (Constant) + 0.1591 (Warm Carcass Weight) + 0.7470 (Gilt) − 11.9143 (Log [Lumbar Backfat x Warm Carcass Weight]).

[c] Shoulder Weight = 20.6179 (Constant) + 0.1817 (Warm Carcass Weight) − 9.6459 (Log [Lumbar Backfat x Warm Carcass Weight]).

[d] Belly Weight = −10.2971 (Constant) + 0.1120 (Warm Carcass Weight) + 6.1636 (Log [Lumbar Backfat x Warm Carcass Weight]).

TABLE XIX

PREDICTED TOTAL WEIGHT OF THE LEAN CUTS FOR GILTS USING MODEL III EQUATIONS

LUMBAR BACKFAT	CARCASS WEIGHT													
	110.	120.	130.	140.	150.	160.	170.	180.	190.	200.	210.	220.	230.	240.
0.7	72.110	76.439	80.874	85.399	90.003	94.674	99.405	104.190	109.021	113.894	118.806	123.752	128.730	133.737
0.8	70.073	74.402	78.837	83.362	87.966	92.637	97.369	102.153	106.984	111.857	116.769	121.716	126.693	131.700
0.9	68.276	72.605	77.040	81.566	86.169	90.841	95.572	100.356	105.187	110.061	114.972	119.919	124.897	129.904
1.0	66.669	70.998	75.433	79.958	84.562	89.233	93.965	98.749	103.580	108.454	113.365	118.312	123.290	128.296
1.1	65.215	69.544	73.979	78.504	83.108	87.780	92.511	97.295	102.126	107.000	111.911	116.858	121.836	126.842
1.2	63.888	68.217	72.652	77.177	81.781	86.452	91.183	95.968	100.799	105.672	110.584	115.530	120.508	125.515
1.3	62.667	66.996	71.431	75.956	80.560	85.231	89.962	94.747	99.578	104.451	109.363	114.309	119.287	124.294
1.4	61.536	65.865	70.300	74.826	79.429	84.101	88.832	93.616	98.447	103.321	108.233	113.179	118.157	123.164
1.5	60.484	64.813	69.248	73.773	78.377	83.048	87.780	92.564	97.395	102.268	107.180	112.127	117.104	122.111
1.6	59.500	63.828	68.263	72.789	77.392	82.064	86.795	91.579	96.410	101.284	106.196	111.142	116.120	121.127
1.7	58.575	62.903	67.338	71.864	76.468	81.139	85.870	90.654	95.486	100.359	105.271	110.217	115.195	120.202
1.8	57.703	62.032	66.467	70.992	75.596	80.267	84.998	89.782	94.614	99.487	104.399	109.345	114.323	119.330
1.9	56.878	61.207	65.642	70.167	74.771	79.442	84.174	88.958	93.789	98.662	103.574	108.521	113.498	118.505
2.0	56.096	60.424	64.859	69.385	73.988	78.660	83.391	88.175	93.006	97.880	102.792	107.738	112.716	117.723
2.1	55.351	59.680	64.115	68.641	73.244	77.916	82.647	87.431	92.262	97.136	102.048	106.994	111.972	116.979
2.2	54.642	58.970	63.405	67.931	72.535	77.206	81.937	86.721	91.553	96.426	101.338	106.284	111.262	116.269
2.3	53.964	58.292	62.727	67.253	71.856	76.528	81.259	86.043	90.874	95.748	100.660	105.606	110.584	115.591
2.4	53.314	57.643	62.078	66.604	71.207	75.879	80.610	85.394	90.225	95.099	100.011	104.957	109.935	114.942
2.5	52.692	57.020	61.455	65.981	70.585	75.256	79.987	84.771	89.603	94.476	99.388	104.334	109.312	114.319

[a]Total Lean Cuts Weight = 73.9916 (Constant) + 0.5656 (Warm Carcass Weight) + 2.1643 (Gilt) - 34.1244 (Log [Lumbar Backfat x Warm Carcass Weight]).

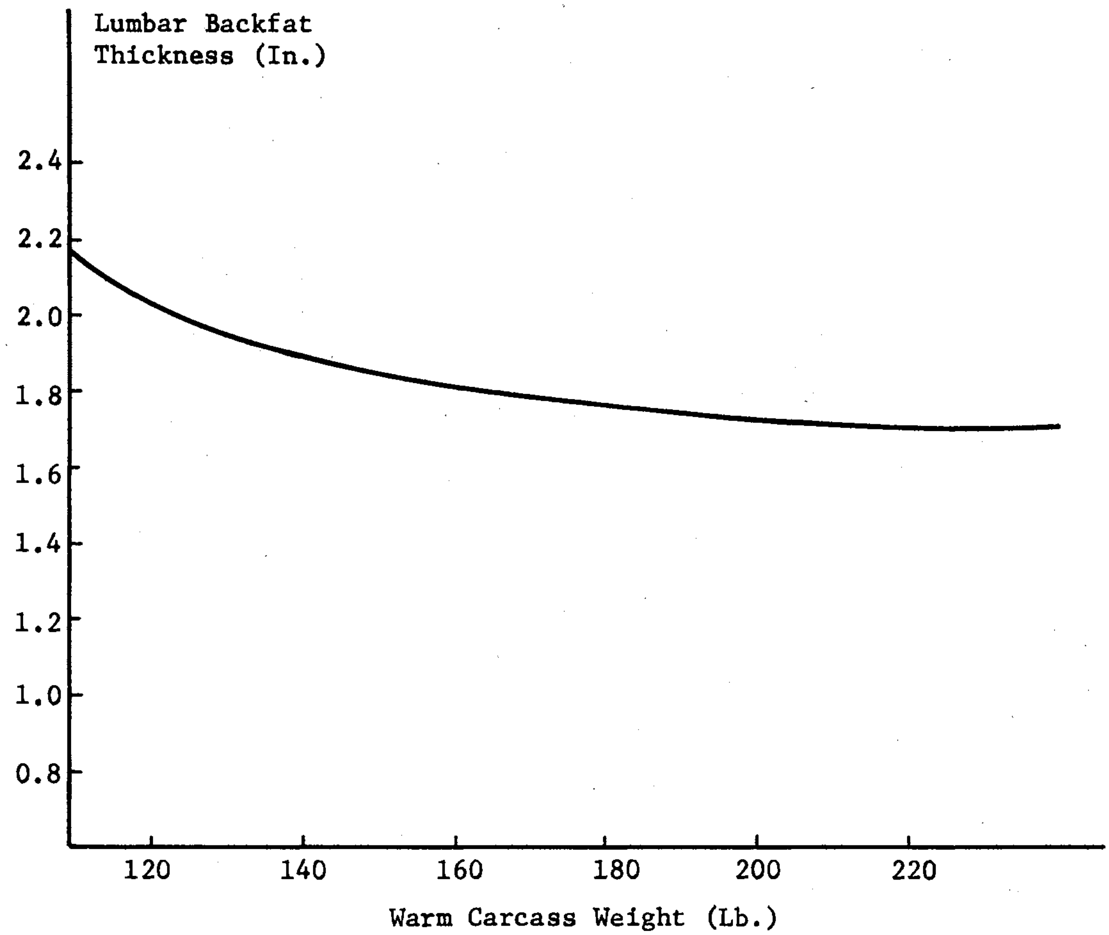

Figure 5. Carcass Weight and Lumbar Backfat Combination Which Yield 50 Percent Lean Cuts of Carcass Weight for Gilts Using Model III Equations

animals to have more backfat in each grade than heavier animals. These results are in conflict, however with USDA carcass grades which indicate that heavier hogs may have more backfat and still yield a comparable percent of lean cuts as do lighter, leaner carcasses. It also indicates that in carcass shows or competition where final scores depend upon lean cut yields, larger animals, even though they may have little backfat, may be at a serious disadvantage. More research needs to be done to reconcile this difference.

Model IV

A pricing model may be constructed as accurately as the packer desires if he is willing to pay the cost of the additional information. For example, if a carcass merit method of purchasing slaughter hogs was desired and the packer was willing to weigh the hams, the three equation system shown in Table XX would be appropriate. The resulting model uses three measured explanatory variables; the ham weight, carcass weight and the lumbar backfat (and sex in the case of equation #2).

When the actual ham weight is included as an explanatory variable the importance of the dummy variable gilt is greatly reduced. The resulting regressions on the loin, shoulder, and belly increased the R^2 over Model III by .0829, .0844, and .0488, respectively, and at the same time reduced the standard error of the estimates to 1.4277, 1.2600, and 1.2431. The value of the addition of ham weight to Model III is perhaps best seen in equations five and six. The regressions on total lean cuts and total primal cuts explain 94 percent and 96 percent, respectively, of the total variation.

Model IV does not easily lend itself to tabular construction as did

TABLE XX

MODEL IV: REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS USING CARCASS WEIGHT AND ACTUAL HAM WEIGHT[a]

	Constant	Carcass Weight	Gilt	Log (Lumbar Backfat x Carcass Weight)	Ham Weight	R^2	Standard Error of Estimate
(1) Ham Weight	(Hams are weighed in this model)						
(2) Loin Weight	15.1581 (3.3209)[b]	0.0696 (0.0160)	0.3343 (0.2262)	-6.3856 (1.8046)	0.3909 (0.0559)	0.6825	1.4277
(3) Shoulder Weight	8.3418 (2.9313)	0.0848 (0.0141)		-3.2716 (1.5891)	0.4026 (0.0496)	0.7780	1.2600
(4) Belly Weight	-1.6597 (2.8908)	0.1801 (0.0139)		1.6787 (1.5671)	-0.2832 (0.0470)	0.7476	1.2431
(5) Total Lean Cuts Weight	23.5222 (4.3983)	0.1541 (0.0212)	0.2659 (0.2996)	-9.2659 (2.3901)	1.7980 (0.0741)	0.9449	1.8910
(6) Total Primal Cuts Weight	21.8628 (4.5515)	0.3342 (0.0220)	0.2647 (0.3101)	-8.0187 (2.4733)	1.5148 (0.0766)	0.9476	1.9568

[a]Weight is measured in pounds.
Backfat is measured in inches.

[b]Standard errors appear in parenthesis below the estimates.

the first three models because of the extra factor of ham weight; and computations using a desk calculator will be more time consuming than with the first three models. However, computations may be made for any increment of carcass weight, backfat, and ham weight. The output or calculations may be used and interpreted in the same manner as was discussed for Model I.

This model, like Model II, may not be desirable to many commercial meat packers because all of the measurements cannot be taken at the same time. The ham must be weighed during the breaking process.

Applying Prices to the Models

The predicted weights of the individual primal cuts using Model III were valued using the Chicago wholesale prices quoted in The National Provisioner, July 24, 1971 [42]. These prices are shown in Table XXI. The resulting values for the primal cuts are shown in Table XXII. This table depicts the weight and backfat class with greatest primal value for the given market prices. It also indicates the actual value difference between hogs of equal weight but different grade (backfat). This could instruct buyers as to what actual differential they can bid for lots of different grades. It is interesting to note that the maximum total value for the primal cuts is for 240[5] pound slaughter gilt carcasses with 1.7 inches lumbar backfat. It is $3.08 greater than the leanest 240 pound class shown. This results from price differentials

[5]The range of this table has been extrapolated beyond the range of sample observations for illustration purposes. Obviously these values are subject to the usual assumption that they are expected to follow the same relationships with backfat and body weight that the estimates within the known range followed.

TABLE XXI

NATIONAL PROVISIONER PRICES FOR PRIMAL PORK CUTS: CHICAGO PRICE ZONE, JULY 22, 1971

Item	Price July 22, 1971
	(Cents Per Pound)
Skinned Hams f.f.a. or Fresh, in Pounds	
14/dn	38
14/17	38 1/4
17/20	38 1/4
20/26	35
26/30	32 1/2
Bellies, Green, Sq. Cut Seedless f.f.a. or Fresh, in Pounds	
8/10	21
10/12	21 1/2
12/14	22 1/2
14/16	22
16/18	22
18/20	21 3/4
20/25	17 1/8
Fresh Loins, in Pounds	
14/dn	53 3/4
14/17	53
17/20	35 1/2
20/up	30 1/2
Shoulders	
Skd. Shoulders 16/dn, Fresh, in Pounds	31

TABLE XXII

PREDICTED WHOLESALE VALUE OF HAM, LOIN, SHOULDER AND BELLY FOR GILTS IN CARCASS AND LUMBAR BACKFAT CLASSES USING MODEL III EQUATIONS

LUMBAR BACKFAT		CARCASS WEIGHT													
		110.	12C.	130.	140.	15C.	160.	17C.	180.	190.	200.	210.	220.	230.	240.
								---VALUES---							
	H[a]	10.49	11.23	11.92	12.62	13.33	14.06	14.79	14.21	14.90	15.59	16.28	16.98	17.69	17.08
0.7	L[b]	11.77	12.38	13.01	13.66	14.32	15.00	15.47	16.15	16.85	17.55	12.23	12.71	13.19	13.68
	S[c]	6.94	7.39	7.85	8.32	8.79	9.27	9.76	10.24	10.74	11.23	11.73	12.24	12.74	13.25
	B[d]	2.87	3.15	3.43	3.71	3.58	4.35	4.63	4.90	5.18	5.45	5.72	5.98	6.39	6.67
TOTAL		32.07	34.16	36.22	38.31	40.43	42.68	44.64	45.51	47.66	49.81	45.96	47.91	50.01	50.68
	H	10.18	10.92	11.61	12.31	13.02	13.74	14.48	15.22	14.61	15.30	16.00	16.70	17.40	18.11
0.8	L	11.40	12.01	12.64	13.29	13.95	14.63	15.10	15.79	16.48	17.18	17.89	12.46	12.95	13.43
	S	6.77	7.22	7.68	8.15	8.62	9.10	9.58	10.07	10.56	11.06	11.56	12.06	12.57	13.08
	B	2.94	3.23	3.51	3.78	4.06	4.43	4.71	4.98	5.25	5.52	5.79	6.20	6.47	6.74
TOTAL		31.29	33.37	35.43	37.53	39.65	41.90	43.87	46.06	46.91	49.06	51.24	47.42	49.39	51.36
	H	9.91	10.57	11.33	12.03	12.74	13.47	14.20	14.94	14.36	15.05	15.74	16.44	17.15	17.86
0.9	L	11.07	11.68	12.31	12.96	13.62	14.30	14.99	15.46	16.16	16.86	17.57	12.25	12.73	13.22
	S	6.62	7.07	7.53	7.99	8.47	8.94	9.43	9.92	10.41	10.91	11.41	11.91	12.41	12.92
	B	3.01	3.29	3.57	3.85	4.12	4.50	4.77	5.05	5.32	5.59	5.86	6.27	6.54	6.81
TOTAL		30.60	32.61	34.74	36.83	38.96	41.21	43.39	45.37	46.24	48.40	50.58	46.87	48.83	50.81
	H	9.66	10.33	11.08	11.78	12.50	13.22	13.55	14.69	14.13	14.82	15.52	16.22	16.92	17.63
1.0	L	10.78	11.39	12.02	12.67	13.33	14.01	14.69	15.17	15.87	16.57	17.28	17.99	12.54	13.02
	S	6.48	6.93	7.39	7.86	8.33	8.81	9.29	9.78	10.27	10.77	11.27	11.77	12.28	12.79
	B	3.07	3.35	3.63	3.91	4.18	4.56	4.84	5.11	5.38	5.65	5.92	6.33	6.60	6.88
TOTAL		29.96	32.00	34.12	36.22	38.34	40.59	42.77	44.76	45.65	47.81	49.99	52.32	48.34	50.31
	H	9.44	10.10	10.86	11.56	12.27	13.00	13.73	14.47	15.22	14.62	15.31	16.01	16.72	17.43
1.1	L	10.51	11.12	11.76	12.40	13.07	13.74	14.43	14.91	15.61	16.31	17.02	17.73	12.36	12.85
	S	6.36	6.81	7.27	7.73	8.21	8.68	9.17	9.66	10.15	10.65	11.15	11.65	12.15	12.66
	B	3.12	3.40	3.68	3.96	4.34	4.61	4.89	5.16	5.44	5.71	5.98	6.39	6.66	6.93
TOTAL		29.43	31.44	33.56	35.66	37.88	40.04	42.22	44.20	46.41	47.28	49.45	51.78	47.89	49.87
	H	9.24	9.90	10.58	11.36	12.07	12.79	13.52	14.27	15.01	14.43	15.12	15.83	16.53	17.24
1.2	L	10.27	10.88	11.51	12.16	12.82	13.50	14.19	14.88	15.37	16.07	16.78	17.49	12.20	12.69
	S	6.24	6.69	7.15	7.62	8.09	8.57	9.06	9.54	10.04	10.53	11.03	11.54	12.04	12.55
	B	3.17	3.45	3.73	4.01	4.39	4.66	4.94	5.21	5.49	5.76	6.17	6.44	6.71	6.98
TOTAL		28.92	30.93	32.98	35.15	37.37	39.53	41.71	43.91	45.90	46.79	49.10	51.29	47.48	49.46
	H	9.05	9.72	10.40	11.17	11.88	12.60	13.34	14.08	14.83	14.26	14.95	15.65	16.36	17.07
1.3	L	10.05	10.66	11.29	11.94	12.60	13.28	13.96	14.66	15.15	15.85	16.56	17.27	18.00	12.54
	S	6.14	6.59	7.05	7.51	7.99	8.47	8.95	9.44	9.93	10.43	10.93	11.43	11.94	12.44
	B	3.21	3.50	3.78	4.06	4.43	4.71	4.99	5.26	5.53	5.80	6.21	6.49	6.76	7.03
TOTAL		28.45	30.46	32.52	34.68	36.90	39.06	41.24	43.44	45.44	46.34	48.65	50.85	53.05	49.08
	H	8.88	9.54	10.22	10.99	11.71	12.43	13.16	13.90	14.65	14.10	14.79	15.49	16.20	16.91
1.4	L	9.84	10.45	11.08	11.73	12.40	13.07	13.76	14.45	14.95	15.65	16.36	17.07	17.79	12.40
	S	6.04	6.49	6.95	7.42	7.89	8.37	8.86	9.34	9.84	10.33	10.83	11.34	11.84	12.35
	B	3.26	3.54	3.82	4.10	4.48	4.75	5.03	5.30	5.57	5.85	6.26	6.53	6.80	7.07
TOTAL		28.01	30.03	32.08	34.24	36.47	38.63	40.80	43.00	45.01	45.92	48.24	50.43	52.63	48.73
	H	8.71	9.38	10.06	10.83	11.54	12.27	13.00	13.74	14.49	15.24	14.64	15.35	16.05	16.76
1.5	L	9.65	10.26	10.89	11.54	12.20	12.88	13.56	14.26	14.96	15.46	16.17	16.88	17.60	12.28
	S	5.95	6.40	6.86	7.33	7.80	8.28	8.77	9.25	9.75	10.24	10.74	11.25	11.75	12.26
	B	3.30	3.58	3.86	4.14	4.52	4.79	5.07	5.34	5.61	5.88	6.30	6.57	6.84	7.11
TOTAL		27.61	29.62	31.68	33.84	36.07	38.22	40.40	42.60	44.82	46.83	47.85	50.04	52.25	48.41

Table XXII (Continued)

1.6	H	8.56	9.23	9.91	10.61	11.39	12.12	12.85	13.59	14.34	15.09	14.51	15.21	15.91	16.62
	L	9.47	10.08	10.71	11.36	12.02	12.70	13.39	14.08	14.79	15.28	15.99	16.71	17.43	12.16
	S	5.67	6.32	6.78	7.25	7.72	8.20	8.68	9.17	9.66	10.16	10.66	11.16	11.67	12.17
	B	3.33	3.62	3.90	4.17	4.55	4.83	5.11	5.38	5.65	5.92	6.33	6.61	6.88	7.15
TOTAL		27.23	29.25	31.30	33.39	35.69	37.84	40.02	42.22	44.44	46.46	47.49	49.68	51.89	48.11
1.7	H	8.42	9.09	9.77	10.47	11.25	11.97	12.71	13.45	14.20	14.95	14.38	15.08	15.78	16.49
	L	9.38	9.91	10.54	11.19	11.86	12.53	13.22	13.91	14.62	15.11	15.82	16.54	17.26	17.99
	S	5.79	6.24	6.70	7.17	7.64	8.12	8.60	9.09	9.58	10.08	10.58	11.08	11.59	12.10
	B	3.37	3.65	3.93	4.31	4.59	4.87	5.14	5.41	5.69	5.96	6.37	6.64	6.92	7.19
TOTAL		26.88	28.89	30.95	33.13	35.33	37.49	39.67	41.87	44.08	46.10	47.15	49.34	51.55	53.76
1.8	H	8.29	8.96	9.64	10.33	11.12	11.84	12.57	13.31	14.06	14.82	14.25	14.95	15.66	16.37
	L	9.14	9.75	10.39	11.03	11.70	12.37	13.06	13.75	14.46	14.96	15.67	16.38	17.10	17.83
	S	5.72	6.17	6.63	7.09	7.57	8.04	8.53	9.02	9.51	10.01	10.51	11.01	11.51	12.02
	B	3.40	3.68	3.96	4.34	4.62	4.90	5.17	5.45	5.72	5.99	6.40	6.68	6.95	7.22
TOTAL		26.54	28.56	30.61	32.80	35.00	37.15	39.33	41.53	43.75	45.77	46.83	49.02	51.23	53.44
1.9	H	8.16	8.83	9.51	10.21	10.99	11.71	12.44	13.19	13.93	14.69	14.14	14.84	15.54	16.25
	L	8.99	9.60	10.24	10.88	11.55	12.22	12.91	13.60	14.31	15.02	15.52	16.23	16.95	17.68
	S	5.65	6.10	6.56	7.02	7.50	7.97	8.46	8.95	9.44	9.94	10.44	10.94	11.44	11.95
	B	3.43	3.71	3.99	4.37	4.65	4.93	5.20	5.48	5.75	6.16	6.44	6.71	6.98	7.25
TOTAL		26.23	28.24	30.29	32.48	34.68	36.84	39.02	41.22	43.43	45.81	46.53	48.72	50.92	53.14
2.0	H	8.04	8.71	9.39	10.09	10.87	11.59	12.32	13.07	13.81	14.57	14.03	14.73	15.43	16.14
	L	8.85	9.46	10.09	10.74	11.40	12.08	12.76	13.46	14.16	14.88	15.38	16.09	16.81	17.54
	S	5.58	6.03	6.49	6.96	7.43	7.91	8.39	8.88	9.37	9.87	10.37	10.87	11.38	11.89
	B	3.46	3.74	4.02	4.40	4.68	4.96	5.23	5.51	5.78	6.19	6.47	6.74	7.01	7.28
TOTAL		25.93	27.94	29.99	32.19	34.38	36.54	38.72	40.91	43.13	45.51	46.24	48.43	50.64	52.85
2.1	H	7.93	8.60	9.28	9.97	10.75	11.48	12.21	12.95	13.70	14.45	15.21	14.62	15.33	16.04
	L	8.71	9.32	9.96	10.61	11.27	11.94	12.63	13.32	14.03	14.74	15.24	15.96	16.68	17.41
	S	5.52	5.97	6.43	6.89	7.37	7.84	8.33	8.82	9.31	9.81	10.31	10.81	11.31	11.82
	B	3.48	3.77	4.05	4.43	4.71	4.99	5.26	5.54	5.81	6.22	6.49	6.77	7.04	7.31
TOTAL		25.64	27.66	29.71	31.90	34.10	36.25	38.43	40.63	42.85	45.22	47.26	48.16	50.36	52.58
2.2	H	7.82	8.49	9.17	9.67	10.57	11.37	12.10	12.84	13.59	14.34	15.10	14.52	15.23	15.94
	L	8.58	9.20	9.83	10.48	11.14	11.81	12.50	13.20	13.90	14.61	15.12	15.83	16.55	17.28
	S	5.46	5.91	6.37	6.83	7.31	7.78	8.27	8.76	9.25	9.75	10.25	10.75	11.25	11.76
	B	3.51	3.79	4.07	4.46	4.74	5.01	5.29	5.56	5.83	6.25	6.52	6.80	7.07	7.34
TOTAL		25.37	27.38	29.44	31.63	33.75	35.98	38.16	40.36	42.57	44.95	46.99	47.90	50.10	52.32
2.3	H	7.72	8.38	9.07	9.76	10.47	11.26	12.00	12.74	13.49	14.24	15.00	14.43	15.13	15.84
	L	8.46	9.07	9.70	10.35	11.02	11.69	12.38	13.07	13.78	14.49	14.99	15.71	16.43	17.16
	S	5.40	5.85	6.31	6.77	7.29	7.73	8.21	8.70	9.19	9.69	10.19	10.69	11.20	11.70
	B	3.54	3.82	4.10	4.48	4.76	5.04	5.31	5.59	5.86	6.27	6.55	6.82	7.09	7.37
TOTAL		25.11	27.12	29.18	31.37	33.49	35.72	37.90	40.10	42.31	44.69	46.73	47.65	49.85	52.07
2.4	H	7.62	8.28	8.97	9.66	10.37	11.16	11.90	12.64	13.39	14.14	14.90	14.34	15.04	15.75
	L	8.34	8.95	9.59	10.23	10.90	11.57	12.26	12.95	13.66	14.37	14.88	15.59	16.31	17.04
	S	5.34	5.79	6.25	6.72	7.19	7.67	8.16	8.64	9.14	9.63	10.13	10.64	11.14	11.65
	B	3.56	3.84	4.12	4.51	4.79	5.06	5.34	5.61	5.88	6.30	6.57	6.85	7.12	7.39
TOTAL		24.86	26.87	28.93	31.12	33.25	35.47	37.65	39.85	42.06	44.44	46.48	47.41	49.61	51.83
2.5	H	7.52	8.19	8.87	9.57	10.28	11.07	11.80	12.54	13.29	14.04	14.80	14.25	14.95	15.66
	L	8.23	8.84	9.47	10.12	10.78	11.46	12.14	12.84	13.54	14.26	14.98	15.48	16.20	16.93
	S	5.29	5.74	6.20	6.67	7.14	7.62	8.10	8.59	9.08	9.58	10.08	10.58	11.09	11.60
	B	3.58	3.87	4.15	4.53	4.81	5.09	5.36	5.64	5.91	6.32	6.60	6.87	7.14	7.42
TOTAL		24.62	26.63	28.69	30.88	33.01	35.23	37.41	39.61	41.83	44.20	46.46	47.18	49.39	51.60

[a]H = Ham Value.

[b]L = Loin Value.

[c]S = Shoulder Value.

[d]B = Belly Value.

for the various weight classes of cuts. The lightest loins were worth $.2325 per pound more than the heaviest reported class and light hams were $.055 more than the heavy hams. This indicates that not only can slaughter hogs be too fat they may also be too lean. Hog buyers may do themselves a disservice by buying hogs which grade too well, depending upon purchase price and in plant cost.

The total values in Table XXII are depicted graphically in Figure 6. This graph is an attempt to illustrate in three dimensions the variation in total wholesale value of the primal cuts as backfat and carcass weight vary. It is apparent that the value surface is not smooth. The reviewer should note that for other price quotations the value surface may be much more or much less irregular; however, major convolutions will generally appear along the contours labelled AA', BB', and CC'. These are the backfat and carcass weight combinations at which the prices of the expected primal cuts change. For example a 140 pound carcass with 0.7 inches lumbar backfat is expected to yield 15 pound hams, 12 pound loins and nine pound bellies. A 160 pound carcass with 0.7 inches lumbar backfat, however, yields 18 pound hams, 14 pound loins, and 10 pound bellies all of which are in different weight categories for pricing purposes when compared to the cuts from the 140 pound carcass. Thus, depending on current price differentials, a major value change may occur between 140 to 160 pound carcasses with 0.7 inches lumbar backfat.

Perhaps of greater interest to packers is the wholesale value of the primal cuts per hundred pounds of carcass shown in Table XXIII. The data in Table XXIII indicate that for any given backfat thickness the smaller carcasses are worth more per hundredweight. This too is perhaps more easily seen graphically. Figure 7 presents the surface of primal

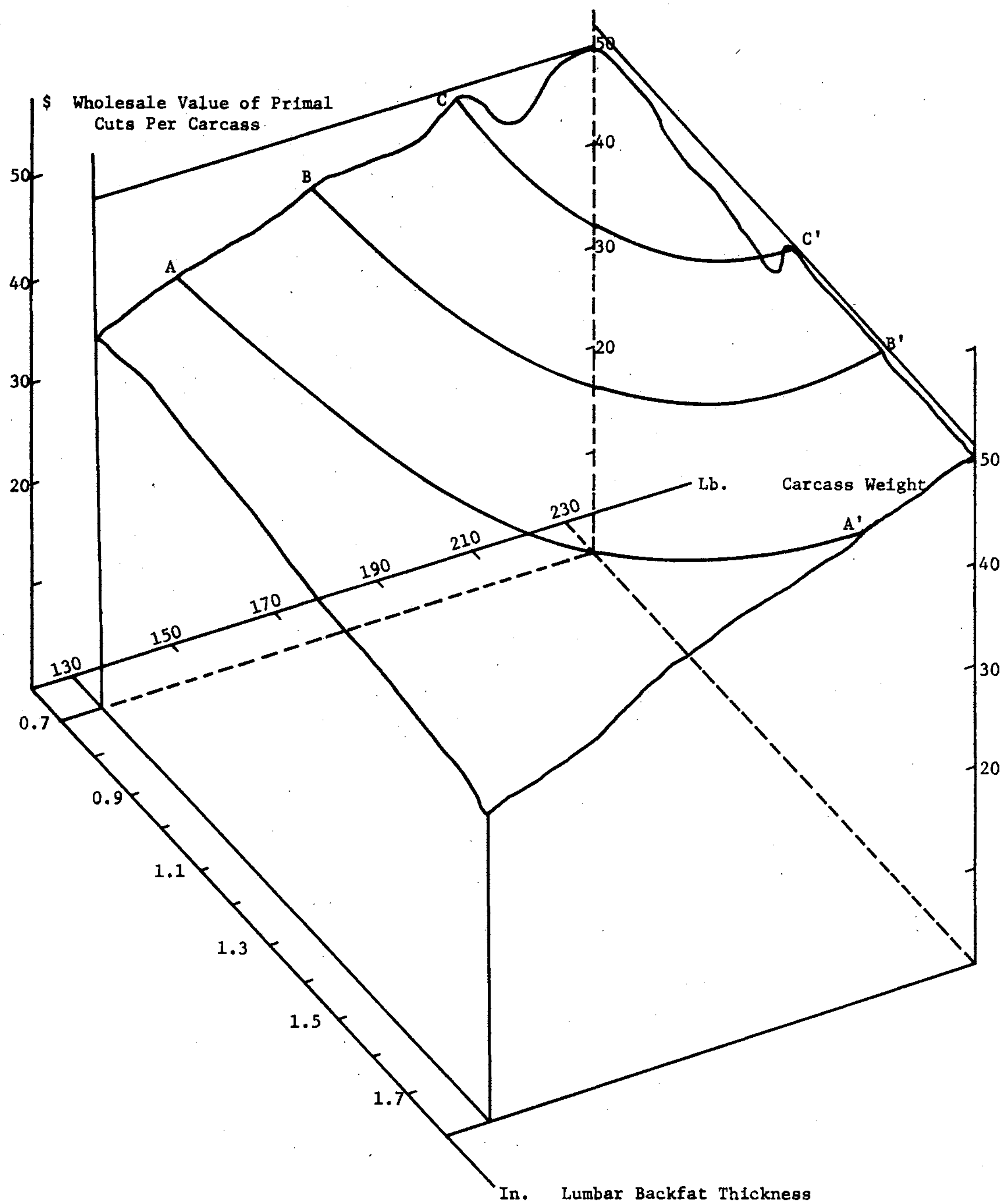

Figure 6. Graphic Picture of Total Value of Primal Cuts of Gilts for Carcass Weight and Lumbar Backfat Combination Using Model III Equations and July 22, 1971, National Provisioner Prices

TABLE XXIII

WHOLESALE VALUE OF PRIMAL CUTS PER HUNDRED POUNDS OF CARCASS (GILTS)[a]

Lumbar Backfat	Carcass Weight										
	130	140	150	160	170	180	190	200	210	220	230
	Value Per Hundredweight										
0.7	27.86	27.36	26.95	26.68	26.25	25.28	25.08	24.90	21.88	21.78	21.74
0.8	27.25	26.81	26.43	26.19	25.81	25.59	24.69	24.53	24.40	21.55	21.47
0.9	26.72	26.31	25.97	25.76	25.51	25.21	24.34	24.20	24.08	21.30	21.23
1.0	26.25	25.81	25.56	25.37	25.15	24.87	24.02	23.90	23.80	23.78	21.02
1.1	25.82	25.47	25.25	25.02	24.83	24.55	24.43	23.64	23.55	23.54	20.82
1.2	25.37	25.11	24.91	24.71	24.53	24.40	24.16	23.40	23.37	23.31	20.64
1.3	25.27	24.77	24.60	24.41	24.25	24.14	23.92	23.17	23.16	23.11	23.06
1.4	24.68	24.46	24.31	24.14	23.99	23.90	23.69	22.96	22.96	22.92	22.83
1.5	24.37	24.17	24.05	23.89	23.76	23.67	23.59	23.42	22.78	22.74	22.72
1.6	24.08	23.85	23.79	23.65	23.53	23.46	23.39	23.23	22.60	22.58	22.56
1.7	23.81	23.66	23.55	23.43	23.32	23.26	23.20	23.05	22.44	22.42	22.41
1.8	23.55	23.43	23.33	23.22	23.13	23.07	23.02	22.88	22.29	22.28	22.27

[a]Weight is measured in pounds.
Backfat is measured in inches.

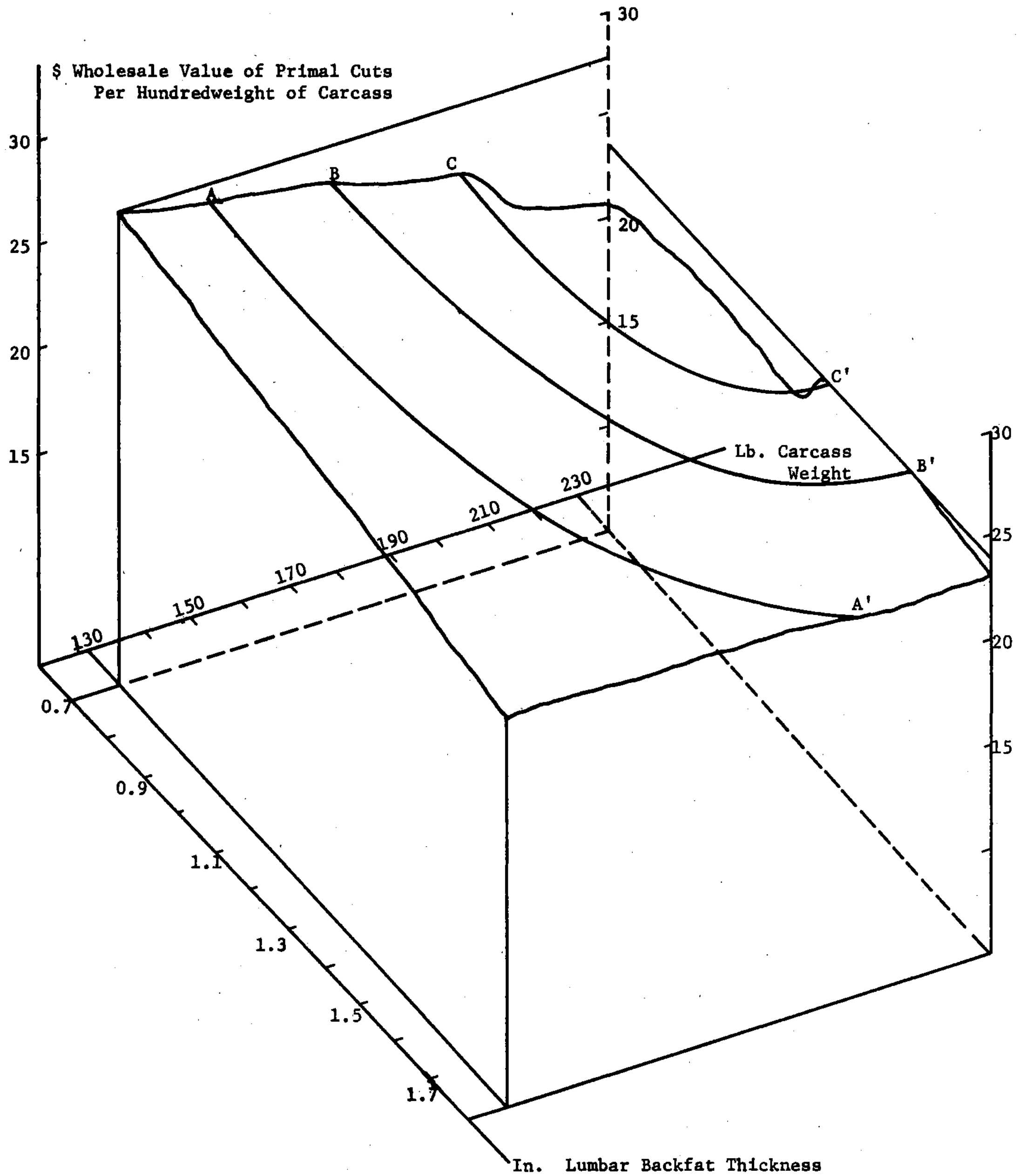

Figure 7. Graphic Picture of Total Value of Primal Cuts Per Hundredweight of Carcass of Gilts for Carcass Weight and Lumbar Backfat Combinations Using Model III Equations and July 22, 1971, National Provisioner Prices

cut values per hundred pounds of carcass. The contours AA', BB', and CC' correspond to those in Figure 6.

Comparison of Model Accuracy

The actual weights of the primal cuts for the 192 sample hogs were valued using the price schedule shown earlier in Table XXI. The standard error of the estimate for each model was then calculated by the formula:

$$\sqrt{\frac{\Sigma(Y_i - \hat{Y}_i)^2}{n}}$$

where Y_i = the value of the primal cuts using actual weight of primal cuts for hog i,

$\hat{Y}_i$ = the expected value of the primal cuts using model predictions of the individual primal cut weights for hog i, and

n = the number of observations in the sample, 192.

The standard errors of the estimates along with the average absolute error, the average absolute percent error, and the range of percent error for each model are shown in Table XXIV.

This table indicates that Model I has the greatest error and Model IV has the least error. The error analysis for both Model I and Model II assumes that the lumbar backfat thickness was estimated exactly. If in fact there are errors when estimating backfat the average error may be much larger. Thus in actual use, if backfat is not mechanically measured the reliability of these models will be much less than for Model III and IV. Also the use of adjusted live weight in Model II requires an additional measurement (gut weight) and additional computations. This limits its practicability for use in a pricing model for

TABLE XXIV

COMPARISON OF ERRORS FOR THE INDIVIDUAL SLAUGHTER HOG PRICING MODELS

Model	Weight Basis	Standard Error of Estimate	Average Absolute Error[a]	Average Absolute Percent Error[b]	Range of Percent Error
		(Dollars)	(Dollars)		
I	Live Weight	1.943	1.608	3.978	+10.720 -6.597
II	Adjusted Live Weight	1.349	1.109	2.527	+7.062 -7.496
III	Carcass Weight	1.370	1.136	2.885	+9.685 -9.334
IV	Carcass and Ham Weight	0.716	0.667	1.688	+4.820 -5.372

[a]Average Absolute Error $= \frac{\Sigma Y - \hat{Y}}{n}$

[b]Average Absolute Percent Error $= \frac{\Sigma \left| \frac{Y - \hat{Y}}{Y} \right|}{n} \times 100.$

commercial packing plants. However, Model II does have a smaller standard error of estimate, average absolute error and average absolute percent error than any of the models except Model IV.

Model III offers an accurate, feasible technique for purchasing slaughter hogs by carcass merit. The average pricing error of \$1.136 is about \$.47 less than live weight method.

The equations for Model IV using actual ham weight as an explanatory variable in addition to carcass weight, sex and lumbar backfat have an average model error of \$0.67. Thus, the packer may reduce his average error from \$1.14 in Model III to \$.67 if he considers the value of the increased accuracy offsets the additional cost of weighing the individual hams. The average absolute percent error of 2.527 for Model II means that the model has an average error of about \$.63 for an estimated wholesale value of \$25 per hundredweight of carcass.

In addition to the data shown in Table XXIV, the percent error of actual value was calculated for Model III for each individual sample hog by the formula:

$$\frac{\text{Actual Value - Predicted Value}}{\text{Actual Value}} \text{ X } 100.$$

The individual percent errors were then plotted against carcass weight and lumbar backfat thickness, respectively, and are shown in Figures 8 and 9. Note that these errors are distributed much like a normal distribution, and do not appear to be skewed toward any particular weight or backfat measurement.

This chapter has presented simplified pricing models which may be used by either packers or producers when evaluating the merit of individual carcasses or live animals. The use of the equations as they are

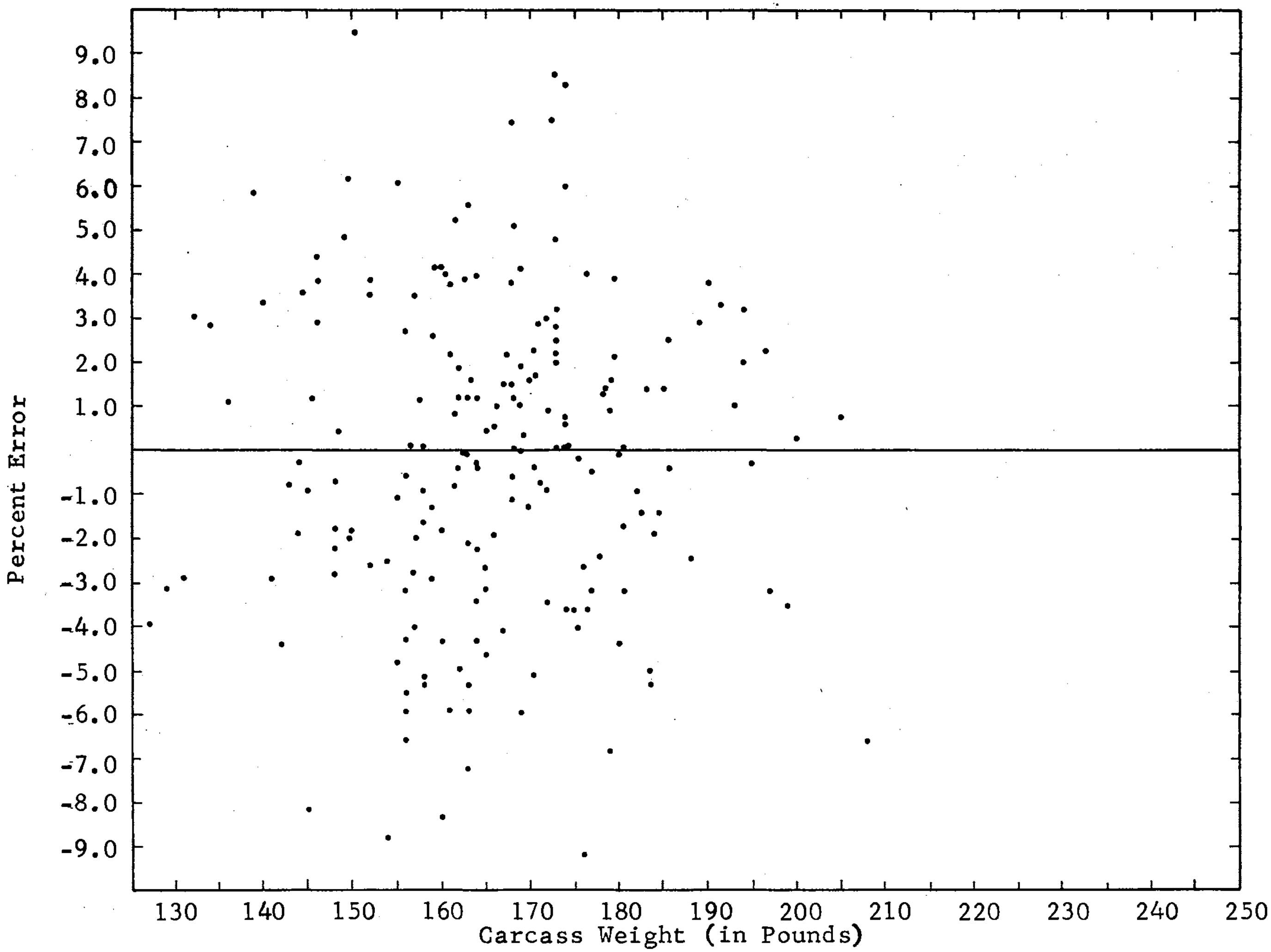

Figure 8. Individual Error of Estimate as a Percent of Actual Value for Each Carcass Weight Using Model III Equations for the Slaughter Hog Sample

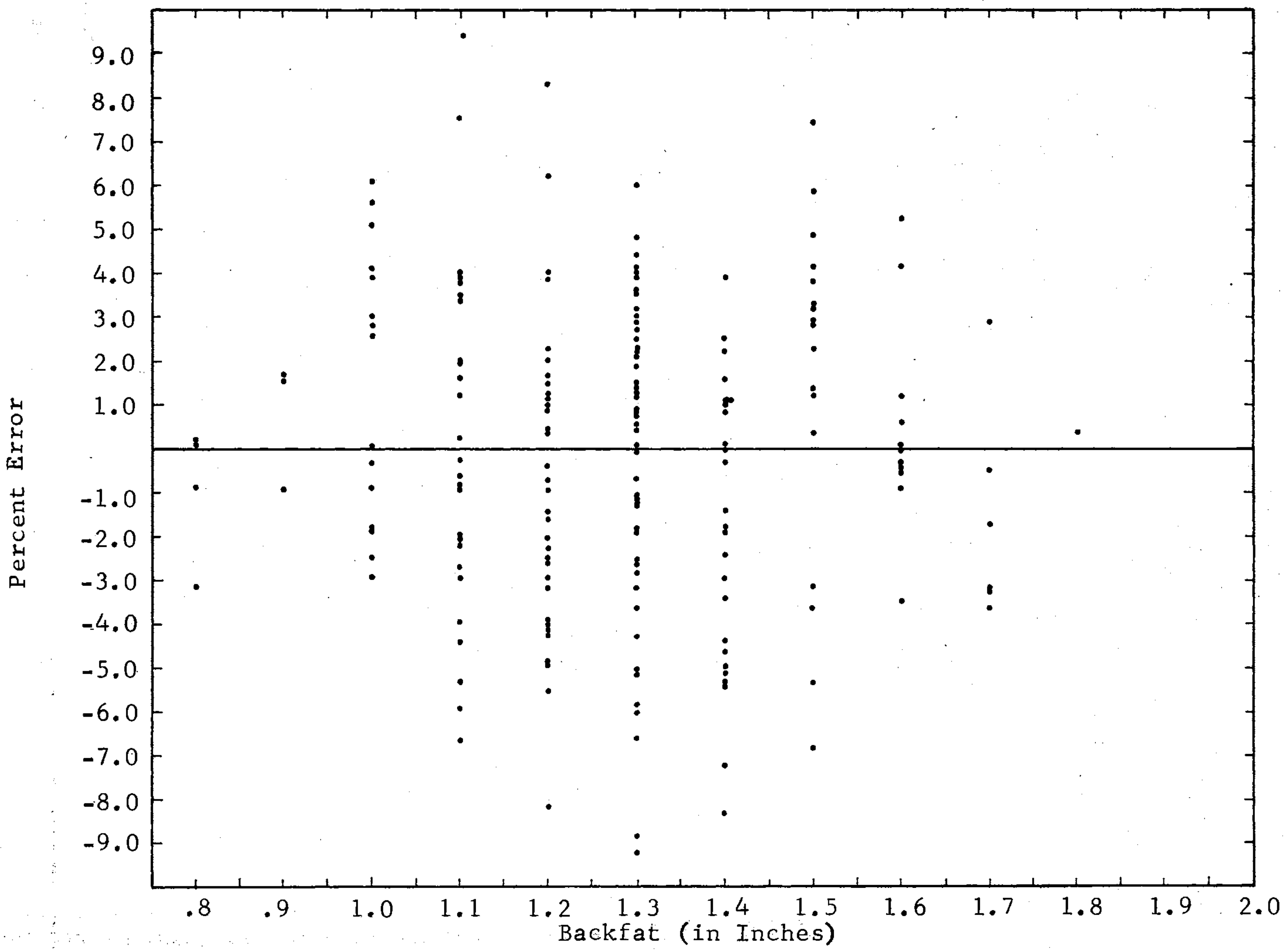

Figure 9. Individual Error of Estimate as a Percent of Actual Value for Each Lumbar Backfat Thickness Using Model III Equations for the Slaughter Hog Sample

presented in this study, however, require the assumption that this sample is representative of the population considered. Normally the preferred technique would be to take a sample from the appropriate population and perform a regression using the relationships indicated by this study. If a total hog cut-out sample were obtained then the model could be expanded to predict the yield of all wholesale cuts from any carcass. This would allow packers to use breakeven analysis in their raw material procurement decision providing they have knowledge of their cost function.

In all models the log of the product of lumbar backfat and body weight reduces the estimated weight of lean cuts and increases the estimated belly weight. All coefficients in these equations are significant at the 0.005 level. Of the three models not using ham weight, the model using adjusted live weight had the largest R^2 and smallest standard error of the estimates. The live weight model has the smallest R^2 and largest standard error of the estimates.

Many other variables were regressed on the individual primal cuts. In general, they added little to the explained variation, were not statistically significant at the 95 percent level, or their measurement was not practical in a slaughter or assembly line. These equations are included in Appendix B.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The objectives of this study were to review pricing techniques currently used in Oklahoma and to construct a model which could be used as a guide in determining the price for slaughter hogs as the yield and wholesale prices of the primal cuts vary.

Slaughter Hog Pricing Survey

Pricing techniques in Oklahoma were studied by interviewing the personnel responsible for slaughter hog procurement at several packing plants in the Oklahoma area. Also, questionnaires were mailed to many of the principal hog buyers in Oklahoma. The respondents to the questionnaire were responsible for the purchase of 960,000 slaughter hogs annually in the Oklahoma area. Of these slaughter hogs, 97.5 percent were purchased on a live weight basis. Generally, the maximum a buyer could bid was established by the packing firm and was related to the current prices of the various wholesale pork products. The current prices for fresh loins was indicated to be the most important single product price influencing bid prices for slaughter hogs.

The bid price varied with supply of slaughter animals in the area, which often is reflected by the USDA market quotations. The quotations given greatest importance for purchasing hogs in the Oklahoma area were those from Oklahoma City, Omaha, and Kansas City.

The most important live animal characteristics in determining the bid price were the live weight, estimated percent lean cuts, and fill. Buyers indicated that these characteristics would be more easily evaluated, that the pricing mechanism would be more accurate, and that generally, bids for high quality hogs would be higher if slaughter hogs were sorted by weight and grade prior to marketing.

Construction of Pricing Models

This study used a 192 slaughter hog sample to examine relationships useful in constructing a pricing model. Data for use in the analysis were collected on the live animals prior to slaughter, on the kill floor for warm carcass data and on the cutting floor for chilled carcass and primal cuts measurements. A total of 146 variables were examined for usefulness in constructing realistic pricing models using multiple regression analysis.

It was determined that in order to be useful equations must individually predict actual weights of the economically important cuts. Equations predicting aggregates such as the total lean cuts or primals cannot be valued because it is not possible to construct an aggregate price when the weights of the individual cuts are unknown and when prices change for the various weight classes of the lean cuts.

Four hog pricing models were developed which are shown in Table XXV. Model I is a live weight model which is appropriate as a guide in evaluating carcass merit from live animals. It may be valuable as a management tool for swine producers when there is an opportunity to measure individual live animals. Live hog buyers may find the model useful by calculating the most profitable live weight and backfat combinations for

TABLE XXV

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL WEIGHTS OF THE INDIVIDUAL PRIMAL CUTS USING LIVE WEIGHT (MODEL I), ADJUSTED LIVE WEIGHT (MODEL II), CARCASS WEIGHT (MODEL III), AND CARCASS WEIGHT AND ACTUAL HAM WEIGHT (MODEL IV)

	Constant	Live Weight	Gilt	Log (Lumbar Backfat x Live Weight)	Ham Weight	R^2	Standard Error of Estimate
MODEL I							
(1) Ham Weight	26.4097 (4.4152)	0.1952 (0.0119)	1.1425 (0.3085)	-14.6319 (2.3181)		0.6551	2.0189
(2) Loin Weight	25.4743 (3.7351)	0.1332 (0.0101)	0.8136 (0.2610)	-12.1349 (1.9611)		0.5433	1.7079
(3) Shoulder Weight	19.1995 (3.4484)	0.1564 (0.0092)		-10.1946 (1.7923)		0.6406	1.5998
(4) Belly Weight	-13.5536 (2.9061)	0.1056 (0.0077)		5.4060 (1.5104)		0.7015	1.3482

	Constant	Adj. Live Weight	Gilt	Log (Adjusted Live Weight x Lumbar Backfat)	Ham Weight	R^2	Standard Error of Estimate
MODEL II							
(1) Ham Weight	24.8951 (3.9586)	0.1912 (0.0099)	1.0810 (0.2757)	-13.8319 (2.0449)		0.7246	1.8042
(2) Loin Weight	24.3155 (3.4249)	0.1330 (0.0086)	0.7598 (0.2385)	-11.7520 (1.7692)		0.6185	1.5609
(3) Shoulder Weight	17.9148 (3.1537)	0.1510 (0.0078)		-9.3385 (1.6136)		0.7017	1.4574
(4) Belly Weight	-14.2359 (2.9608)	0.0945 (0.0073)		6.4583 (1.5149)		0.6926	1.3683

	Constant	Warm Carcass Weight	Gilt	Log (Lumbar Backfat x Warm Carcass Weight)	Ham Weight	R^2	Standard Error of Estimate
MODEL III							
(1) Ham Weight	28.0704 (3.8166)	0.2288 (0.0126)	1.0558 (0.2848)	-14.1425 (2.1154)		0.7066	1.8620
(2) Loin Weight	26.1317 (3.2779)	0.1591 (0.0108)	0.7470 (0.2446)	-11.9143 (1.8168)		0.5996	1.5992
(3) Shoulder Weight	20.6179 (2.9821)	0.1817 (0.0097)		-9.6459 (1.6382)		0.6938	1.4767
(4) Belly Weight	-10.2971 (2.7350)	0.1120 (0.0089)		6.1636 (1.5025)		0.6988	1.3543

	Constant	Warm Carcass Weight	Gilt	Log (Lumbar Backfat x Carcass Weight)	Ham Weight	R^2	Standard Error of Estimate
MODEL IV							
(1) Ham Weight	(Hams are weighed in this model)						
(2) Loin Weight	15.1581 (3.3209)	0.0696 (0.0160)	0.3343 (0.2262)	-6.3856 (1.8046)	0.3909 (0.0559)	0.6825	1.4277
(3) Shoulder Weight	8.3418 (2.9313)	0.0848 (0.0141)		-3.2716 (1.5891)	0.4026 (0.0496)	0.7780	1.2600
(4) Belly Weight	-1.6597 (2.8908)	0.1801 (0.0139)		1.6787 (1.5671)	-0.2832 (0.0470)	0.7476	1.2431

any given set of wholesale cut prices. The value of this technique, however, will be limited to the ability of live hog buyers to accurately estimate lumbar backfat thickness.

Model II also provides a tool for evaluating live slaughter hogs. Adjusted live weight allows the effect of fill to be considered. This system does require, however, the additional measurement of gut weight which may limit its usefulness as a pricing model for commercial packing plants.

Model III is suitable for purchasing by carcass merit. The use of the model requires only warm carcass weight and lumbar backfat measurements, both of which may be easily taken in the packer assembly lines with little time or effort.

Model IV involves the addition of actual ham weight as an explanatory variable to the set of equations composing Model III. The pricing accuracy is increased, but at an increased cost for obtaining the additional measurements.

In all of the models the lean cuts (ham, loin, and shoulder) have a positive relationship with the body weight and a negative curvilinear relationship with the indicator of fatness, the log of the product of weight and backfat. Increasing body weight, with backfat constant, increases lean cut weights; whereas increasing backfat for any body weight causes decreased lean cut weights. The opposite is true of the belly which is a fat cut.

The four pricing models were evaluated using the actual value of the sample primal weight observations as a standard for comparison with the values of the models' predictions for primal cut weight. Prices for these cuts were obtained from <u>The National Provisioner</u> [42].

Comparisons of the four models were made using the standard error of the estimate, the average absolute error, the average absolute percent error, and the range of percent error. With the exception of the range of percent error the models are ranked from greatest error to least error: I, III, II, and IV. The differences, however, between Model III and Model II is slight for these measurements. The average absolute error was 1.608, 1.109, 1.136, and 0.667 for Models I, II, III, and IV, respectively. The standard errors were 1.943 (Model I), 1.349 (Model II), 1.370 (Model III), and 0.716 (Model IV). When the range of percent error is used as the measure of model accuracy the ranking of models from greatest error to least error is III, I, II, and IV. This reflects only the presence of a small number of individuals in the sample for whom the model predictions were in greatest error and generally the maximum positive and negative errors are of equal magnitude.

The equations may be used with a computer to evaluate any carcass; or the model equations may be evaluated for one-tenth inch lumbar backfat thickness and 10 pound carcass weight increments, for example, and placed in tabular form for a hog buyer's use. Wholesale primal cut values in either case may be calculated using appropriate market prices for each cut. This procedure will give the buyer about 70 percent of the value of the carcass and will account for approximately 95 percent of the variation in the total value of the hog as its edible cuts vary. Although beyond the scope of this study, predicting equations using weight, last lumbar backfat thickness, and sex as explanatory variables could possibly be developed to estimate the other miscellaneous products. This would provide the user with the total expected cut-out for any market weight slaughter hog, allowing the calculations of total wholesale value for any carcass.

If the packers have knowledge of their average cost per carcass processed, then the returns above cost for any carcass class can be calculated. When the packers do not have specific cost information the model is still useful. There appears to be little variation in slaughter and cut up cost regardless of size differential in market weight animals. The model, therefore, can indicate the actual value difference between classes of carcasses. This provides the information to apply premiums or discounts for any class carcass without the need for specific slaughter and processing cost information.

The user may increase the accuracy of any model by including additional information or measurements. However, increasing accuracy is accompanied by the cost of increased measurements. This increased cost may often exceed the value of the improved accuracy.

If any packer feels this study's sample is not representative of the population from which he purchases slaughter hogs, similar equations to those presented here may be obtained from a sample of his selection.

Further Observations

The disadvantages of the current practice of buying on a live weight and grade system are well known and were discussed in Chapter I. Kohls [35] has listed the following criticism of the present method.

1. Consumer wants are not reflected accurately and quickly to producer. This leads to inefficient use of resources in production.

2. Farmers are paid on the basis of averages. Producers of high consumer value livestock get less than carcass value whereas producers of poor livestock get more.

3. Bruise and disease losses are shared by all producers.

4. The method encourages the wasteful practice of filling before selling.

5. Price and market information now is inaccurate.

Generally a system of carcass merit buying will meet these disadvantages.[1] If hogs are purchased on the basis of actual value derived from each individual animal then the farmer can be paid what his product is actually worth. He has specific price information about each animal. The producer would be able to more accurately evaluate his operation with regard to consumer preferences as measured in dollars. This would be a definite incentive to produce what consumers want most and would tend to increase pork's share of the consumer meat dollar as pork, because of higher quality, becomes more desirable to consumers.

Purchasing based on carcass weight would result in the live weight having little significance. The practice of excessive filling would not be profitable to producers. This would result in increased pricing accuracy and savings for the packer. The producer might gain by utilizing that feed in animals who have not yet reached market weight.

If all hogs were sold on a carcass yield method, research in swine genetics and nutrition could be made more effective by increased attention to the lean rate of gain. Bruise and disease loss could be assessed against the producer who owns the animals. This could mean added value to the careful producer. It would also increase pork production with no increase in the national herd size.

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[1] An excellent discussion of the comparative advantages and disadvantages of carcass purchasing procedures is contained in the publication by Engelman, Dowell, and Olson, Relative Accuracy of Pricing Butcher Hogs on Foot and by Carcass Grade and Yield, pp. 27-43 [20].

Suggestions for Further Research

This study was limited by the small size of the sample. There is a need for additional studies to verify the models developed here or to suggest additions. Such studies should include equations to predict the yields of the non primal cuts so that total wholesale value may be determined.

Meat packers and ultimately consumers would benefit from studies to develop and perfect optimum slaughter procurement programs. Such an optimum program would depend upon all the different possible products which may be obtained from the primal and other pork cuts (e.g., smoked vs. fresh hams), their wholesale prices, implant costs for each product, and the yields of these products from the different types of hogs.

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APPENDIX A

Confidential

Dept. of Agricultural Economics
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Stillwater, Oklahoma 74074

All information in this schedule will be kept in complete confidence. You will never be identified with any of the information which you provide. Questions may be answered by checking the appropriate blanks or filling in the proper numbers. Please feel free to comment on any of your answers.

1. a. How many slaughter hogs do you buy in an average year? ________

   b. What percentage of the above number of hogs did you purchase on
      (1) live weight basis _____%
      (2) carcass basis _____%

   Comment?

2. Are USDA grades useful to you in buying slaughter hogs?

   a. _____Yes
   b. _____No

   Comment?

3. Is the breed or cross of hogs important to you in arriving at a price offer?

   a. _____Yes
   b. _____No (If no, please skip question #4)

   Comment?

4. If you answered yes to question #3, what breeds or crosses do you consider most desirable? (List top 2 or 3)

   a. _________
   b. _________
   c. _________

   Least desirable?

   a. _________
   b. _________
   c. _________

Comment?

5. Does the sex of the pen of hogs influence your offering price?

   a. _____Yes
   b. _____No (If no, please skip question #6)

   Comment?

6. If yes to question #5, for which sex do you pay more, other things equal?

   a. _____Barrow
   b. _____Gilt

   Comment?

7. In establishing a base price for slaughter hogs, do you prefer to:

   a. _____"open the market"
   b. _____use a USDA market quotation as a guide

   Comment?

8. In pricing a pen of hogs of mixed grades (with respect to muscling and backfat) but similar weights, what do you primarily use as a basis? (Please check one of the following.)

   a. _____lowest grade of lot
   b. _____highest grade of lot
   c. _____average grade of lot
   d. _____mixed ones and twos
   e. _____sorted number ones
   f. _____carcass grade and yield
   g. _____Other (please specify) ____________________

   Comment?

9. What market price quotation do you feel is of most importance to you? (If you use more than one of the following, please rank in order of importance with 1 signifying most important.)

   a. _____Omaha
   b. _____Sioux City
   c. _____Oklahoma City
   d. _____Kansas City
   e. _____East St. Louis
   f. _____Other buyer or firm
   g. _____Other (please specify) ____________________

   Comment?

10. In pricing a pen of hogs with some variation in both weight and grade, do you primarily use: (Check one)

   a. _____average weight
   b. _____average weight & grade
   c. _____average weight & backfat
   d. _____estimated dressing percentage along with average weight & grade

Comment?

e. _____carcass grade & yield
f. _____Other (please specify)
____

11. When considering only the characteristics of a hog, please rank the following in their importance in determining your buying price: (A "1" would signify most important, "2" next in importance, etc. Leave blank those which do not affect your price.)

a. _____estimated % lean cuts
b. _____live weight
c. _____sex
d. _____breed
e. _____cleanliness
f. _____fill
g. _____dressing percentage
h. _____backfat
i. _____carcass length
j. _____Other (please specify)
____

Comment?

12. When considering market prices, please rank the following in order of their importance in affecting your buying price. (Use "1" to signify most important, "2" for next in importance, etc. Even if the wholesale prices do not affect you directly, please rank according to which you consider most important, next important, etc.)

a. _____USDA market price quotations
b. _____authorized price from your packer
c. _____wholesale prices of fresh hams
d. _____wholesale prices of fresh loins
e. _____wholesale prices of fresh shoulders
f. _____wholesale prices of fresh bellies
g. _____wholesale prices of byproducts

Comment?

The following questions are included to learn how you feel about the market pricing system. If you have some ideas which we have not included, please add them.

1. Are you satisfied with the way hog prices are reported?

a. _____Yes
b. _____No

Comment?

2. Would you offer a generally higher price if lots of hogs were sorted according to: (check those for which the answer would be yes)

a. _____weight
b. _____grade
c. _____sex
d. _____breed
e. _____none of above
f. _____Other (specify)
____

Comment?

3. Within the next 10 years, how do you think most hogs in Oklahoma will be sold? (Please check one)

   a. _____terminal
   b. _____auction
   c. _____direct (If you checked direct, please rank the following subheadings according to your feeling as to their future importance, using 1 as signifying most important.)

      (i) _____ live weight and grade
      (ii) _____ carcass grade and yield
      (iii) _____ forward contract buying based on future markets

   d. _____Other (specify)_____________________________

   Comment?

4. Other suggestions:

HOG DATA SHEET

LIVE HOG DATA

Lot No._____ Lot Weight_____ Distance hogs hauled to market_____ Temperature and weather________________ Date and time of weight of lot_______________ Date and time of live evaluation of individual hogs in the lot____________________ Expected date and time to slaughter_______________ Price per cwt.________________

Tattoo No.	Live Weight (lb)	Breed	Sex	Grader Estimates				
				Carcass Yield	Backfat th.(in)	Body Length (in)	Carcass Grade	Percent Lean Cuts
___	___	___	___	___	___	___	___	___

KILLING FLOOR DATA

Hot Carcass Weight (lb)	Gut Weight (lb)	Leaf Fat Weight (lb)	Estimated Carcass Grade	Yield	Adjusted Live Weight (Live-Guts) x 1.10
___	___	___	___	___	___

CHILLED CARCASS DATA

Carcass Weight (lb)	Body Length (tenths)	Backfat Thickness (tenths)				Estimated		Muscling				
		First Rib	Last Rib	Last Lumbar	Average Backfat Thickness	Percent L.C.	Percent Ham	Ham (1-6)	Shoulder (1-6)	Loin (1-6)	Belly (1-6)	Carcass Grade
___	___	___	___	___	___	___	___	___	___	___	___	___

CUTTING FLOOR DATA

Hams (lb)	Loins (lb)	Picnics (lb)	Butts (lb)	Total Lean Cuts (lb)	Bellies (lb)	Spare Ribs (lb)
___	___	___	___	___	___	___

APPENDIX B

TABLE XXVI

REGRESSION RESULTS FOR EQUATIONS USING CARCASS WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE HAM WEIGHT

	Constant	Warm Carcass Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Carcass Weight	Log of Lumbar Backfat x Carcass Weight	Average Backfat x Carcass Weight	Gilt	Carcass Length	Yield	Carcass Weight Squared	Lumbar Backfat x Carcass Weight Squared	R^2	Standard Error of Estimate
Ham Weight	2.3380	0.2063	-4.3712					1.0247					0.7056	1.8655
	(0.6084)	(0.0085)	(0.7173)					(0.2865)						
Ham Weight	6.3425	0.1897	-4.8834					1.0223	0.0549				0.7057	1.8701
	(5.5139)	(0.0114)	(0.7517)					(0.2873)	(0.2004)					
Ham Weight	0.8792	0.1889		-14.0727				1.0386		3.2064			0.7066	1.8672
	(5.9135)	(0.0126)		(2.1445)				(0.2862)		(9.1839)				
Ham Weight	0.7612	0.2414			-0.0337								0.6874	1.9172
	(1.6275)	(0.0126)			(0.0045)									
Ham Weight	30.4906	0.2403				-15.8320							0.6852	1.9238
	(3.8850)	(0.0126)				(2.1342)								
Ham Weight	-0.9616	0.2446	1.9510		-0.0417			1.0092					0.7070	1.8660
	(9.3816)	(0.0572)	(7.2903)		(0.0440)			(0.2871)						
Ham Weight	-3.0757	0.2441	2.1926		-0.0429			1.0057	0.0704				0.7072	1.8704
	(11.1739)	(0.0573)	(7.3400)		(0.0443)			(0.2879)	(0.2011)					
Ham Weight	0.0124	0.2548					-0.0387	0.9021	0.0072				0.6994	1.8900
	(5.4403)	(0.0183)					(0.0063)	(0.2964)	(0.2041)					
Ham Weight	27.9815	0.2300			-14.1444			1.0553			$-.3x10^{-5}$		0.7066	1.8669
	(12.0119)	(0.1444)			(2.1347)			(0.2925)			(0.0004)			
Ham Weight	9.4518	0.0967						1.0553			0.0004	$-0.6x10^{-4}$	0.7037	1.8764
	(11.8839)	(0.1430)						(0.2943)			(0.0004)	$(.1x10^{-4})$		
Ham Weight	21.9644	0.1884			-9.6397			1.0420			0.0001	$-0.2x10^{-4}$	0.7076	1.8688
	(14.2184)	(0.1537)			(6.0699)			(0.2932)			(0.0005)	$(0.3x10^{-4})$		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXVII

REGRESSION RESULTS FOR EQUATIONS USING LIVE WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE HAM WEIGHT

	Constant	Live Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Live Weight	Gilt	Carcass Length	Yield	Yorkshire	Red Cross	White Cross	Hampshire	R^2	Standard Error of Estimate
Ham Weight	3.5557	0.1723	-5.7813										0.6310	2.0828
	(2.0395)	(0.0096)	(0.8127)											
Ham Weight	-2.1971	0.1725		-16.5066									0.6300	2.0857
	(2.0452)	(0.0097)		(2.3360)										
Ham Weight	-3.9224	0.2074			-0.0270								0.6344	2.0731
	(2.0910)	(0.0119)			(0.0037)									
Ham Weight	-1.3805	0.1658		-14.5976		1.1334							0.6547	2.0203
	(1.9935)	(0.0095)		(2.3218)		(0.3091)								
Ham Weight	-30.5611	0.1440		-14.1893		1.0180		44.4962					0.7065	1.8676
	(5.4042)	(0.0096)		(2.1475)		(0.2864)		(7.7466)						
Ham Weight	-31.4017	0.1739			-0.0229	0.9884		43.5872					0.7069	1.8663
	(5.4073)	(0.0118)			(0.0035)	(0.2872)		(7.7468)						
Ham Weight	0.5575	0.1780			-0.0165	1.1127			-2.6707	0.2036	-1.2664	-0.0085	0.7818	1.6233
	(1.9319)	(0.0106)			(0.0031)	(0.2567)			(0.4273)	(0.5194)	(0.4964)	(0.5002)		
Ham Weight	5.1122	0.1565	-3.5185			1.1278			-2.6890	0.1905	-1.2705	-0.0136	0.7806	1.6278
	(1.8850)	(0.0088)	(0.6814)			(0.2570)			(0.4281)	(0.5207)	(0.4978)	(0.5016)		
Ham Weight	9.0887	0.1620	-3.5970			1.1472	-0.1641		-2.7688	0.0959	-1.2704	-0.0743	0.7815	1.6288
	(4.8861)	(0.0107)	(0.6876)			(0.2581)	(0.1860)		(0.4378)	(0.5319)	(0.4981)	(0.5066)		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXVIII

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATIONS IN THE LOG OF HAM WEIGHT

	Constant	Log of Warm Carcass Weight	Log of Live Weight	Log of Adjusted Live Weight	Adjusted Live Weight	Log of Average Backfat x Carcass Weight	Log of Average Backfat x Live Weight	Log of Lumbar Backfat x Live Weight	Log of Average Backfat x Adjusted Live Weight	Log of Lumbar Backfat x Adjusted Live Weight	Gilt	Log of Carcass Length	Log of Carcass Length x Carcass Weight	R^2	Standard Error of Estimate
Log Ham Weight	-0.6051	1.2612				-0.2710					0.0115		-0.0080	0.7089	0.0239
	(0.2289)	(0.2348)				(0.0432)					(0.0037)		(0.1814)		
Log Ham Weight	-1.4618					-0.1642					0.0137		0.9101	0.6640	0.0256
	(0.1760)					(0.0411)					(0.0040)		(0.0651)		
Log Ham Weight	-0.6051	1.2532				-0.2710					0.0115	-0.0080		0.7089	0.0239
	(0.2289)	(0.0881)				(0.0432)					(0.0037)	(0.1814)			
Log Ham Weight	-0.9466		1.2486					-0.1851			0.0145			0.6603	0.0258
	(0.1401)		(0.0758)					(0.0296)			(0.0039)				
Log Ham Weight	-0.9928		1.3443				-0.2524				0.0137			0.6449	0.0263
	(0.1485)		(0.0954)				(0.0467)				(0.0041)				
Log Ham Weight	1.4038				0.0025					-0.1744	0.0145			0.7316	0.0229
	(0.0502)				(0.0001)					(0.0260)	(0.0035)				
Log Ham Weight	-1.0265			1.3636					-0.2592		0.0123			0.7231	0.0233
	(0.1241)			(0.0806)					(0.0408)		(0.0036)				

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXIX

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE PERCENT HAM OF WARM CARCASS WEIGHT

	Constant	Warm Carcass Weight	Average Backfat	Lumbar Backfat	Average Backfat x Carcass Weight	Lumbar Backfat x Carcass Weight	Log of Lumbar Backfat x Carcass Weight	Gilt	Barrow	Carcass Length x Carcass Weight	R^2	Standard Error of Estimate
Percent Ham	27.1035 (1.3200)	-0.0028 (-4.5327)	0.0077 (0.7519)								0.1860	1.4794
Percent Ham	27.4293 (1.3140)	-0.0074 (0.0079)	-4.0105 (0.7789)						-0.5117 (0.2251)		0.2070	1.4640
Percent Ham	28.5893 (10.0894)	-0.0118 (0.0612)	-5.5795 (7.0740)		0.0063 (0.0425)						0.1861	1.4832
Percent Ham	27.2181 (7.8181)	-0.0095 (0.0478)	-4.7597 (5.4519)		0.0052 (0.0330)			0.5267 (0.1777)			0.2821	1.1299
Percent Ham	25.9317 (1.2443)	-0.0085 (0.0074)		-3.4179 (0.5623)							0.1880	1.4777
Percent Ham	24.2729 (7.2929)	0.0016 (0.0442)		-2.1079 (5.7022)		-0.0079 (0.0343)					0.1882	1.4812
Percent Ham	22.9853 (5.6255)	0.0055 (0.0343)		-1.3650 (4.3716)		-0.0098 (0.0264)		0.5842 (0.1721)			0.2959	1.1189
Percent Ham	44.6753 (14.0679)	0.0293 (0.0266)		1.7830 (3.4266)			-13.6945 (9.7859)	0.6178 (0.1724)			0.3027	1.1135
Percent Ham	25.3759 (0.8620)			-3.0083 (0.4393)					-0.5832 (0.1715)	-0.0002 (0.0002)	0.2943	1.1172

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXX

REGRESSION RESULTS FOR EQUATIONS USING CARCASS WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE LOIN WEIGHT

	Constant	Warm Carcass Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Carcass Weight	Log of Lumbar Backfat x Carcass Weight	Gilt	Yield	Carcass Length	Carcass Length x Carcass Weight	Ham Weight	R^2	Standard Error of Estimate
Loin Weight	9.0411 (1.4018)	0.1322 (0.0084)	-4.5357 (0.6336)									0.5779	1.6376
Loin Weight	4.4763 (1.3466)	0.1329 (0.0083)		-13.2552 (1.8107)								0.5820	1.6297
Loin Weight	4.8894 (1.3265)	0.1270 (0.0083)		-12.0402 (1.8199)			0.7308 (0.2447)					0.6009	1.5966
Loin Weight	-1.0896 (5.0496)	0.1196 (0.0107)		-11.7652 (1.8312)			0.7254 (0.2444)	9.6227 (7.8424)				0.6041	1.5944
Loin Weight	27.8441 (3.3000)	0.1672 (0.0107)				-13.1097 (1.8128)						0.5797	1.6341
Loin Weight	5.2944 (1.0718)										0.5913 (0.0317)	0.6470	1.4937
Loin Weight	9.5122 (1.6856)	-0.0433 (0.0403)								0.0045 (0.0011)		0.5060	1.7716
Loin Weight	-19.5794 (9.2610)	0.1831 (0.0475)	5.7911 (6.0834)		-0.0580 (0.0367)		0.6760 (0.2386)		0.6236 (0.1666)			0.6278	1.5502
Loin Weight	3.7702 (1.3708)	0.1596 (0.0109)			-0.0251 (0.0038)		0.7116 (0.2461)					0.5990	1.6004

[a] Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXI

REGRESSION RESULTS FOR EQUATIONS USING LIVE WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE LOIN WEIGHT

	Constant	Live Weight	Lumbar Backfat	Average Backfat x Live Weight	Gilt	Yield	Carcass Length	Live Weight Squared	Average Backfat x Live Weight Squared	Ham Weight	Yorkshire	Red Cross	White Cross	Hampshire	R^2	Standard Error of Estimate
Loin Weight	6.6080 (1.6782)	0.1085 (0.0081)	-4.1731 (0.6877)		0.7944 (0.2628)										0.5403	1.7134
Loin Weight	-25.6927 (4.7160)	0.1322 (0.0120)		-0.0255 (0.0040)	0.5802 (0.2508)	39.1700 (6.6325)									0.6023	1.5979
Loin Weight	-16.7046 (4.6526)	0.0911 (0.0082)	-4.0296 (0.6431)		0.7059 (0.2461)	35.3557 (6.6433)									0.6008	1.6011
Loin Weight	-5.6245 (16.5346)	0.2027 (0.1525)		-0.0243 (0.0044)	0.6960 (0.2767)			-0.0001 (0.0003)							0.5285	1.7400
Loin Weight	-7.4451 (17.7823)	0.2316 (0.1838)		-0.0328 (0.0303)	0.6960 (0.2773)			-0.0002 (0.0004)	0.13×10^{-4} (0.47×10^{-4})						0.5287	1.7443
Loin Weight	-5.4168 (4.3698)	0.0962 (0.0096)	-2.5864 (0.6149)		0.8663 (0.2309)		0.4474 (0.1664)				-1.8933 (0.3916)	-0.6597 (0.4757)	-0.5972 (0.4455)	0.3420 (0.4531)	0.6766	1.4567
Loin Weight	5.4221 (1.7152)	0.1111 (0.0080)	-2.8005 (0.6200)		0.9192 (0.2339)						-2.1109 (0.3895)	-0.9173 (0.4738)	-0.5967 (0.4529)	0.1766 (0.4564)	0.6638	1.4811
Loin Weight	3.7444 (1.6358)	0.0598 (0.0123)	-1.6458 (0.6204)		0.5491 (0.2299)					0.3282 (0.0627)	-1.2285 (0.4015)	-0.9798 (0.4432)	-0.1797 (0.4310)	0.1811 (0.4269)	0.7076	1.3852

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXII

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN LOG OF LOIN WEIGHT

	Constant	Log of Warm Carcass Weight	Log of Live Weight	Log of Adjusted Live Weight	Adjusted Live Weight	Log of Average Backfat x Warm Carcass Weight	Log of Average Backfat x Live Weight	Log of Lumbar Backfat x Live Weight	Log of Average Backfat x Adjusted Live Weight	Log of Lumbar Backfat x Adjusted Live Weight	Gilt	Log of Carcass Length	Log of Carcass Length x Warm Carcass Weight	R^2	Standard Error of Estimate
Log Loin Weight	-1.2954	1.0730				-0.2826					0.0100	0.6600		0.6277	0.0269
	(0.2570)	(0.0990)				(0.0485)					(0.0042)	(0.2037)			
Log Loin Weight	-1.2954	0.4129				-0.2826					0.0100		0.6600	0.6277	0.0269
	(0.2570)	(0.2636)				(0.0485)					(0.0042)		(0.2037)		
Log Loin Weight	-0.8669		1.2785				-0.2916				0.0123			0.5347	0.0299
	(0.1688)		(0.1085)				(0.0531)				(0.0047)				
Log Loin Weight	-0.8055		1.1589					-0.2085			0.0134			0.5508	0.0294
	(0.1600)		(0.0866)					(0.0338)			(0.0045)				
Log Loin Weight	1.3724				0.0023					-0.1993	0.0133			0.6221	0.0270
	(0.0592)				(0.0001)					(0.0306)	(0.0041)				
Log Loin Weight	-0.9506			1.3268					-0.3053		0.0106			0.6234	0.0269
	(0.1437)			(0.0934)					(0.0473)		(0.0042)				
Log Loin Weight	-1.5759					-0.2476					0.0107		0.9606	0.6228	0.0270
	(0.1851)					(0.0433)					(0.0042)		(0.0685)		

[a] Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXIII

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE SHOULDER WEIGHT

	Constant	Warm Carcass Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Warm Carcass Weight	Log of Lumbar Backfat x Warm Carcass Weight	Gilt	Yield	Carcass Length x Carcass Weight	Ham Weight	R^2	Standard Error of Estimate
Shoulder Weight	6.8084	0.1559	-3.3752								0.6942	1.4757
	(1.2633)	(0.0075)	(0.5710)									
Shoulder Weight	3.4318	0.1562		-9.6886							0.6941	1.4759
	(1.2195)	(0.0075)		(1.6398)								
Shoulder Weight	3.6301	0.1538		-9.1053			0.3508				0.6980	1.4703
	(1.2216)	(0.0077)		(1.6760)			(0.2253)					
Shoulder Weight	2.5388	0.1816			-0.0202						0.6932	1.4780
	(1.2547)	(0.0097)			(0.0034)							
Shoulder Weight	20.6179	0.1816				-9.6459					0.6938	1.4767
	(2.9821)	(0.0097)				(1.6382)						
Shoulder Weight	4.8701	0.1293							0.0004		0.6379	1.6057
	(1.5278)	(0.0365)							(0.0010)			
Shoulder Weight	3.0292	0.1530		-9.0777			0.3503	0.9670			0.6981	1.4742
	(4.6689)	(0.0099)		(1.6932)			(0.2259)	(7.2511)				
Shoulder Weight	19.7895	0.1776				-9.0676	0.3614				0.6979	1.4705
	(3.0142)	(0.0100)				(1.6707)	(0.2249)					
Shoulder Weight	6.1149									0.6614	0.7221	1.4029
	(1.0067)									(0.0298)		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXIV

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE BELLY WEIGHT

	Constant	Warm Carcass Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Warm Carcass Weight	Log of Lumbar Backfat x Warm Carcass Weight	Gilt	Yield	Ham Weight	Yorkshire	Red Cross	R^2	Standard Error of Estimate
Belly Weight	-1.4922	0.1283	2.1856									0.6997	1.3523
	(1.1576)	(0.0069)	(0.5232)										
Belly Weight	0.6802	0.1283		6.1532								0.6986	1.3547
	(1.1194)	(0.0069)		(1.5051)									
Belly Weight	1.3432	0.1104			0.0138							0.7023	1.3465
	(1.1430)	(0.0089)			(0.0031)								
Belly Weight	-10.2971	0.1120				6.1636						0.6988	1.3543
	(2.7350)	(0.0089)				(1.5025)							
Belly Weight	-9.6089	0.1153				5.6832	-0.3002					0.7021	1.3503
	(2.7678)	(0.0091)				(1.5341)	(0.2065)						
Belly Weight	-1.6594	0.1801				1.6780	-0.0012		-0.2832			0.7476	1.2464
	(2.8992)	(0.0140)				(1.5754)	(0.1975)		(0.0488)				
Belly Weight	0.5135	0.1303		5.6628			-0.2949					0.7018	1.3510
	(1.1225)	(0.0070)		(1.5400)			(0.2070)						
Belly Weight	11.7826	0.1460		5.1444			-0.2847	-18.1368				0.7137	1.3275
	(4.2044)	(0.0089)		(1.5247)			(0.2035)	(6.5296)					
Belly Weight	-8.0512	0.1207				4.5323	-0.3441			0.5791	-0.2949	0.7202	1.3157
	(2.8770)	(0.0092)				(1.5624)	(0.2034)			(0.2202)	(0.3355)		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXV

REGRESSION RESULTS FOR EQUATIONS USING CARCASS WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE TOTAL LEAN CUTS WEIGHT

	Constant	Warm Carcass Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Warm Carcass Weight	Log of Lumbar Backfat x Warm Carcass Weight	Gilt	Yield	Yorkshire	Red Cross	R^2	Standard Error of Estimate
Total Lean	23.6678	0.4864	-13.4414								0.7547	3.9699
Cuts Weight	(3.3983)	(0.0203)	(1.5359)									
Total Lean	10.1915	0.4879		-38.8380							0.7559	3.9600
Cuts Weight	(3.2722)	(0.0202)		(4.3998)								
Total Lean	6.5419	0.5908			-0.0816						0.7560	3.9590
Cuts Weight	(3.3607)	(0.0261)			(0.0092)							
Total Lean	78.9525	0.5892				-38.5876					0.7549	3.9681
Cuts Weight	(8.0136)	(0.0261)				(4.4023)						
Total Lean	11.3910	0.4735		-35.3099			2.1221				0.7717	3.8399
Cuts Weight	(3.1904)	(0.0200)		(4.3771)			(0.5884)					
Total Lean	2.8189	0.4616		-34.9156			2.1143	13.7962			0.7724	3.8447
Cuts Weight	(12.1764)	(0.0259)		(4.4157)			(0.5893)	(18.9107)				
Total Lean	58.2900	0.5410				-25.7370	2.6162		-4.6437	-0.1412	0.8485	3.1448
Cuts Weight	(6.8765)	(0.0220)				(3.7343)	(0.4862)		(0.5264)	(0.8019)		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXVI

REGRESSION RESULTS FOR EQUATIONS USING LIVE WEIGHT AND OTHER SELECTED VARIABLES TO EXPLAIN VARIATION IN THE TOTAL LEAN CUTS WEIGHT

	Constant	Live Weight	Lumbar Backfat	Log of Lumbar Backfat	Lumbar Backfat x Live Weight	Log of Lumbar Backfat x Live Weight	Gilt	Yield	Yorkshire	Red Cross	R^2	Standard Error of Estimate
Total Lean	13.4600	0.4214	-14.0219								0.6902	4.4611
Cuts Weight	(4.3684)	(0.0206)	(1.7407)									
Total Lean	-0.5295	0.4221		-40.2427							0.6902	4.4613
Cuts Weight	(4.3747)	(0.0207)		(4.9966)								
Total Lean	-4.6504	0.5062			-0.0654						0.6934	4.4384
Cuts Weight	(4.4766)	(0.0256)			(0.0080)							
Total Lean	75.8042	0.5027				-40.1118					0.6898	4.4641
Cuts Weight	(9.6228)	(0.0256)				(5.0012)						
Total Lean	1.1708	0.4082		-36.2673			2.3602				0.7098	4.3294
Cuts Weight	(4.2720)	(0.0204)		(4.9755)			(0.6624)					
Total Lean	-73.9885	0.3521		-35.2158			2.0630	114.6073			0.7727	3.8420
Cuts Weight	(11.1174)	(0.0197)		(4.4179)			(0.5893)	(15.9363)				
Total Lean	52.6820	0.4658				-26.9101	2.7787		-5.1225	0.8479	0.8159	3.4667
Cuts Weight	(8.1114)	(0.0209)				(4.1388)	(0.5356)		(0.5835)	(0.8735)		

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXVII

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE PERCENT LEAN CUTS OF WARM CARCASS WEIGHT

	Constant	Warm Carcass Weight	Log of Warm Carcass Weight	Lumbar Backfat	Average Backfat	Log of Average Backfat	Average Backfat x Carcass Weight	Carcass Length	Grade	Estimated Grade	R^2	Standard Error of Estimate
Percent Lean Cuts	67.8040	-0.0284		-8.2973							0.3167	2.6147
	(2.2018)	(0.0130)		(0.9950)								
Percent Lean Cuts	70.7542	-0.0142			-11.1446						0.3195	2.6094
	(2.3282)	(0.0136)			(1.3261)							
Percent Lean Cuts	71.4479	-0.0132			-12.0311				0.2678		0.3202	2.6146
	(2.7582)	(0.0137)			(2.3024)				(0.5680)			
Percent Lean Cuts	71.0504	-0.0160			-10.7886					-0.3495	0.3224	2.6105
	(2.3514)	(0.0137)			(1.3824)					(0.3812)		
Percent Lean Cuts	70.8393	-0.0141			-11.1484			-0.0032			0.3196	2.6161
	(7.7062)	(0.0164)			(1.3679)			(0.2751)				
Percent Lean Cuts	70.8093	-0.0145			-11.1834		0.0002				0.3196	2.6161
	(17.8035)	(0.1080)			(12.4827)		(0.0751)					
Percent Lean Cuts	64.1864	-0.0327		-8.2073				0.1379			0.3176	2.6197
	(7.4688)	(0.0156)		(1.0125)				(0.2719)				
Percent Lean Cuts	68.6789		-4.7778			-36.7748					0.3250	2.5988
	(11.1727)		(5.1421)			(4.3023)						

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

TABLE XXXVIII

REGRESSION RESULTS FOR EQUATIONS EXPLAINING VARIATION IN THE TOTAL PRIMALS WEIGHT

	Constant	Warm Carcass Weight	Live Weight	Lumbar Backfat	Log of Lumbar Backfat	Log of Lumbar Backfat x Warm Carcass Weight	Log of Lumbar Backfat x Live Weight	Gilt	Yield	Ham Weight	R^2	Standard Error of Estimate
Primal Weight	22.1217 (2.9481)	0.6024 (0.0179)		-10.1682 (1.3700)				1.8045 (0.5289)			0.8681	3.4440
Primal Weight	11.9045 (2.8465)	0.6038 (0.0179)			-29.6471 (3.9053)			1.8271 (0.5250)			0.8695	3.4261
Primal Weight	14.6015 (10.8776)	0.6075 (0.0231)			-29.7711 (3.9447)			1.8296 (0.5264)	-4.3406 (16.8936)		0.8696	3.4346
Primal Weight											0.8692	3.4298
Primal Weight	21.9488 (4.5471)	0.3330 (0.0219)				-8.1719 (2.4649)				1.5318 (0.0739)	0.9575	1.9554
Primal Weight	-29.3005 (12.1593)		0.5239 (0.0215)				-30.1600 (3.9408)	1.7829 (0.5255)	128.5236 (14.2283)		0.8698	3.4304

[a]Standard deviations appear in parenthesis below the estimates; weight for all variables is in pounds; backfat and length are measured in inches.

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