Pricing Practices on the Peoria Hog Market

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Pricing Practices on the Peoria Hog Market

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SALABLE HOG RECEIPTS at Peoria have followed a pattern similar to that of other terminal markets in recent years. While total marketings showed little change, there was a pronounced decrease in the salable receipts beginning in 1956 (Table 1).

At the Peoria market there was definite evidence of a shift from terminal to direct country buying by major packers. As shown in Table 2, the proportion of hogs coming to the market for sale has decreased considerably while the proportion bought directly at the country points has greatly increased. This trend in market flow and the changing importance of terminal markets has been widely discussed in recent years. It was the motivating factor for making this study.

The purpose of the study was to determine how butcher hog prices at the Peoria market were affected by average weight of the hogs, size of lot in which they were sold, season, day of week, pricing practices of buying and selling firms, and the salable receipts at 12 major midwestern hog markets.

A related objective was to determine if meatiness and uniformity within lots, as determined by visual appraisal, had a significant effect on prices paid. This aspect of the study was concerned with three questions: Were premiums paid for meaty hogs? If so, what were these premiums? Could an observer differentiate for value differences among lots of hogs marketed?

Source of Data

Data were collected for the following time periods:

September 14 through 25, 1959.
November 30 through December 11, 1959.
February 15 through 26, 1960.
June 20 through July 1, 1960.

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Table 1. — Salable Hog Receipts at 12 Major Terminal Markets, National Stock Yards (St. Louis), Chicago, and Peoria, and Total Hog Marketings for the United States, East North-Central States, Iowa, Missouri, and Illinois, 1947-1962

	Salable receipts				Total marketings			
	12 terminals	NSY	Chicago	Peoria	U. S.	ENC and Iowa	ENC, Iowa and Missouri	Illinois
	(1,000 head)							
1947	13,065	2,140	1,949	740	63,499	35,176	39,623	7,489
1948	14,805	2,368	2,389	790	61,790	32,733	36,945	7,177
1949	16,391	2,520	2,485	848	69,249	37,817	42,870	7,869
1950	17,323	2,770	2,579	971	71,969	40,377	45,999	8,221
1951	18,902	3,073	2,701	1,083	79,316	43,748	49,776	9,287
1952	17,097	2,823	2,883	1,161	81,506	44,989	50,480	9,622
1953	14,951	2,224	2,261	1,004	70,513	41,822	46,998	9,182
1954	15,095	2,208	2,197	956	69,360	40,716	45,752	8,722
1955	18,029	2,532	2,741	1,109	75,381	43,156	48,025	9,299
1956	18,337	3,242	2,416	1,162	78,407	44,248	50,129	10,143
1957	16,112	3,139	2,029	1,044	74,618	42,375	47,980	9,948
1958	15,652	2,727	2,074	1,034	73,835	41,892	47,279	10,027
1959	18,449	3,238	2,235	1,106	84,379	47,452	53,201	11,236
1960	16,429	3,059	1,780	929	80,087	45,327	51,016	10,651
1961	15,619	2,606	1,687	857	80,065	45,038	50,809	10,864
1962	16,315	2,574	1,722	893	81,660	45,893	51,658	11,468

Source: *Agricultural Statistics*, USDA, 1947-56. *Livestock and Meat Statistics*, USDA, 1957-62.

Table 2. — Salable and Direct Hog Receipts at the Peoria Union Stock Yards, 1947-1963

	Peoria salable receipts	Peoria direct receipts	Salable as a percent of total receipts
	(1,000 head)		
1947	740	29	96.2
1948	790	68	92.1
1949	848	15	98.3
1950	971	30	97.0
1951	1,083	29	97.4
1952	1,161	24	98.0
1953	1,004	68	93.6
1954	956	87	91.6
1955	1,109	135	89.1
1956	1,162	208	84.8
1957	1,044	244	81.1
1958	1,034	241	81.1
1959	1,106	322	77.5
1960	929	406	70.0
1961	857	463	64.9
1962	893	602	59.7
1963	929	690	57.0

Source: Peoria Union Stock Yards Co. records.

These periods represent peaks and troughs in the seasonal hog pricing pattern. They also avoid seasons affected by holidays and other short-term disturbances in the normal pricing relationships.

The raw data were obtained by collecting sales invoices for all transactions made during the sample periods. The data included date of sale, number of hogs in the lot, total weight of the lot, price per 100 pounds, selling firm, and buying firm.

During the June, 1960, period, every lot of hogs sold on the Peoria market was evaluated for meatiness, degree of uniformity in weight, and conformation. An attempt was made to also identify the predominant breed of each lot. The bases for classification are shown in the appendixes.

The recorders who gathered the information for this phase of the study had been trained in how to differentiate for quality, conformation, and weight. They graded hogs under supervision to learn how to consider basic differences in loads of hogs as they were being weighed to the buyers. These men were stationed at each scale weighing hogs at the market, and they were rotated to different scales each day.

The identity of the buyers and sellers, weight, breed, size of lot, price, and meat-type characteristics of each lot were observed for all hogs marketed. Each individual sale was evaluated, recorded, and summarized. The results are indicated later in this report.

Methods of Study and Analysis

Hogs selling for less than $10 per 100 pounds were considered "junk" (runts, ruptures, etc.) and were not included in the analysis. Boars were also excluded from the analysis, it being assumed that neither boars nor "junk" had an appreciable effect on the market pricing structure for the normal run of butcher hogs.

Only hogs weighing 170-270 pounds were considered in the analysis. Those under 170 pounds were considered as feeder pigs, and weights over 270 pounds were excluded from the butcher class.

Average weights and prices were computed for each lot of hogs marketed. The lots were classified into 10-pound average weight classes (170-180, 180-190, 190-200 pounds, etc.) or into combined weight classes (180-200, 200-220, 220-240, 240-270 pounds), depending on the particular phase of the analysis. All lots falling within designated weight classes were accumulated, and weighted average prices for the various weight classes were determined and compared.

The average price paid per 100 pounds was adjusted for marketing charges so that comparisons could be made on a net price paid to pro-

ducers. Marketing charges included yardage, commission, yard insurance, feed, and National Livestock and Meat Board deductions.

A deviation price was determined for each transaction (each lot of hogs sold). This was done by first calculating a daily base price, which was the weighted daily average price of all 200-220 pound hogs. Then the average price paid for each lot of hogs was expressed as a plus or minus deviation from this daily base price. The use of deviation prices rather than average prices had the effect of eliminating seasonal changes in the price level, thus facilitating the comparison of prices for lots sold at different times of the year.

Least squares multiple regression analysis with the use of dummy variables[1] was used to determine the influence that weight, size of lot, day of sale, time period, and buyers and sellers (independent variables) had on the dependent variable, the deviation price. The first phase of the analysis in the Peoria market study dealt with all four time periods. The meatiness aspects of market pricing were considered in another evaluation in which data for the June period only were evaluated.

The models for the combined period analysis of pricing practices were set up as shown in Appendix A. The models for evaluating the effects of relations among meatiness, conformation, and weight as factors in pricing in the June period are shown in Appendix B.

The resulting regression coefficients (b's) were tested for significance using the test statistic $t = \frac{b}{S_b}$. With dummy variables the test amounts to a test of the difference between the average of deviation prices for the base class and for any other class of a given set of dummy variables. The symbol b in the test statistic stands not only for b_1, b_2, b_3, or b_4 (Appendix A), but also for any coefficient represented by a subscripted capital in the models.

Combined Period Analysis of Pricing Practices

Weight as a Continuous Variable

Average weight and average weight squared were used in Model I to measure the curvilinear relation of weight to the dependent variable.

The positive b for average weight and the negative b value for average weight squared were significant at the 1-percent level, and result from the pricing of both light and heavy hogs below the intermediate weights.

[1] Suits, D. B., Use of Dummy Variables in Regression Equations, Jour. Amer. Stat. Assoc., Dec., 1957, p. 550.

These regression coefficients for average weight and average weight squared were consistent with the dummy variable analysis of weight classes in a general way. Both analyses indicate that highest prices were paid in the 200-220 pound range.

Lot Size as a Continuous Variable

The regression coefficients for size of lot as a continuous variable were positive and significant at the 1-percent level in all models, indicating that greater returns could be obtained by marketing hogs in a few larger lots rather than in small shipments. A significant difference in price was paid among lot size classifications.

In Model I, lot size was included as a set of dummy variables. Lots of 1 to 10 head were discounted 44 cents per 100 pounds from the base lot size of 21 to 30 head. This difference was significant at the 1-percent level. Obviously some of the small lots would include undesirable hogs sorted from larger consignments. On this market no other lot sizes were priced significantly different from the base.

Pricing by Weight Class

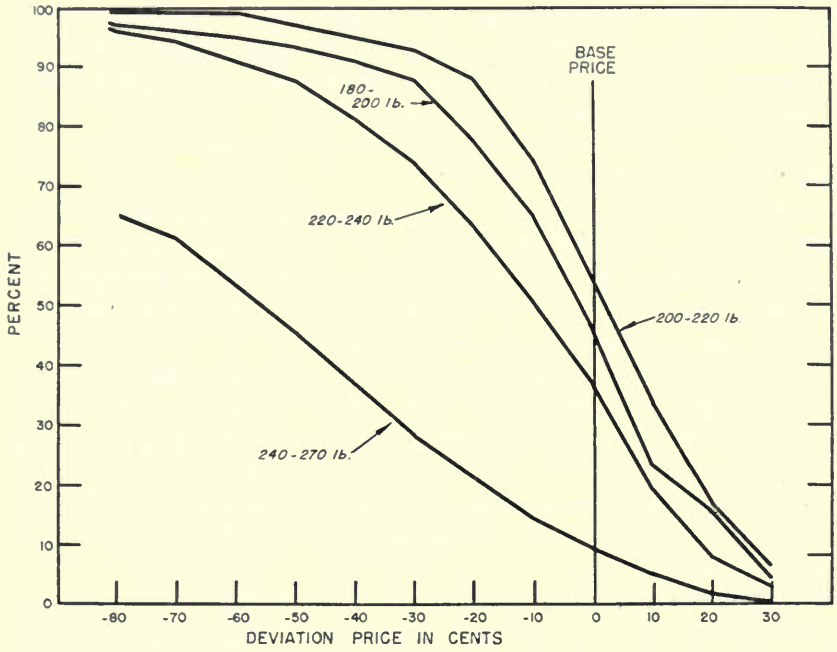
Weight was included as a set of dummy variables in Models II, III, and IV. The regression coefficients, which indicate the average deviation from the base price associated with each weight class, ranged from a deduction of 15 cents a hundred for the 220-240 pound class to 57 cents less than the base price for the 240-270 pound hogs (Appendix A, Table 1). All coefficients were significant at the 1-percent level.

Model III indicated that 180-200 pound hogs averaged 26 cents less than the 200-220 pound class, while the 220-240 pound and 240-270 pound hogs averaged 15 and 54 cents less, respectively.

More than half (54 percent) of the 200-220 pound hogs sold at a price equal to or above the base price. Only 9 percent of the heavy (240-270 pound) hogs sold for the base price or more, while 35 percent were discounted 80 cents or more below the base (Fig. 1 and Appendix Table 2).

Pricing by Day of the Week

This phase of the analysis indicated that there was no significant difference in the deviation price paid for various weight classes on different days of the week. The spread between the 200-220 pound hogs and other weight classes remained essentially the same on different days.



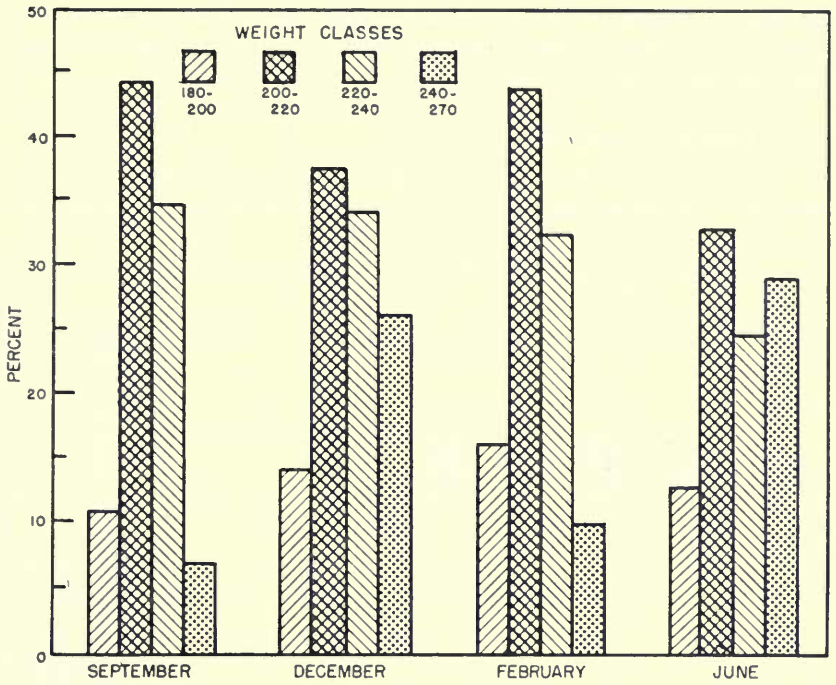
Cumulative distribution of hogs sold in 10-cent deviation price classes on the Peoria market, 1959-60. (Fig. 1)

Pricing by Season of the Year

Dummy variables for each season were included in all models. Differences in deviation prices between the base period (June, 1960) and all other time periods were significant at the 1-percent level in Models II, III, and IV. In Model I the difference in the deviation price between September, 1959, and the base period was significant at the 1-percent level. Deviation prices in December, 1959, and February, 1960, were significantly different from deviation prices during the base period at the 5-percent level.

The regression coefficients indicate that the average deviation prices for September, 1959, December, 1959, and February, 1960, were about 34 cents, 16 cents, and 27 cents, respectively, above the average deviation price for June, 1960. These differences were largely a function of consist (the distribution of hogs marketed among the different weight classes). In the June, 1960, period nearly 29 percent of all hogs sold were in the 240-270 pound class (Fig. 2).

Figure 3 shows further differences in seasonal prices. Highest average prices were paid for all weights in June, and lowest prices were



Seasonal variation in hog consist on the Peoria market, 1959-60. (Fig. 2)

paid in December. The 240-270 pound hogs brought the lowest prices, relative to the other weights, in June when the proportion of hogs in that weight class on the market was greatest. On the other hand, in September, when the proportion of 180-200 and 240-270 pound hogs was the lowest relative to the intermediate weights, price differentials among weight classes were least.

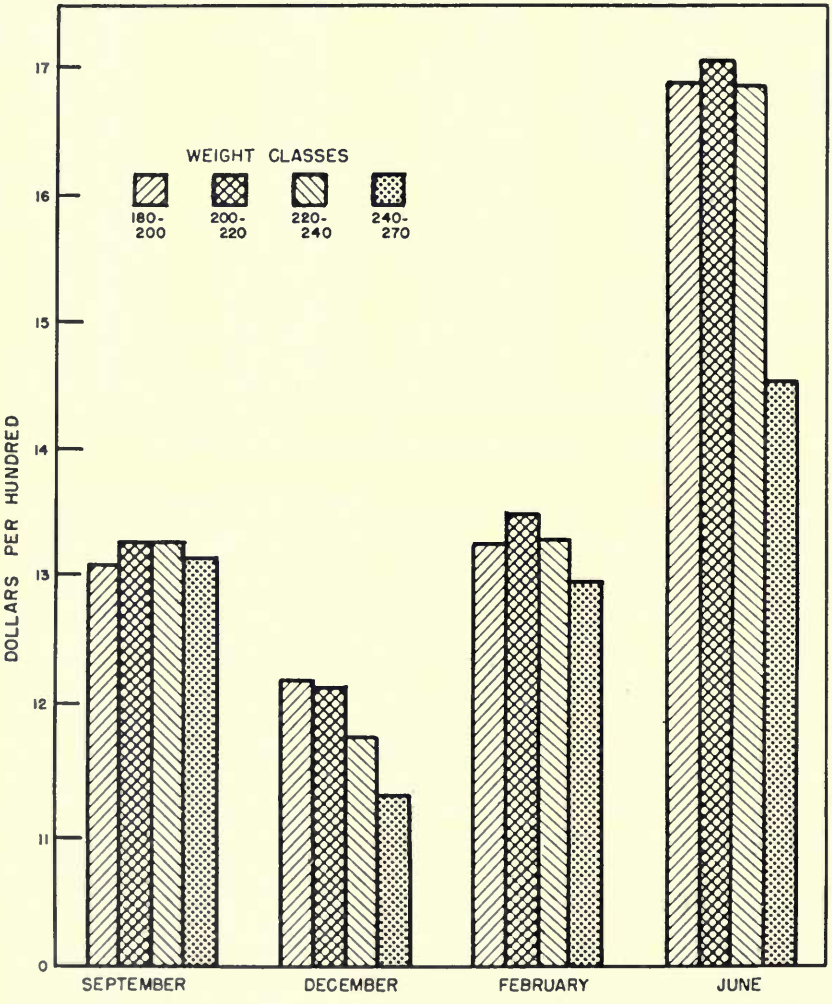
In general there was very little difference among seasons in the relative prices paid for hogs weighing from 180 to 240 pounds. Furthermore, the proportion of hogs selling near the highest average price varied among seasons. In the September period, 96 percent of all hogs were sold within 25 cents of the highest average price[1] and were within a 70-pound weight range of from 190 to 260 pounds. During the December, 1959, period 52 percent of all hogs were sold within 25 cents of the highest average price, covering a 50-pound range from 170 to 220 pounds. In February and June, 1960, 74 and 73 percent sold within 25 cents of the highest average price, with weight ranges of 40 and 50

[1] The average price of the weight class which received the highest average price for a given time period.

pounds, respectively. These figures suggest little price differentiation was made among weights in periods when the supply of heavier weight hogs was smallest.

Pricing by Buying Firms

Model III (Appendix A and Appendix Table 1) included a set of dummy variables for buying firms. Buyers 2 and 6 paid average devi-



Seasonal variation in average prices paid for hogs on the Peoria market, 1959-60. (Fig. 3)

ation prices of 16 cents and 81 cents below the base price (Buyer 1). These differences were significant at the 1-percent level. Buyer 5 paid an average deviation price of about 6½ cents less than prices paid by the base firm. This difference was significant at the 5-percent level.

Table 3 shows the average prices paid by five selected buyers for all periods combined. Buyer 4 was obviously the most aggressive buyer of 200-220 pound hogs (the class where the best cutout value is likely to occur), and greatly discounted the heavier weight classes which have lower cutout values. Buyer 1 paid less differential among weight classes than any other buyer shown. Buyer 5 also differentiated little, and buyer 3 tended to discriminate relatively more among weight classes. For more detail, see Appendix Table 3.

Pricing by Commission Selling Firms

Model II (Appendix A and Appendix Table 1) included dummy variables for selling firms, with Firm 1 used as the base. Selling practices of Firms 4 and 5 appeared to have most closely approached actual cutout value of the hogs. They received 8¾ and 9 cents per 100 pounds more than the base firm, a difference significant at the 1-percent level. Seller 6 received 6 cents per hundred more than the base, a difference significant at the 5-percent level. Possibly some of the price differences may be accounted for by the type of trade that has been developed. The more progressive firms have actively solicited better

Table 3. — Average Prices per 100 Pounds by Commission Selling Firms and Buying Firms for 200-220 Pound Butcher Hogs and Deviations From Those Prices for Other Weight Classes, Peoria Market, 1959-60

	Average price, 200-220 lb. weights	Difference from 200-220 lb. price		
		180-200 lb.	220-240 lb.	240-270 lb.
Average prices and deviation prices received by selling firms				
Seller 1	$13.45 (40.5)[a]	$−.03 (12.4)	$−.10 (34.1)	$−.67 (13.0)
Seller 2	13.71 (45.3)	−.18 (14.4)	−.49 (29.2)	−.41 (11.1)
Seller 3	13.54 (45.7)	−.54 (13.6)	−.18 (30.0)	−.41 (10.7)
Seller 4	13.71 (40.2)	−.22 (13.7)	−.39 (32.6)	−.83 (13.5)
Seller 5	13.79 (39.1)	−.32 (13.5)	−.29 (34.6)	−1.05 (12.7)
Average prices and deviation prices paid by buying firms				
Buyer 1	$13.51 (42.4)[a]	$+.10 (6.6)	$−.04 (36.6)	$−.17 (14.4)
Buyer 2	13.42 (38.4)	−.05 (11.1)	−.14 (37.8)	−.88 (12.7)
Buyer 3	13.56 (49.8)	−.30 (13.6)	−.69 (28.8)	−.49 (7.8)
Buyer 4	13.78 (53.1)	−.17 (33.0)	−.07 (9.9)	−1.03 (4.0)
Buyer 5	13.52 (36.5)	−.24 (12.3)	−.30 (36.7)	−.37 (14.5)

[a] Numbers in parentheses indicate percentages of each firm's transactions in each weight class.

kinds of hogs and have worked with producers to improve the quality of hogs marketed.

Little difference existed among sellers in the proportion of their total sales in each weight class, although Firm 1 was unique in that it sold slightly more 240-270 pound hogs than 180-200 pound hogs. However, Firm 1 patrons received substantially less (9 to 34 cents) per 100 pounds for 200-220 pound hogs, and there was relatively less differential for hogs weighing from 180 to 240 pounds (Table 3). Thus each of these firms received a higher average price than the base firm, but only for 200-220 pound hogs. For more detail, see Appendix Table 4.

This phase of the analysis highlights a key marketing problem facing producers as they attempt to evaluate reports of prices paid on the market. Just what do individual market price quotations mean? Actual prices vary significantly between weight classes and among individual buyers and individual sellers who operate on a given market. A careful evaluation of weighted average prices negotiated by the five major buying and selling firms[1] reveals considerably different prices for the various weight classes of hogs marketed.

If producers knew how these firms sell their hogs on the Peoria market, they would not sell 200-220 pound hogs through Firm 1; but if they had lighter and medium-weight butcher hogs, this might be the best firm to use. Firm 5 obtained 34 cents a hundred more than Firm 1 for 200-220 pound hogs, but it sold heavy butchers at a discount of $1.05 a hundred. Despite the price variations, these different firms had a comparatively uniform distribution in the weight classes marketed. Obviously, producer patrons were not aware of the different prices obtainable by these commission firms.

Pricing practices of both the buying and selling firms indicate evidence of "merit" hog marketing, but the farmer may have difficulty in identifying the best firm to handle his meaty hogs.

Effects of Meatiness, Conformation, and Weight

The data in Appendix Table 5 show the results of the regression analysis. In all models, weight and size of lot had a significant effect on price, thus supporting findings of previous studies. Meaty hogs brought an average premium of 16 cents per 100 pounds over average type hogs and 20 cents over fat hogs. Uniform conformation within

[1] These commission firms bought and sold most of the hogs on the Peoria market.

lots sold was rewarded an average of 11 cents over average conformation, and 25 cents over lots of mixed conformation.

No significant differences were found among prices paid for different breeds.

Whether or not these premiums paid for meat-type hogs and uniform conformation, and discounts assessed for fat-type hogs and lots which lacked uniform conformation, persist throughout the year and from year to year is not known. Whether the seasonal pattern of price differentiation according to weight is similar for meaty and for fat hogs was not clear in this study. The extent to which price differentials for quality and uniformity varied among weight classes is indicated in Table 4.

For weights over 200 pounds, there was pronounced discrimination against the fat-type, more heterogeneous lots of hogs. In the lightweight category (180-200 pounds), however, 82 percent of the poorest type hogs sold at or above the price for the base class (200-220 pound) hogs, suggesting that there is little meat-type discrimination for lightweight hogs. At the other extreme, no 240-270 pound hogs, not even those judged highest by all meat conformation and weight criteria, brought a price equal to or greater than the base price.

Given a general price level for hogs, weight remains the most important factor in hog pricing. An additional price advantage appeared to be associated with marketing larger lots, although the extent to which one could compromise between the loss of homogeneity and increased lot size was not clear.

Further research designed to identify and analyze more exact indexes of meatiness or "quality" is needed.

Table 4. — Cumulative Percent of Hogs of Highest, Average, and Poorest Combinations of Meatiness, Conformation, and Uniformity Selling at a Deviation Price Equal to or Above the Deviation Price of 200-220 Pound Hogs on the Peoria Market, 1959-60

Weight class	Meat type Uniform conformation Uniform weight	Average meatiness Average conformation Average weight variation	Fat type Mixed conformation Mixed weights
		(percent)	
180-200	63	39	82
200-220	82	61	62
220-240	59	13	9
240-270	0	0	0

Implications

The results of this study imply some very practical suggestions for the hog producer:

1. Sort hogs before taking them to market. Mixed lots sell at a discount.
2. Market hogs in as large and as uniform lots as possible.
3. Remember that hogs weighing from 200 to 220 pounds nearly always bring highest prices regardless of the season, the buyer, or the commission salesman who handles your hogs.
4. Learn to know the commission firms that sell your hogs. They are not all alike. Some firms are able to obtain higher prices for given weight classes of hogs. Much of this difference may come about because the commission firms know the buying firms who operate on your market.
5. Remember that order buyers and commission firms tend to specialize in one or two weight classes of hogs. Produce for the specialty higher-priced outlets.
6. Be conscious of the way the market discounts for heavy and light hogs during different seasons of the year. Greatest price discounts occur when the most heavyweight hogs come to the market.
7. When hog prices are reported, understand what the quotation means. Posted prices are not always the same as prices being paid, and price quotation practices vary among markets. Don't read something into the quotation that is not there.

Summary and Comment

This study of hog pricing on the Peoria market relates the extent to which hog prices were influenced by weight, size of lot, buying firm, selling firm, and time of marketing. The prices paid for all lots of hogs marketed during four different periods of two marketing weeks — in September, December, February, and June — were analyzed. During the June period an attempt was also made to measure the effect of breed, meatiness (meat-type vs. fat-type hogs), conformation, and mixed vs. uniform weight lots on prices paid for hogs. To simplify the analysis all prices for all weight classes for all lots marketed were reduced to deviations from a base price paid for the 200-220 pound weight classes marketed.

Average weight of hogs sold was a significant factor in determining the price paid for hogs. Hogs weighing either more or less than 200-220 pounds were discounted. The 180-200 pound hogs were sold for an average of 26 cents per 100 pounds below the base, 220-240 pound hogs were discounted 15 cents per 100 pounds, and 240-270 pound hogs were marketed for 57 cents below the base price.

Larger lots were marketed at higher prices than the small lots, but the average lot size was only 15.6 head. Small lots of from 1 to 10 head were discounted 44 cents from the base grouping of 21 to 30 head.

Differences in price deviations from the base (200-220 pounds) hogs varied significantly during different seasons of the year. There was least price deviation in June. Using June weighted average prices for comparison, average price deviations of 34 cents, 16 cents, and 27 cents from this June price occurred in September, December, and February, respectively. These seasonal price differences were largely the result of seasonal variation in consist (the distribution of different weight classes marketed).

Average prices varied seasonally and inversely with the number of hogs marketed. Highest prices were paid for all weights in June. In September 96 percent of all hogs sold within 25 cents of the highest average weight class price when the proportion of 240-270 pound hogs on the market was the smallest, and the weight range covered by this price interval was 70 pounds (from 190 to 260 pounds). In periods when there was a more even distribution of hogs in all weight classes marketed, a smaller proportion of the hogs were sold within 25 cents of the highest average price.

Differences of up to 81 cents per 100 pounds were found in prices paid for hogs by the packer buyers and order buyers who bought butchers on this market during the periods studied. Average price data for each firm revealed substantial variations existed in the prices paid for different weight classes bought by different buying firms. Noticeable differences also existed among the buyers in the proportion of their purchases made from different weight classes.

Significant differences in deviation prices received by various selling firms ranged from 6 to 9 cents per 100 pounds over the base firm's price. There was little difference in the consist handled by different selling firms.

The days of the week on which hogs were sold had no significant effect on prices.

Similarly, daily hog receipts at the 12 terminal markets and interior Iowa markets had no significant effect on the deviation price paid at

the Peoria market. The flow of receipts at other terminal and country markets may have affected the price level at Peoria, but this was beyond the scope of the study.

This market discriminated among lots of hogs bought on the basis of meaty characteristics. Further, this discrimination tended to be greater for heavier weight hogs than for lighter hogs.

It is debatable whether the price differentials paid for meatiness are great enough to encourage production of more desirable kinds of hogs, and this question was not fully answered by this research.

The validity of claims made by some market organizations that the terminal markets set the prices paid for all hogs, and that the terminal markets are the "competitive markets," can be questioned. Evidence of price differentiation by both the buying and selling firms on this market clearly demonstrated that there is considerable departure from the theoretical concept of a competitive market. There is abundant evidence of price differentiation within as well as between the different weight classes marketed. A comparison of prices paid by the various organizations shows that these prices are affected by factors not related to the characteristics of the lots purchased. It is then unclear which set of prices really represent the "competitive market price" which guides producers and the trade in their market decisions. Such differentiation naturally limits the usefulness of price summaries, such as those reported by the market news reporting service, since these factors cannot be included in the classification.

Appendix A

(Combined Periods Analysis)

The data used to test the influence of weight, size of lot, time of sale, and buyers and sellers on prices paid for hogs on the Peoria market were deviation prices (Y) classified into the following categories:

W_g = weight classes with subclasses W_1 = 180-200, W_2 = 200-220, W_3 = 220-240, W_4 = 240-270.

L_h = lot size (number of head) with subclasses L_1 = 1-10, L_2 = 11-20, L_3 = 21-30, L_4 = 31-40, L_5 = 41-50, L_6 = 51-75, L_7 = 76-100, L_8 = over 100.

D_i = day of week where D_1 = Monday, D_2 = Tuesday, D_3 = Wednesday, D_4 = Thursday, D_5 = Friday.

T_j = time period with subclasses T_1 = Sept. 14-25, 1959, T_2 = Nov. 30-Dec. 11, 1959, T_3 = Feb. 15-26, 1960, T_4 = June 20-July 1, 1960.

B_{li} = buyers with subclasses B_1 = buyer 1, B_2 = buyer 2, B_3 = buyer 3, B_4 = buyer 4, B_5 = buyer 9, B_6 = buyers 5, 6, 7, 8, and 10-28.

S_m = sellers with subclasses S_1 = seller 1, S_2 = seller 2, S_3 = seller 3, S_4 = seller 4, S_5 = seller 5, S_6 = sellers 6-10.

Dummy variables[1] were used to measure the effect of the non-quantitative variables as well as weight and lot size classes. Average weight and size of lot were also used as continuous variables in certain models. The symbols are:

G = average weight as a continuous variable

G^2 = average weight squared

H = size of lot sold as a continuous variable

I = daily number of hogs sold at 12 terminal markets and interior Iowa

The subscripted capital letters present the mnemonic notation used for the regression coefficients of the dummy variables.

[1] For a detailed presentation on the use of dummy variables, see Suits, D. B. Use of Dummy Variables in Regression Equations, *Jour. Amer. Stat. Assoc.*, Dec., 1957, p. 550.

Models Used in Combined Periods Analysis

The coefficients of regression and selected other statistics are presented in Appendix Table 1 for four models which are specified as follows:

$$I — Y = A + b_1G + b_2G^2 + b_4I + L_h + D_i + T_j$$

$$II — Y = A + W_g + b_3H + T_j + S_m$$

$$III — Y = A + W_g + b_3H + T_j + B_h$$

$$IV — Y = A + W_g + b_3H + T_j$$

The subscripts have the ranges shown by the classification above with "base" coefficients set at zero. No special notation has been introduced to indicate that the coefficients in the various equations are different.

Model I — In Model I, weight was included as a continuous variable (G and G^2). Dummy variables were included for lot size (L_h), day of the week (D_i), and time periods (T_j). Also included in this model was the daily number of hogs sold at 12 terminal markets and at markets in interior Iowa (I).

Model II — In Model II, weight was included as a set of dummy variables (W_g), as was time period (T_j), and seller (S_m). Size of lot was included as a continuous variable (H).

Model III — Model III included weight (W_g), time period (T_j), and buyer (B_h) as sets of dummy variables, and size of lot as a continuous variable (H).

Model IV — Model IV included only weight and time period as dummy variable sets, and size of lot as a continuous variable.

The net regression coefficients (b values) and their standard errors (s_b) are of particular importance. The b values represent the average amount and direction the dependent variable changes with a one-unit change in the independent variable, after the effects of the other independent variables have been considered.

In the case of the dummy variables, b represents the amount and direction the dependent variable differs with the occurrence of a particular characteristic or quality represented by a dummy variable compared to the occurrence of another characteristic or quality regarded as the base of a given set of dummy variables.

Appendix Table 1. — Coefficients of Regression, Standard Errors of Regression Coefficients, Multiple Correlation Coefficients, and Standard Errors of Estimate of Four Models Used in the Combined Period Analysis of the Peoria Market, 1959-60

Independent variable	Model I		Model II		Model III		Model IV	
	b	s_b	b	s_b	b	s_b	b	s_b
Average weight	15.158**	.770	...	...	...	...	...	...
Average weight squared	−.035**	.002	...	...	...	...	...	...
Weight:								
W_1	...	...	−28.096**	2.429	−26.498**	2.331	−28.126**	2.430
W_2	...	...	base	...	base	...	base	...
W_3	...	...	−18.984**	2.095	−15.210**	20.006	−18.972**	2.045
W_4	...	...	−56.715**	2.609	−53.602**	2.476	−56.736**	2.607
Size of lot (continuous)	...	...	1.637**	.067	1.570**	.063	1.647**	.067
L_1	−44.184**	2.484	...	...	...	...	...	...
L_2	...	2.613	...	...	...	...	...	...
L_3	base	...	...	...	...	...	...	...
L_4	1.360	3.907	...	...	...	...	...	...
L_5	.681	6.278	...	...	...	...	...	...
L_6	2.782	6.852	...	...	...	...	...	...
L_7	2.829	17.639	...	...	...	...	...	...
L_8	19.683	39.202	...	...	...	...	...	...
Daily receipts at 12 terminal and interior Iowa	.005	.006	...	...	...	...	...	...
Day of week								
D_1	1.744	3.828	...	...	...	...	...	...
D_2	1.426	3.438	...	...	...	...	...	...
D_3	.747	3.630	...	...	...	...	...	...
D_4	1.129	4.037	...	...	...	...	...	...
D_5	base	...	...	...	...	...	...	...
Time period								
T_1	30.264**	3.391	34.451**	2.517	33.943**	2.391	34.018**	2.513
T_2	16.953**	4.380	21.645**	2.453	16.531**	2.339	21.401**	2.451
T_3	28.141**	3.475	29.254**	2.627	26.803**	2.485	28.937**	2.624
T_4	base	...	...	...	...	...	...	...
Seller								
S_1	base	...	base	...	...	...	...	...
S_3	...	...	4.629	2.921	...	...	...	...
S_3	...	...	3.495	3.116	...	...	...	...
S_4	...	...	8.765**	3.102	...	...	...	...
S_5	...	...	8.097**	3.117	...	...	...	...
S_6	...	...	5.952*	3.514	...	...	...	...
Buyer								
B_1	...	...	...	...	base	...	...	...
B_2	...	...	...	...	−15.932**	2.167	...	...
B_3	...	...	...	...	−2.882	3.132	...	...
B_4	...	...	...	...	−.483	2.620	...	...
B_5	...	...	...	...	−6.655*	3.297	...	...
B_8	...	...	...	...	−80.980**	2.716	...	...
Coefficient of multiple correlation	.427	...	.402	...	.499	...	.401	...
Standard error of estimate	78.21	...	79.20	...	74.96	...	79.24	...

** Significant at the 1-percent level
* Significant at the 5-percent level

Appendix B

(Meatiness, Conformation, and Weight Studies)

Criteria and Analysis Used

The criteria for segregating meatiness, conformation, and weight in different lots of hogs on the Peoria market were set up as follows:

1. *Meatiness* was considered as an estimation of the proportion of primal cuts in the hogs.

2. *Conformation* referred to the shape and contour of the hogs and the distribution of muscling in the primal parts (ham, loin, shoulder, and side). *Uniform conformation* was used to describe lots of hogs in which all the animals exhibited, in the judgment of the evaluators, well-developed hams and loins, firm sides, and smooth shoulders. *Average conformation* was the class in which lots of hogs of acceptable but somewhat heterogeneous conformation were grouped. Lots of hogs which were poorly muscled and of uneven conformation were classed under *mixed conformation.*

3. The classification for uniformity of weight was based on the observers' estimates of the uniformity with respect to the weights of the individual hogs making up the lot. Lots consisting of hogs of very similar weights, whether they were all heavy or light hogs, were called *uniform weight* lots. If the weight was judged to vary noticeably but less than 20 pounds within any given lot, the lot was said to vary *within 20 pounds.* If the estimated variation within the lot was more than 20 pounds, the lot was said to vary *over 20 pounds.*

These were obviously rough empirical estimates, but this phase of the study was set up to see whether there was a significant difference paid for meatiness and uniformity in conformation and in uniform weight classes.

Least squares multiple regression analysis with the use of dummy variables for nonmeasurable variables (quality, breed, etc.) was used to analyze the data.

Weight and lot size were included as independent variables in the models because they were known to exert a pronounced effect on hog prices.

Multiple regression analysis was used to fit relations of deviation prices (Y) to weight (W), and size of lot (L), and to dummy variables reflecting some of the following data classification:

Q_g = meatiness of the hogs in the lot with subclasses Q_1 = meat type, Q_2 = average type, Q_3 = fat type.

Appendix Table 2. — Distribution of Hogs Selling in 10-Cent Deviation Price Classes by Combined Weight Classes for Separate and Combined Time Periods, Peoria Market, 1959-60

Time period and weight class	Deviation price in cents													Number of hogs
	−80 or more	−70-79	−60-69	−50-59	−40-49	−30-39	−20-29	−10-19	−1-9	+0-9	+10-19	+20-29	+30 or more	
	(percent)													
Sept. 14-25, 1959														
180-200	2.8	1.4	...	.96	4.5	5.3	18.4	25.6	17.6	17.9	4.6	1.0	...	4,563
200-220	.4	.03	...	.1	.3	1.1	3.7	14.6	29.1	29.9	16.0	3.5	1.3	19,226
220-240	.5	.02	.01	.007	.4	.1	2.9	15.2	26.5	24.9	20.1	7.6	1.8	14,255
240-270	3.6	.1	.6	.5	2.0	4.1	12.5	19.9	16.7	18.5	14.9	5.2	1.4	2,897
Nov. 30-Dec. 11, 1959														
180-200	1.1	.2	.6	.7	.4	1.8	8.4	5.0	18.4	24.8	12.8	17.3	8.5	5,856
200-220	.4	.3	.7	4.1	3.2	4.4	6.3	9.7	13.8	14.5	15.0	20.4	6.2	15,435
220-240	9.3	6.0	10.3	6.3	16.5	12.2	14.4	7.8	2.6	4.6	3.4	3.8	2.8	13,118
240-270	60.7	7.1	13.2	9.2	4.3	3.5	.3	.4	.7	...	.6	...	...	6,661
Feb. 15-26, 1960														
180-200	3.6	2.8	2.9	3.2	3.3	6.1	6.2	13.1	27.1	12.2	12.0	6.4	1.1	4,088
200-220	.6	.3	.2	1.4	1.0	4.2	6.2	13.1	21.8	18.0	16.5	11.5	5.2	12,767
220-240	1.6	.07	.1	3.7	2.9	6.9	20.2	5.8	18.9	25.0	6.8	5.7	2.2	9,595
240-270	8.9	3.7	4.0	9.3	15.4	13.7	20.0	14.1	5.0	5.1	.3	.3	.2	2,975
June 20-July 1, 1960														
180-200	.9	.1	.07	1.0	.07	...	.9	.7	2.0	.4	3.2	16.1	74.5	2,986
200-220	.02	...	.03	2.1	...	1.6	1.0	2.2	4.4	2.6	2.6	20.4	69.8	9,078
220-240	.6	.2	...	1.0	...	.9	2.9	.3	14.1	7.4	9.0	27.5	36.1	6,630
240-270	9.8	2.6	1.9	12.9	4.1	7.2	11.0	6.7	26.6	3.4	5.7	6.5	2.6	3,219
Combined time periods														
180-200	2.6	1.1	1.0	1.4	2.4	3.6	10.2	13.4	18.6	22.3	8.8	10.3	4.3	17,747
200-220	.5	.2	.2	1.5	1.9	2.9	4.8	13.9	19.9	21.0	17.1	10.8	5.3	56,623
220-240	3.7	1.8	3.5	3.0	6.9	7.2	10.5	13.1	13.9	17.3	11.3	5.3	2.5	43,786
240-270	34.8	3.8	7.7	8.1	8.1	9.1	7.2	6.9	5.1	4.5	3.1	1.3	.3	15,959

C_h = conformation of hogs with subclasses C_1 = uniform conformation, C_2 = average conformation, C_3 = mixed conformation.

U_i = uniformity of weight within lots with subclasses U_1 = uniform weight, U_2 = within 20-pound variation, U_3 = over 20-pound variation within lot.

B_j = breed with subclasses B_1 = Berkshire, B_2 = Duroc, B_3 = Hampshire, B_4 = Chester White, B_5 = Poland China, B_6 = Spotted Poland China, B_7 = Yorkshire and Landrace, B_8 = other or unidentified breeds.

Appendix Table 3. — Average Price and Consist for Selected Buying Firms for Each Time Period Studied, Peoria Market, 1959-60

	Weight class								
	180-190	190-200	200-210	210-220	220-230	230-240	240-250	250-260	260-270
Sept. 14-25, 1959									
Buyer 1 $	13.14	13.18	13.22	13.27	13.32	13.30	13.25	13.23	12.96
%	1.03	4.56	18.21	28.85	27.16	13.06	5.49	1.31	.32
Buyer 2 $	12.82	13.19	13.30	13.27	13.26	13.17	13.23	13.07	13.09
%	2.58	6.55	14.96	29.23	26.87	13.26	4.61	1.01	.92
Buyer 3 $	13.05	13.22	13.16	13.26	13.22	13.23	13.29	13.89	13.17
%	.95	5.50	19.71	27.24	24.32	14.58	5.01	1.54	1.14
Buyer 4 $	12.89	13.15	13.24	13.32	13.27	13.14	12.99	12.80	12.25
%	9.39	19.20	34.07	23.55	9.84	1.51	1.18	.77	.49
Buyer 5 $	13.22	13.21	13.26	13.37	13.32	13.30	13.20	12.93	...
%	2.65	5.80	16.75	15.92	18.41	22.89	17.08	.50	...
Nov. 30-Dec. 11, 1959									
Buyer 1 $	12.18	12.22	12.24	12.11	11.92	11.66	11.47	11.16	11.12
%	2.27	6.35	17.68	23.81	18.78	12.85	10.07	5.97	2.22
Buyer 2 $	12.16	12.21	12.21	11.98	11.79	11.55	11.43	11.19	11.01
%	2.94	8.57	14.20	16.23	19.37	18.51	10.67	5.60	3.90
Buyer 3 $	12.13	12.29	13.13	12.14	12.00	11.60	11.35	11.30	11.09
%	1.45	13.31	18.94	26.66	17.71	10.68	6.73	2.01	2.51
Buyer 4 $	12.09	12.23	12.31	12.19	12.19	12.17	11.36	11.06	10.73
%	15.15	25.88	24.85	21.39	5.85	1.67	.72	2.29	2.20
Buyer 5 $	12.28	12.12	12.15	12.05	11.91	11.68	11.46	11.16	11.20
%	1.50	10.02	13.28	21.23	19.16	18.48	9.57	5.11	1.64
Feb. 15-26, 1960									
Buyer 1 $	13.12	13.43	13.40	13.35	13.27	13.14	13.03	12.92	12.90
%	.28	5.11	16.10	24.90	22.92	15.70	9.66	2.97	2.35
Buyer 2 $	13.06	13.23	13.49	13.33	13.35	13.22	13.01	13.14	12.88
%	4.03	5.74	17.68	26.93	23.39	12.33	7.71	1.07	1.12
Buyer 3 $	13.40	13.43	13.59	13.60	13.42	13.11	12.86	13.03	...
%	4.27	21.42	28.49	19.59	16.90	6.83	1.89	.61	...
Buyer 4 $	13.06	13.39	13.60	13.60	13.48	13.20	12.84	12.55	12.69
%	12.22	20.92	29.25	23.21	6.25	2.04	1.40	2.51	2.20
Buyer 5 $	12.76	13.29	13.44	13.28	13.37	13.30	13.09	13.10	12.43
%	2.89	14.60	17.69	23.15	19.22	17.50	3.80	1.01	.13
June 20-July 1, 1960									
Buyer 1 $	16.84	17.00	16.98	16.93	16.86	16.73	16.57	16.41	16.08
%	1.40	6.39	16.77	19.03	16.05	17.34	9.46	6.69	6.82
Buyer 2 $	16.88	17.09	17.12	17.07	17.00	16.56	16.63	16.49	16.32
%	4.51	11.09	15.19	22.48	22.40	13.82	6.83	2.08	1.61
Buyer 3 $	16.87	17.09	17.11	17.08	17.20	17.12	15.02	17.11	15.95
%	2.57	9.66	30.32	41.86	8.58	4.66	.81	.47	1.08
Buyer 4 $	17.03	17.00	17.14	17.13	17.25	16.59	16.99	16.48	15.57
%	9.51	23.24	26.08	26.36	9.83	1.70	.50	1.39	1.39
Buyer 5 $	16.86	17.04	17.02	16.86	16.81	16.69	16.56	16.35	16.17
%	1.09	7.66	15.87	21.15	25.33	7.97	14.97	2.85	3.05

Models Used to Evaluate Meatiness and Related Factors

The specific models fitted were:

$$V - Y = A + b_1W + b_2W^2 + b_3L + Q_g + C_h + U_i + B_j$$

$$VI - Y = A + b_1W + B_2W^2 + b_3L$$

$$VII - Y = A + b_1W + b_2W^2 + b_3L + Q_g + C_h + U_i$$

The coefficients of regression and selected other statistics are presented in Appendix Table 5. Again the subscripts have the ranges indicated in the data classification with the base coefficient set at zero. The estimated coefficients in the various equations are not necessarily the same, even though indicated by the same symbol.

Appendix Table 4. — Average Price and Consist for Selected Selling Firms for Each Time Period Studied, Peoria Market, 1959-60

	Weight class								
	180-190	190-200	200-210	210-220	220-230	230-240	240-250	250-260	260-270
Sept. 14-25, 1959									
Seller 1 $	12.72	13.16	13.26	13.29	13.26	13.21	13.20	12.84	12.97
%	1.70	9.59	17.56	26.08	23.20	14.42	5.61	1.05	.79
Seller 2 $	12.69	13.12	13.24	13.30	13.28	13.17	13.30	13.11	12.64
%	2.30	9.82	21.83	29.62	17.22	13.65	4.33	.71	.52
Seller 3 $	12.92	13.15	13.25	13.28	13.32	13.23	13.19	13.22	12.83
%	3.44	6.59	18.66	34.97	23.87	5.28	4.54	2.12	.52
Seller 4 $	12.94	13.01	13.09	13.19	13.24	13.17	13.18	12.49	13.14
%	3.82	8.38	19.98	22.42	25.75	10.98	8.34	.58	.34
Seller 5 $	12.94	13.27	13.27	13.27	13.24	13.24	13.16	13.15	13.17
%	3.82	10.00	20.02	22.57	24.59	10.34	4.77	2.51	1.38
Nov. 30-Dec. 11, 1959									
Seller 1 $	12.12	12.22	12.21	12.05	11.75	11.50	11.35	11.11	11.01
%	3.30	10.98	14.92	21.02	13.84	15.80	11.91	4.93	3.30
Seller 2 $	12.00	12.08	12.15	12.02	11.96	11.69	11.52	11.22	11.13
%	4.26	11.54	20.36	20.93	17.66	11.69	7.18	3.91	2.49
Seller 3 $	12.09	12.20	12.16	12.09	11.89	11.62	11.48	11.18	10.93
%	3.66	14.40	17.66	22.30	12.90	15.59	7.30	4.66	1.53
Seller 4 $	12.05	12.19	12.15	12.01	11.85	11.62	11.50	11.17	11.12
%	3.30	11.45	15.39	18.68	20.00	12.78	12.50	4.15	1.75
Seller 5 $	12.27	12.28	12.30	12.09	11.94	11.65	11.39	11.15	10.99
%	5.58	9.76	14.37	17.35	16.92	17.28	6.99	7.27	4.48
Feb. 15-26, 1960									
Seller 1 $	12.89	13.12	13.39	13.31	13.33	13.18	13.20	12.97	12.73
%	2.84	7.48	20.83	24.35	19.03	15.25	4.89	3.62	1.70
Seller 2 $	13.01	13.44	13.40	13.30	13.26	13.06	12.99	12.94	12.61
%	3.15	10.99	13.73	29.88	21.63	10.44	6.60	2.17	1.41
Seller 3 $	12.78	13.23	13.47	13.36	13.39	13.34	12.94	12.82	12.88
%	4.03	12.69	16.64	24.60	22.23	11.05	4.83	1.27	2.66
Seller 4 $	13.05	13.31	13.57	13.46	13.23	13.22	13.06	12.82	12.82
%	5.12	9.49	25.78	18.53	17.93	11.35	8.41	1.98	1.41
Seller 5 $	13.20	13.40	13.53	13.52	13.36	13.25	13.03	13.89	12.75
%	2.86	8.96	16.29	24.88	21.58	14.41	7.91	1.98	1.12
June 20-July 1, 1960									
Seller 1 $	16.84	17.14	17.03	16.98	16.99	16.79	16.41	16.59	16.03
%	4.17	10.05	18.88	16.33	17.33	17.51	8.65	3.17	3.92
Seller 2 $	17.02	17.03	17.02	16.92	17.00	15.72	16.61	15.98	15.98
%	5.42	11.01	21.66	22.44	15.74	6.21	13.11	2.53	1.87
Seller 3 $	16.69	16.87	17.02	17.01	16.87	16.76	16.66	16.56	16.25
%	1.07	5.93	23.90	22.61	17.48	10.36	8.08	4.64	3.91
Seller 4 $	16.51	17.07	17.17	17.05	16.92	16.66	16.65	16.33	15.88
%	1.11	12.81	19.15	24.94	19.28	9.93	6.81	3.56	2.41
Seller 5 $	16.76	16.95	17.02	17.00	16.97	16.76	16.54	16.66	16.29
%	4.05	7.94	16.76	27.12	19.93	12.91	6.68	1.47	3.13

Appendix Table 5. — Coefficients of Regression, Standard Errors of Regression Coefficients, Multiple Correlation Coefficients, and Standard Errors of Estimate of Three Models Used in the Analysis of the June Period Data of the Peoria Market

Independent variable	Model V		Model VI		Model VII	
	b	s_b	b	s_b	b	s_b
Average weight	1.174**	.132	1.189**	.133	1.182**	.132
Average weight squared	−.028**	.003	.029**	.003	.028**	.003
Size of lot	−.622**	.133	.703**	.130	.636**	.130
Quality:						
Q_1	16.007**	3.452	...	...	16.365**	3.436
Q_2	base	...	...	...	base	...
Q_3	−4.208	4.264	...	...	3.794	4.247
Conformation:						
C_1	10.734*	4.418	...	...	10.712*	4.401
C_2	base	...	...	...	base	...
C_3	−13.809**	4.090	...	...	13.784**	4.092
Uniformity						
U_1	−7.248	5.754	...	...	6.265	5.670
U_2	base	...	...	...	base	...
U_3	3.202	3.994	...	...	3.356	3.977
Breed						
B_1	42.655	37.851	...	...	...	...
B_2	−7.411	11.217	...	...	...	...
B_3	base	...	...	...	...	...
B_4	4.764	6.451	...	...	...	...
B_5	17.849	24.073	...	...	...	...
B_6	−14.555	16.275	...	...	...	...
B_7	6.263	24.056	...	...	...	...
B_8	2.673	3.337	...	...	...	...
Coefficient of multiple correlation	.462		.420		.459	
Standard error of estimate	52.60		53.90		52.90	

** Significant at the 1-percent level
* Significant at the 5-percent level

6M—7-65—86675