Factors That Influence Prices Producers Receive for Hogs: Statistical Analysis of Killsheet and Survey Data

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ABSTRACT: This paper evaluates the results of a survey of Iowa pork producsers, examining potential price discrimination by packers. Prices varied greatly across producers, and the examined variables explain just over half of the variation. Factors under the producer's control were the most significant variables and accounted for the vast majority of the explainable difference in price among producers. Packer buying systems also accounted for some difference in producer prices. Finally, variables related to operation size, while statistically significant, increased the explanatory values of the equation very little.

KEYWORDS: Market access, carcass merit, hog marketing, price determination, price discrimination

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The Iowa Pork Producers Association surveyed its members in late summer of 1995. Nearly 1,000 usable surveys were returned from the more than 8,000 that were mailed out. In addition to completing and returning the four-page survey, over 300 producers sent in killsheets from loads of hogs they had sold. Combining the load-specific quality characteristics from the killsheets with information about the operation from the survey may provide greater insight into key marketing questions such as :

"What factors determine the price producers receive for their hogs?"

"Do producers receive equal price for equal quality?"

"If price difference exists, how much of it can be explained by factors under the producer's control?"

The killsheet data were matched to the survey data by a producer identification number assigned when the return envelop was received. If data needed for the statistical analysis were missing from the killsheet or the survey, the combination could not be used in this analysis, but the remaining information was used in other parts of the study. Of the 846 killsheets received, there were 771 from 310 producers that could be successfully matched to a survey with complete information.

Table 1 summarizes the killsheet and survey data used in this portion of the analysis. It is highly likely that the killsheets represent above-average hogs. First, producers who took the time to complete and return the survey are probably more dedicated to their pork enterprise than other producers, and may have better-than-average hogs. These producers are also concerned enough to keep and monitor carcass information. Second, if selling on a carcass merit basis (either grade and weight or previous load performance) was not in their best interest, these producers would sell on a live basis. Finally, it is human nature to sort the killsheets to find the better ones. The hogs from loads in this analysis averaged 0.89" 10th rib backfat, weighed 249 pounds, and received $1.66/cwt. lean premium and $0.44/cwt. sort discount. The operations represented sold between 75 and 20,340 hogs in 1994.

Over 80 percent of the killsheets were from hogs sold in June, July, and August, 1995; and the plant price reported by the USDA ranged from $36.00 to $53.50. The point of comparison—the dependent variable—was the difference in the price the producer received and the USDA reported plant top for the day the hogs were sold as reported on the killsheet. The hogs averaged more than $1.00/cwt. (live basis) over the plant-delivered top price for the

day. This premium over the plant top is explained by the USDA reporting procedure. The USDA reports live prices for a U.S. #2 hog which has 1 to 1.25 inches of last rib backfat compared to the 1.05 inches of last rib backfat on these hogs.

Table 1. Killsheet summary statistics from 771 loads of hogs and 310 operations responding to the Iowa Pork Producers Association Market Survey.

VARIABLE	AVERAGE	STANDARD DEVIATION	MINIMUM	MAXIMUM
Annual marketings	2305	2269	75	20,340
Average weight (pounds)	249	14	216	306
10th Rib backfat (inches)	0.89	0.12	0.25	1.39
Yield (%)	74.62	1.37	68.51	78.41
Grade premium[1]	$1.66	$1.39	-$3.92	$7.42
Sort loss[1]	$0.44	$0.48	$0.00	$3.94
Price v. Plant top[1]	$1.02	$2.14	-$12.71	$15.02

[1]/ Dollar values are expressed on cwt.. live basis.

The standard deviation column is a measure of variability in the data. Approximately 68 percent of the observations will fall in a range of the average, plus or minus one standard deviation. For example, we would expect that 68 percent of the loads will have a 10th rib backfat between 0.77 and 1.01 inches (0.89-0.12 and 0.89+0.12) . Note the amount of variability in prices received. Sixty-eight percent of the loads received between $1.12/cwt. under the plant top to $3.16/cwt. over the plant top. The extreme price differences of -$12.71 and $15.02 may possibly have been due to forward pricing or special niche market opportunities rather than normal cash market trades. Figure 1 plots the average and one standard deviation on either side of the average by size of operation. There is wide variation in price within each size group. Reading across the graph, one sees a great deal of price range overlap among groups, with some smaller producers receiving more than some larger producers.

Linear regression analysis was performed on the data to try to determine what variables affect the price producers received for their hogs and why producers receive different prices. The analysis was performed on a live weight basis and all killsheet data were converted to a live basis using the actual dressing percentage of the load. Loads were also converted to a 10th rib backfat standard using USDA conversions for percent lean and last rib backfat.

One potential problem with this analysis is that hogs sold on the performance of previous loads may have received a price not reflected in the actual killsheet. The killsheet data represented the actual quality (yield, sort, lean) of the current load, but the price the producer received was based on the killsheets of previous loads. This mismatch of data introduces variation into the analysis that cannot be statistically explained without additional information.

The following tables identify the effect that selected variables had on explaining the price producers received for their hogs. This dependent variable is measured as the net price after lean premiums and sort loss that the producer was paid, minus the plant top on a hundredweight live basis reported by the USDA. The first column is the variables that may impact the dependent variable. The second column in the estimate of the impact that a one-unit change in the listed variable has on the dependent variable. For example, in Table 2, a one-unit (inches) change in 10th rib backfat resulted in a $7.889/cwt. decrease in the price the producer received. Likewise, one tenth of an inch increase in backfat would have a $0.7889/cwt. negative impact on price. The second column is the t-statistic that measures whether the variable is statistically significant. A t-statistic with this many observations should be 2.0 or larger, or more negative than -2.0 for the variable to be significant with 95 percent confidence. At the top of the table is the adjusted r^2. This is a measure of the accuracy of the equation or essentially the percent of the price difference explained by the listed variables.

The first equation, shown in Table 2, contains variables under the producer's control and explained approximately 46 percent of the variation in price. Significant variables include yield (because this is a live weight comparison), 10th rib backfat, sort loss, and plant versus buying station delivery. Producers who reported that they typically receive two or more bids did not receive a higher live price. Producers who have a long-term packer contract also did not receive a significantly high price. The contract variable may be dependent on the time of year and price level during the analysis. The numbers of miles that a producer hauled hogs also did not impact the price producers receive.

Table 2. Regression analysis using factors under the producer's control: Dependent variable is price received minus plant-reported top price for the day.

Adjusted R-SQUARE = 0.4562

VARIABLE NAME	**ESTIMATED COEFFICIENT**	**T-RATIO 763 DF**
BIDS2	-0.107	-0.89
YIELD	0.670	15.94
FB10	-7.889	-17.01
SORT	-0.618	-5.17
PLANT	0.548	3.89
CONTRACT	0.424	1.47
PACKMILE	0.004	1.48
CONSTANT	-41.985	-13.35

In Table 3, packers were entered as individual variables and the explanatory power of the equation was increased from 46 to 51 percent. The analysis procedure required that one packer serve as a standard to which the remaining packers were compared. All but one of the tested packers paid lower base prices than did the standard packer and they were significant at the 95 percent confidence level. This does not say that the net price a packer pays is necessarily lower, but rather that the base price differs after accounting for lean premiums and

sort loss. The results for the variables under the producer's control have similar coefficients and most of the same ones were significant. The exception was plant versus station delivery. After identifying packers separately, there was no longer a premium for plant delivery. Although producers may have received a higher price at the plant when they called for bids, plant delivery across all producers and packers did not explain differences in price.

Table 3. Regression analysis using factors under the producer's control and individual packers: Dependent variable is price received minus plant-reported top price for the day.

ADJUSTED R-SQUARE = 0.5109

VARIABLE NAME	**ESTIMATED COEFFICIENT**	**T-RATIO 758 DF**
BIDS2	-0.126	-1.10
YIELD	0.648	16.20
FB10	-7.626	-17.06
SORT	-0.545	-4.64
PLANT	0.162	1.13
CONTRACT	0.296	1.08
PACKMILE	0.005	1.84
PACKER A	-0.499	-2.43
PACKER B	-1.816	-8.18
PACKER C	-0.766	-5.04
PACKER D	0.212	1.21
PACKER E	-0.655	-2.24
CONSTANT	-40.073	-13.38

One of the concerns often expressed among producers is the belief that larger operations receive higher prices for their hogs. Producers were asked in the survey how the price they received compared to the price reported by the media (the USDA price). Sorted by size of operation, the results suggest that producers believe that they received between $0 to $1/cwt. higher prices than were reported. This result did not differ greatly by size of operation (Table 4).

The killsheet data were also examined for price differences due to size of operation (Table 5). Referring to Figure 1, it was hypothesized that price increased with size, but at a decreasing rate. The number of hogs marketed annually and marketings squared were included to examine if size impacts the price producers receive. The two variables were statistically significant, but the explanatory power of the equation did not improve dramatically (.5167 versus .5109 in Table 3). This equation indicates that price increases at a decreasing rate as operations get larger. Figure 2 illustrates the impact of size on price assuming that all other factors are identical. It suggests that a producer marketing 9,000 to 10,000 hogs a year would receive about $0.85/cwt. more than a producer marketing only 100 hogs a year. As was seen in Figure 1, prices to producers marketing over 5,000 head leveled off and this equation

suggests that the size advantage peaks in the 9,000 to 10,000 head range. The producer and packer variables maintained the same significance and approximately the same coefficient size.

Table 4. Prices that producers believe they receive compared to what is reported in the media.

ANNUAL MARKETINGS	NUMBER OF FARMS	AVERAGE MARKETINGS	AVERAGE DIFFERENCE ($)[1]
Under 500	112	244	4.08
500 - 999	168	736	4.33
1000 - 1999	290	1362	4.22
2000 - 3999	184	2551	4.18
4000 and up	93	6501	4.13

[1] Producers choose a discrete response for the difference between their price and the media price: 1) more than $1 below; 2) -$1 to $0; 3) $0; 4) $0 to +$1; 5) +$1 to +$2; 6) +$2 to +$3; and 7) +$3 or more.

Table 5. Regression analysis using factors under the producer's control, individual packers, and annual marketings: Dependent variable is price received minus plant-reported top price for the day.

ADJUSTED R-SQUARE = 0.5167

VARIABLE NAME	ESTIMATED COEFFICIENT	T-RATIO 756 DF
BIDS2	-0.134	-1.18
YIELD	0.636	15.86
FB10	-7.440	-16.60
SORT	-0.546	-4.68
PLANT	0.090	0.62
CONTRACT	0.365	1.26
PACKMILE	0.003	1.11
PACKER A	-0.527	-2.57
PACKER B	-1.806	-8.18
PACKER C	-0.769	-5.07
PACKER D	0.164	0.93
PACKER E	-0.702	-2.41
HOGS	0.00018564	3.29
HOGSQ	-0.00000001	-2.61
CONSTANT	-39.622	-13.21

A second way to test for price differences by size of operation is to divide the data into size categories based on annual marketings. In Table 6, three size categories were compared to the base group marketing less than 1,000 head of hogs a year. The three categories were: 1,000 to 3,000 head, 3,001 to 5,000 head, and over 5,000 head. This equation explained only slightly more price difference than did the previous one (0.5221 versus 0.5167), and two of the

size variables were significant. This equation indicates that producers marketing 1,000 to 3,000 head a year receive $0.37/cwt. more than those marketing less than 1,000 head, and those marketing 3,000 to 5,000 head received $0.90/cwt. more than the less-than-1,000-head group, holding other factors the same. Interestingly, the over-5,000 head group did not receive prices higher than the under-1,000-head group. Compared to Table 4, the equation in Table 5 represents a stair step effect rather than a smooth continuous curve (Figure 3). It also indicates that the highest prices occur with producers who market less than 5,000 head a year, rather than with the group who markets the highest number of hogs shown in Figure 2. The significance and size of the other variables remained stable.

Table 6. Regression analysis using factors under the producer's control, individual packers, and annual marketings by size group: Dependent variable is price received minus plant-reported top price for the day.

ADJUSTED R-SQUARE = 0.5221

VARIABLE NAME	**ESTIMATED COEFFICIENT**	**T-RATIO 755 DF**
BIDS2	-0.167	-1.46
YIELD	0.638	16.00
FB10	-7.478	-16.81
SORT	-0.573	-4.91
PLANT	0.149	1.04
CONTRACT	0.434	1.56
PACKMILE	0.002	0.75
PACKER A	-0.396	-1.93
PACKER B	-1.701	-7.68
PACKER C	-0.743	-4.94
PACKER D	0.212	1.21
PACKER E	-0.701	-2.42
HOGS13	0.369	2.60
HOGS35	0.904	4.38
HOGS5	0.213	0.82
CONSTANT	-39.778	-13.33

Table 7 replaces annual marketings with load size delivered to market. Although load size may be correlated to annual marketings, this variable may capture part of the differences in procurement costs. The base group of hogs is 12 or fewer at a time compared to 13 to 40 and over 40, which is essentially comparing a pickup to a trailer, a specialized trailer, or a truck. The result suggests that load size may have more influence on price than does annual marketings. This equation explains more than Table 3 and more than the two previous equations that used annual marketings. The coefficients for load size were more significant than the ones for annual marketings. This equation indicates that producers marketing 13 to 40 hogs at a time receive $1.28/cwt. more than those selling 12 or fewer at a time. Producers marketing 40 or more hogs received $1.39/cwt. more than the 12 or fewer group—only

$0.11/cwt. more than the 13 to 40 group, and this difference is not likely to be significantly different.

Table 7. Regression analysis using factors under the producer's control, individual packers, and load size delivered to market: Dependent variable is price received minus plant-reported top price for the day.

ADJUSTED R-SQUARE = 0.5312

VARIABLE NAME	ESTIMATED COEFFICIENT	T-RATIO 756 DF
BIDS2	-0.115	-1.02
YIELD	0.622	15.76
FB10	-7.568	-17.29
SORT	-0.523	-4.55
PLANT	0.136	0.96
CONTRACT	0.275	1.02
PACKMILE	0.004	1.49
PACKER A	-0.537	-2.66
PACKER B	-1.844	-8.48
PACKER C	-0.754	-5.07
PACKER D	0.195	1.13
PACKER E	-0.664	-2.32
LOAD1340	1.280	5.63
LOAD41	1.389	5.77
CONSTANT	-39.411	-13.39

The final equation includes annual marketings, load size, and a measure of specialization in hog production. In the survey, producers reported the percent of income from various enterprises in 25 percent increments. The base group of producers received less than 25 percent of their income from hog production. The three variables listed in Table 8 are for 26 to 50 percent, 51 to 75 percent, and over 75 percent of their income from hogs. This equation accounts for quality, packer differences, and measures of size, and explains approximately 54 percent of the price difference. Although the variables were significant, including load size, annual marketings, and specialization increased the explanatory power of the model only slightly. Because annual marketings, load size, and specialization may be related, tests were conducted to check for multicolinearity, but no significant problems were detected.

The coefficient size and degree of significance on the variables under producer control and packer differences are similar to those of earlier equations. However, combining load size and level of specialization with annual marketings changes the importance of size of operation. Load sizes larger than 12 head of hogs continue to receive a higher price than load sizes less than 12 head, but the increase is now $1.22 and $1.28 per cwt.. for the 13 to 40 and the over 40 groups, respectively. This figure is slightly lower than when load size alone is used in the

equation (compare to Table 6) The degree of significance is similar to that of equation 6 and is more significant than that of the annual marketing variables. Now, only those operations marketing 3000 to 5000 head of hogs a year receive a significantly higher price than those selling less than 1000 head. The coefficient is $0.61/cwt. and the t-ratio is 2.88, significant at the 95 percent confidence level, but not as significant as other measures. The more specialized producers also received higher prices. Producers who received at least 75 percent of their income from hogs achieved $0.635/cwt. more for their hogs—a significantly higher price than that received by producers who receive less than 25 percent of their income from hogs.

Table 8. Regression analysis using factors under the producer's control, individual packers, and load size delivered to market: Dependent variable is price received minus plant-reported top price for the day.

ADJUSTED R-SQUARE = 0.5427

VARIABLE NAME	**ESTIMATED COEFFICIENT**	**T-RATIO 750 DF**
BIDS2	-0.189	-1.67
YIELD	0.607	15.19
FB10	-7.412	-16.92
SORT	-0.540	-4.72
PLANT	0.120	0.84
CONTRACT	0.442	1.62
PACKMILE	0.002	0.66
PACKER A	-0.494	-2.41
PACKER B	-1.730	-7.96
PACKER C	-0.778	-5.21
PACKER D	0.190	1.10
PACKER E	-0.708	-2.47
HOGS13	0.096	0.65
HOGS35	0.611	2.88
HOGS5	-0.253	-0.93
LOAD1340	1.219	5.22
LOAD41	1.279	5.10
INCOME2550	0.276	1.66
INCOME5075	0.294	1.67
INCOME75	0.635	3.11
CONSTANT	-38.680	-12.91

In summary, what does the analysis of this data tell us? First, a great deal of variability in price exists across producers, and the examined variables explain just over half of it. Second, factors under the producer's control (backfat, yield, sort loss) alone were the most significant variables and accounted for the vast majority of the difference in price among producers. Third, packer carcass-merit buying systems do differ and these differences helped explain variation in producer prices. Finally, variables related to operation size, while statistically

significant, increased the explanatory value of the equation very little—only about three percentage points. Of these variables, load size was more significant than annual marketings, suggesting that procurement cost per hundredweight increases at smaller load sizes. Specialized pork operations also received higher prices for their hogs than did more diversified farms.

Within this data set representing Iowa farms marketings from less than 100 to over 10,000 head of hogs a year, the analysis indicates that factors under the producer's control had the greatest influence on price. Size-related factors had very little effect on prices received. What little advantage there was began with relatively small size producers (load size greater than 12 head and annual marketings 3000 to 5000 head). This analysis did not include data from extremely large operations, and the results cannot be extrapolated to producers outside this examined size range.

The study also identified a large variation in price across farms and established that only slightly more than half of the difference can be accounted for by the data provided. Further analysis of additional data and information may provide insight into reasons for price differences. Part of the unexplained difference may be due to data provided by producers who sold on past performance, but provided a killsheet of the current load. Additional variation may arise from time of day that the hogs were delivered or sold, or from pricing hogs a day or more before they were delivered. Value to the packer, and therefore price differences, may be due to tangible, but unmeasured variables such as pork quality, dependability of supply and delivery, consistency of product, and packer-producer communication and relations. Finally, variation may be due to the marketing skills of individual producers—skills which can only be measured by the price received for the hogs.

Price Difference from Reported Plant Top, by Size of Operation, Live Weight, Average Plus or Minus One Standard Deviation

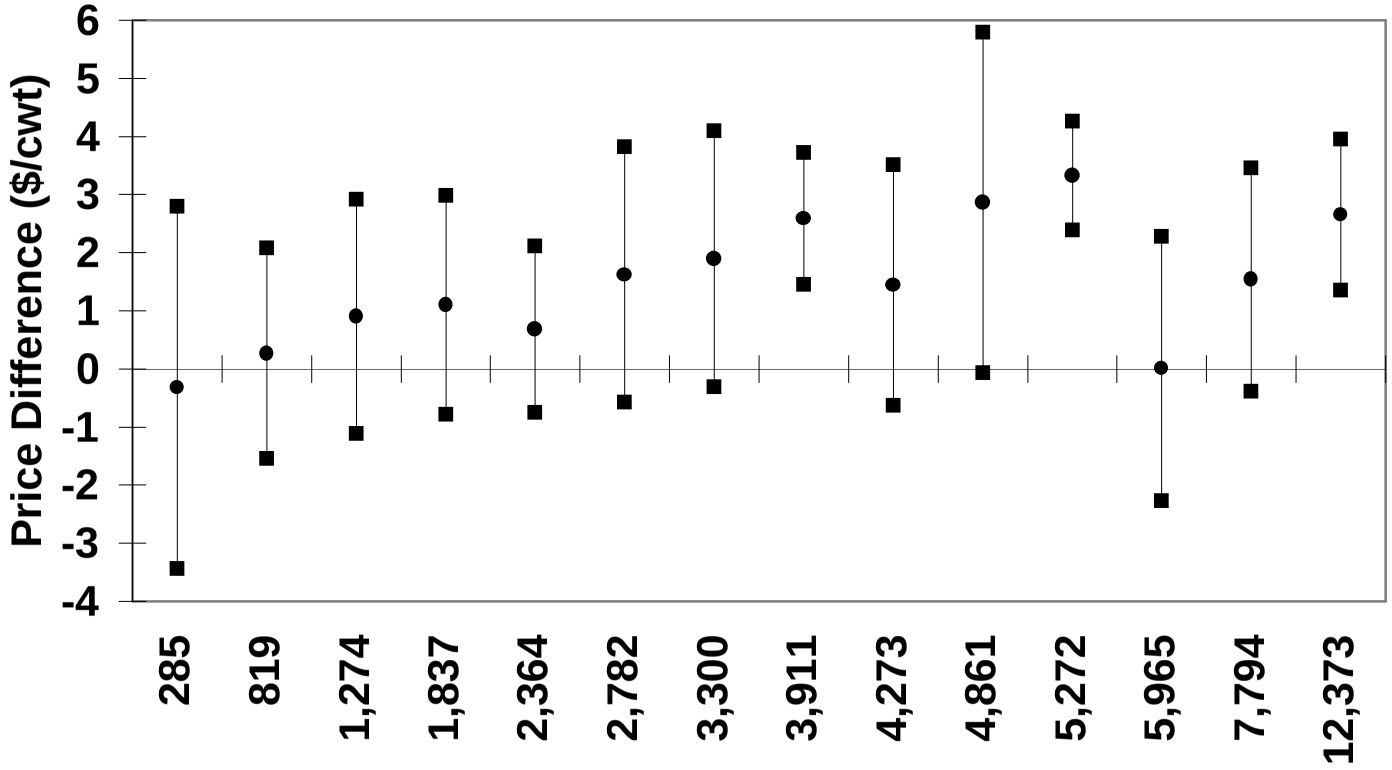

Figure 1

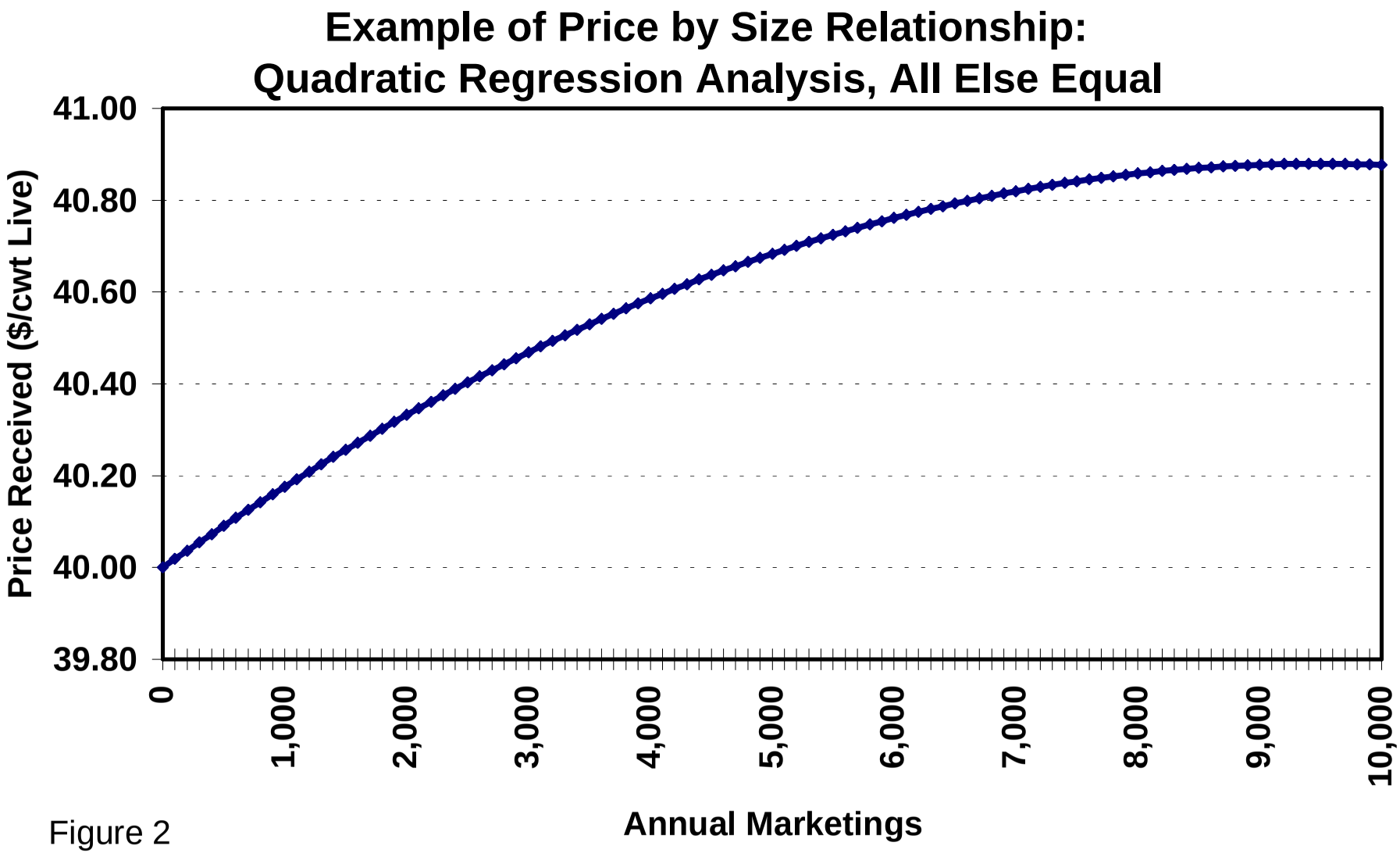
Example of Price by Size Relationship:
Quadratic Regression Analysis, All Else Equal
Price Received ($/cwt Live)
41.00
40.80
40.60
40.40
40.20
40.00
39.80
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Annual Marketings

Figure 2

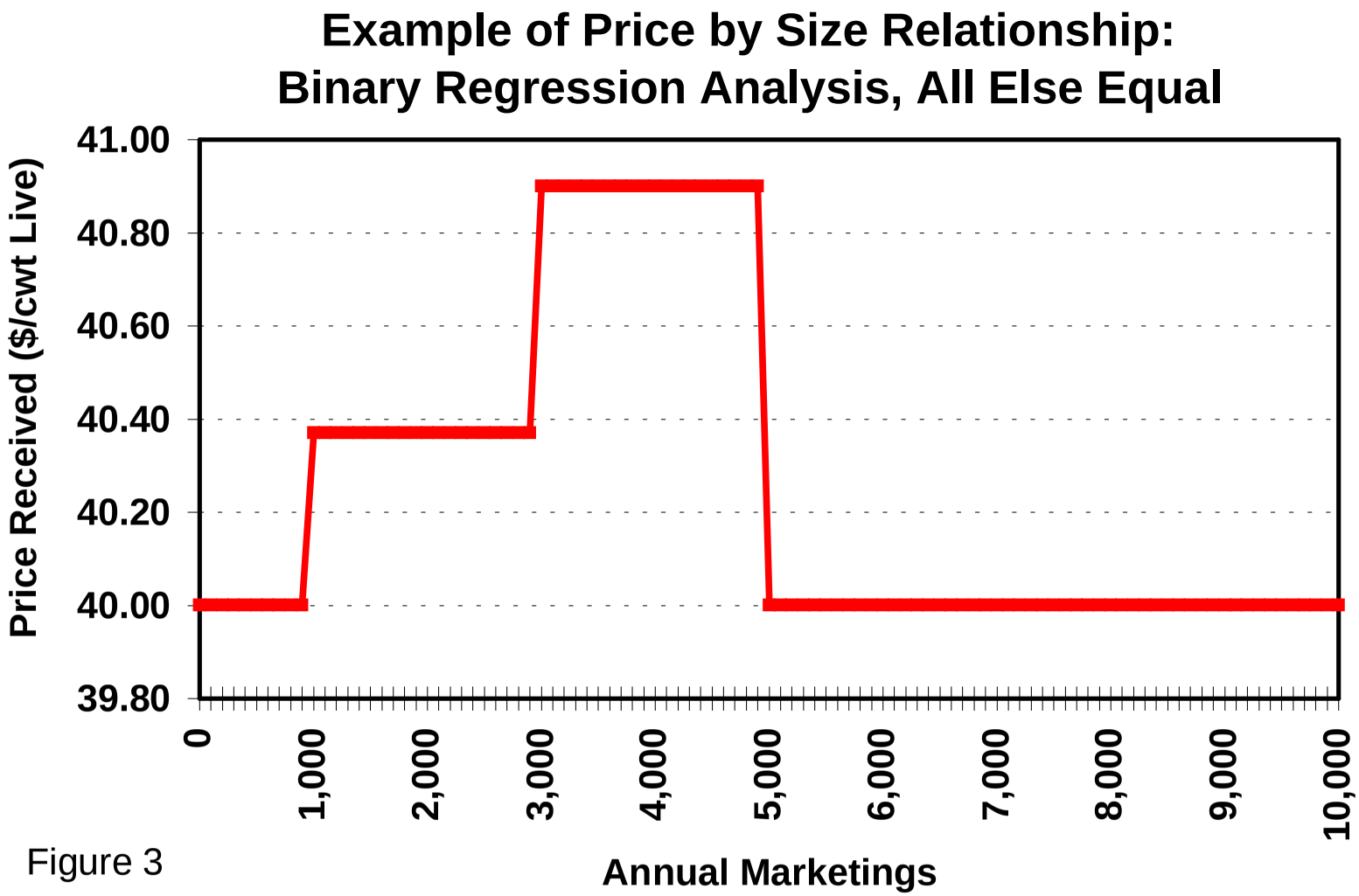
Example of Price by Size Relationship:
Binary Regression Analysis, All Else Equal
Price Received ($/cwt Live)
41.00
40.80
40.60
40.40
40.20
40.00
39.80
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Annual Marketings

Figure 3