Feeder Cattle Price Slides

by

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Abstract

A theoretical model is developed to explain the economics of determining price slides for feeder cattle. The contract is viewed as a dynamic game with continuous strategies where buyer and seller are the players. We determine the value of the slide that assures subgame perfect equilibrium when the seller gives an unbiased estimate of cattle weight. An empirical model using Superior Livestock Auction (SLA) data shows that price slides used are smaller than those needed to cause the producer to give unbiased estimates of weight. Consistent with the model's predictions, producers slightly underestimate cattle weights.

Feeder cattle prices normally decrease as cattle weights increase. Also, a given buyer only wants cattle that are within some weight range. Thus, the weight of feeder cattle is critical in determining their price. Estimating the weight of cattle is difficult for both buyers and sellers. This is especially true when cattle are sold for future delivery. In many private treaty sales the buyer never sees the cattle before purchase (although an order buyer might). In video auctions, the buyer only sees the cattle on a television screen. Thus, the seller is often better able to estimate weights than the buyer. Since sellers and buyers have asymmetric information about cattle weights, contracts need to be structured to provide sellers with an incentive to not misrepresent their estimates of average delivery weights. The contract must also provide an incentive for sellers to not excessively feed cattle. Even when the buyer sees the cattle, the buyer may want to share the risk of cattle weighing more than expected.

The usual approach to dealing with uncertain weight is to adjust the original contract price by a "price slide." The price slide (sometimes called a one-way slide) specifies the rate at which the original contract price will be reduced when the average delivered weight is greater than the weight established in the contract plus a specified tolerance. No adjustment is made to

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the original contract price if delivered cattle weigh less than the specified limit. Suppose, for example, that a producer estimates average delivered weight at 500 lbs. The producer could sell cattle at $70/cwt. with a price slide of 10 cents per cwt. for each pound of actual average weight over 520 lbs. If cattle average 530 lbs. at delivery, then $1/cwt (10 cents/(cwt.×lbs.) times 10 lbs.) is deducted from the original contract price, i.e., from the $70/cwt. If, however, actual average weight is 515 lbs., no adjustment is made from the original contract price. The price slide is an implicit option and therefore the value of the option should be reflected in the price.

Superior Livestock Auction (SLA) currently sells over a million head a year which is more than any other auction in the United States. Feeder cattle sold through SLA are sold with a price slide. Most private treaty sales also use a price slide. Price slides are not used in traditional auctions. We would estimate that over half of the feeder cattle sold in the United States are sold using a price slide. Thus, understanding feeder cattle price slides is important to the majority of feeder cattle buyers and sellers. The interest of producers in the topic is demonstrated by two extension articles (Bailey and Holmgren; and Prevatt) that have been written about price slides. However, no research has yet been done in support of extension efforts. The proper way of determining the contract price and price slide is still poorly understood. Our research shows that price slides should be higher than Prevatt suggests.

A contract has four essential variables: the contract price (or base price), the price slide, the allowable weight difference (or weight slide), and the estimated cattle average delivery weight (or base weight). Other important elements of the contract are time to delivery and cattle weight variability. Bailey, Brorsen, and Fawson found the surprising result that time to delivery has a positive effect on prices at Superior Livestock Auction (SLA). Other empirical studies on cash forward contracting have consistently found that forward contract prices decrease as time to delivery increases (e.g., Brorsen, Coombs, and Anderson; Elam). We argue that the positive relationship between time to delivery and the contract price is due to the implicit option created by the price slide. Bailey and Holmgren argued that sellers may obtain higher contract price offers if they select small allowable weight differences (or weight slides) and large price slides. Our research is able to support this hypothesis regarding the contract price, but is inconclusive regarding the price net of the slide.

In this paper, a theoretical model is developed to explain the economics of determining price slides for feeder cattle. The contract between buyer and seller is viewed as a dynamic game with continuous strategies where buyer and seller are the players. If the seller sets the value of the price slide, only necessary conditions for subgame perfect equilibrium can be obtained. However it is also possible to determine the value of the slide (as an exogenous variable) so that subgame perfect equilibrium is reached only when the seller gives an unbiased estimate of cattle weight. In other words, optimal values of the slide are obtained so that it is in the seller's best interest to give an accurate estimate of the cattle's weight. The model's predictions are then compared to actual SLA observations. The slides used in SLA are smaller than those needed to give the producer an incentive not to underestimate weight. Consistent with the model's predictions, producers slightly underestimate cattle weights.

Analytical Model

Consider a feeder cattle buyer who contracts with a seller for future delivery of cattle at a price per hundredweight (cwt.) established at the time of the contract (this is the contract price, p_0). The seller sets the estimated average weight of the cattle to be sold, called the base weight (y_0), and the price slide (γ). To this the buyer responds by offering a contract price (p_0) per cwt. that maintains expected utility at zero (to simplify the model, perfect competition is assumed so that neither buyer nor seller are able to make profits). The seller then decides either to accept or reject the contract.

The price slide modifies the contract price in the following way:

$$p(y;y_0,p_0,\gamma,\delta) = \begin{cases} p_0 - \gamma(y - y_0 - \delta) & \text{if } y \geq y_0 + \delta \\ p_0 & \text{if } y < y_0 + \delta \end{cases} \tag{1}$$

The tolerance in estimation error is known as weight allowance and is represented by δ. We assume that it is pre-established so that neither buyer nor seller can decide upon its value[1]. The delivery weight is given by y, and $p(y)$ is the price actually paid per cwt. at the time of delivery, when the average weight is finally revealed to buyer and seller. The payment $p(y)$ is a compensation scheme which penalizes the seller if delivered weights are greater than $y_0+\delta$. Compensation schemes of this type are used in many real world contractual relationships where asymmetric information exists (e.g., Phlips; Harris and Raviv).

Let r_s and r_b be the seller's payoff and the buyer's share of the cattle's value, respectively:

$$r_s = \begin{cases} (p_0 - \gamma(y - y_0 - \delta))y & \text{if } y \geq y_0 + \delta \\ p_0 y & \text{if } y < y_0 + \delta \end{cases} \tag{2}$$

$$r_b = \begin{cases} (\nu(y,z) - p_0 + \gamma(y - y_0 - \delta))y & \text{if } y \geq y_0 + \delta \\ (\nu(y,z) - p_0)y & \text{if } y < y_0 + \delta \end{cases} \tag{3}$$

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[1] In practice, the weight slide is also a choice variable of the seller. For a time, the SLA did fix the weight slide, but quit since it was unpopular. In order to keep the model as simple as possible, weight slide is assumed fixed. Weight slides observed in the SLA do vary little for a given weight range, so the assumption is reasonable. Although one could take $y_0+\delta$ as a single variable throughout the analysis, y_0 and δ are kept separate to match the real world situation.

Here, $v(y,z)$ is the value per cwt. of the cattle when weight is known and z is a vector of other relevant variables. That $v(y,z)$ is a decreasing function of y is a consequence of valuing heavier cattle lower than lighter cattle. The utility of buyer and seller will depend on r_b and r_s respectively[2].

The contract can be viewed as a two-person dynamic game with continuous strategies that will be approached using 'backwards induction' (Gibbons, 1992; Fundenberg and Tirole, 1992). The stages of the game are as follows:

1. The seller offers an estimate of the weight y_0 and the price slide γ.

2. The buyer offers a price per cwt., the contract price p_0.

3. The seller either accepts or rejects the offer.

Assume the seller accepts the contract at stage 3. This implies that the buyer offered a contract price that, given the values of y_0 and γ (fixed for the buyer), maximizes the seller's utility while keeping the buyer's utility at its reservation level (which we will assume to be zero). So the seller knows the problem with which the buyer is confronted. If he could solve the buyer's problem, that is obtain the buyer's best response function $p_0^*(y_0,\gamma)$ that guarantees the buyer his reservation utility, the seller would be able to select the optimum values for weight and price slide, y_0^* and γ*, so that $p_0^*(y_0^*,\gamma^*)$ maximized his own utility. The existence of $p_0^*(y_0,\gamma)$, y_0^*, and γ* would guarantee sub-game perfection and the problem would be solved.

Unfortunately, although the seller knows the general problem faced by the buyer, he is not able to 'rationally guess' the buyer's subjective probability distribution of cattle weights (note that the distribution of weights is crucial in calculating expected profit or utility). Most likely the buyer will choose a distribution of weights based on the information given by the seller (y_0 and γ). With this probability distribution, the buyer is to obtain his best response function $p_0^*(y_0,\gamma)$. If we were to assume the form of the distribution, say, normal, we would still face the problem of having two more variables: the buyer's estimate of the cattle's mean weight and variance. With fewer equations than variables, solutions are no longer possible or guaranteed, but future research could focus on trying to determine general characteristics of

[2] Prevatt refers to the compensation scheme in (1) as a one-way slide. When buyer and seller have symmetric information, a two-way slide could be used where premiums are paid if cattle are lighter than expected. With additional assumptions such as risk neutrality, no incentive problem regarding excessive feeding, and a single buyer with known value function $v(y, z)$ then it is actually optimal to have a slide equal to $v_y(y, z)$ and have both, discounts and premiums. But, none of these assumptions are actually true. Two-way slides are sometimes used (Prevatt). We use a one-way slide since it is what SLA uses.

the buyer's subjective distribution function that would allow for equilibrium solutions to the problem.

Still, we do obtain a necessary condition for optimally selecting the price slide that suggests that the price slide should be bigger than the market's weight discount and not equal to it as has been proposed by Prevatt. Also, with further assumptions on the probability distribution of weights used by buyer and seller, values for γ are found as if determined exogenously, such that the seller has no incentive to give an erroneous estimate of the cattle's weight.

A lower bound for the price slide

The buyer's problem is to find p_0 that satisfies

$$\int_{y_{\min}}^{y_{\max}} u_b(r_b(p_0; y_0, \gamma)) f_b(y; y_0, \gamma) dy = 0,$$

where y_0 and γ are taken as constants, u_b is the buyer's utility function, and f_b is the buyer's subjective density function of cattle weights. Assume the solution to the buyer's problem is the best response function $p_0^*(y_0, \gamma)$; then the seller's problem is to find y_0 and γ that satisfy

$$\max_{y_0, \gamma} \int_{y_{\min}}^{y_{\max}} u_s(r_s(p_0^*, y_0, \gamma)) f_s(y; y_0, \gamma) dy, \tag{5}$$

where u_s is the seller's utility as a function of his payoff and f_s is the density function of cattle weights according to the seller's beliefs. Assuming risk neutrality we can directly replace (3) into (4) and express the buyer's problem as

$$\int_{y_{\min}}^{y_0+\delta} (v - p_0) y f_b(y) dy \quad + \quad \int_{y_0+\delta}^{y_{\max}} (v(y) - p_0 + \gamma(y - y_0 - \delta)) y f_b(y) dy \quad = 0$$

Rearranging, we have that the contract price should satisfy

$$p_0 = \frac{E_b(v(y)y) + \gamma \int_{y_0+\delta}^{y_{\max}} (y - y_0 - \delta) y f_b(y) dy}{E_b(y)} \tag{6}$$

where E_b denotes the expectation with respect to the buyer's density function of cattle weights.

This result indicates that the contract price can be interpreted as the expected value per cwt. according to the buyer plus the discount per cwt. the buyer expects will apply. In other words, the buyer includes in the contract price the discount he expects will be 'returned' to him at the time of delivery.

To analyze the seller's problem, one more assumption is made; the seller's distribution of weights is assumed normal with parameters μ and σ^2. So he will want to solve:

$$\max_{y_0,\gamma} \quad S = p_0^*(y_0,\gamma)\mu - \frac{\gamma}{\sigma\sqrt{2\pi}} \int_{y_0+\delta}^{y_{max}} (y - y_0 - \delta) y \exp(-\frac{(y-\mu)^2}{2\sigma^2}) dy \,. \tag{7}$$

The first order conditions are $\partial S / \partial y_0 = 0$, and $\partial S / \partial \gamma = 0$.

Since $\partial S / \partial y_0 = \mu(\partial p_0^* / \partial y_0) + \frac{\gamma}{\sigma\sqrt{2\pi}} \int_{y_0+\delta}^{y_{max}} y \exp(-\frac{(y-\mu)^2}{2\sigma^2}) dy = 0$, or

$$-\frac{(\partial p_0^* / \partial y_0)}{\gamma} = \frac{\frac{1}{\sigma\sqrt{2\pi}} \int_{y_0+\delta}^{y_{max}} y \exp(-\frac{(y-\mu)^2}{2\sigma^2}) dy}{\mu} \le 1,$$

we have as a necessary (but not sufficient) condition for optimality that

$$\gamma \ge -(\partial p_0^* / \partial y_0) \,. \tag{8}$$

Equation (8) says that the slide should be set above the absolute value of the slope of the buyer's best response function. Since $p_0^*(y_0,\gamma)$ is expected to be very close to the real value of the cattle, $v(y)$, equation (8) also suggests that the slide should be greater than market's weight discount. Thus the result does not agree with Prevatt's general rule of setting the slide *equal* to the market's weight discount.

A price slide that provides incentives for unbiased estimates of cattle weight

Now let us further assume that the slide could be determined by a 'supervising entity' in order to promote fair contracts. Rather than letting the seller set the price slide value to his own convenience, we would like to set the value of the slide so that subgame perfect equilibrium is reached when the seller gives an unbiased estimate of the weight.

The seller's revenue in equation (7) is maximized but now, γ is set exogenously. The first order condition implies setting $\partial S / \partial y_0 = 0$. Then the equivalency $y_0 \equiv \mu$ is imposed, and γ^{**} is obtained that satisfies the first order condition modified by setting y_0 equal to μ. Since the buyer knows that the price slide is not a variable for the seller any more, he will take the seller's estimate of weight as the mean of his subjective probability distribution of weights; i.e., $\mu_b = y_0$. The variance of weights is assumed to be equal for buyer and seller, σ^2.

With γ^{**}, the seller will optimize revenue (by satisfying his first order condition), when he chooses the base weight y_0 to be equal to his real estimate of the weight μ.

The value of the slide derived by proceeding in this way, and after simplification is:

$$\gamma^{**} = \frac{\int_{y_{\min}}^{y_{\max}} \nu(y) y \left(\frac{y-\mu}{\sigma^2} - \frac{1}{\mu}\right) \exp\left(-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2\right) dy}{\int_{\mu+\delta}^{y_{\max}} (y-\mu-\delta) y \left(\frac{y-\mu}{\sigma^2} - \frac{1}{\mu}\right) \exp\left(-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2\right) dy} \qquad (9)$$

where y_{min} and y_{max} are $-\infty$ and ∞ respectively in theory, but for interpretation purposes they can be understood as realistic lower and upper bounds for the weight of the animal since the probability of y values beyond those limits can be considered negligible. Since equation (9) above is hard to interpret intuitively, a graph is presented for γ^{**} as a function of the slope of $\nu(y)$, the value of the cattle.

Empirical Models

In this section we take an empirical approach to better understand feeder cattle contracts and check the findings from the previous section. First we test whether base weights are unbiased predictors of actual weights. Then, we use regression analysis to test if weight variability increases with time to delivery, and estimate the effects of the contract weight, weight slide, price slide, and time to delivery on the contract price. Finally, the slide required for sellers to provide an unbiased estimate of the weight (γ^{**} given in equation (9)) is plotted against $\nu(y)$, the value of the cattle. This allows comparing actual values of the price slide with those predicted by the game theoretical model, for given values of the market's weight discount.

The data used to test for unbiasedness of the base weights and to estimate the two regression models are actual Superior Livestock Auction data for the 1987-1989 period[3]. The data contain information on lot characteristics, contract prices, base weights, and other relevant variables needed to estimate the models. Summary statistics are reported in table 1.

Test for unbiasedness

If sellers' estimates of average delivered weights are unbiased, the mean of the differences between actual and estimated delivery weights should be zero. This hypothesis is tested using a paired differences t-test.

[3] 1993 data were later available. Since data were incomplete, regression equations could not be estimated but the test for unbiasedness was conducted.

The t-ratio and p-value of the paired t-test are 5.007 and .0001 respectively, for the 1987-1989 period[4]. The p-values indicate that the weights are significantly different at the 5 percent level, so sellers underestimate average weights. Table 1 shows that the bias was small (3.5 lbs.).

Weight variability and time to delivery relationship

The assumption that weight variability increases with time to delivery is tested using the following equation:

$$y - y_0 = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_3 + \alpha_3 D_4 + \alpha_4 Year88 + \alpha_5 Year89 + \alpha_6 Steers + \alpha_7 West + \alpha_8 South + \alpha_9 Upper + \alpha_{10} WCoast + \upsilon$$

where υ is distributed with mean zero and variance

$$\sigma_\upsilon^2 = \exp(\beta_0 + \beta_1 Y_0 + \beta_2 Y_0^2 + \beta_3 Steers + \beta_4 Time + \beta_5 Year88 + \beta_6 Year89 + \beta_7 D_1 + \beta_8 D_3 + \beta_9 D_4 + \beta_{10} West + \beta_{11} South + \beta_{12} Upper + \beta_{13} WCoast)$$

The variable y is actual weight, y_0 is base weight, *Steers* is a dummy variable for steers, *Time* denotes time to delivery, *Year88* and *Year89* are dummy variables for year, the D_is are quarter dummy variables, and *West, South, Upper*, and *WCoast* are dummy variables representing the regions where the cattle are located. Equations (10) and (11) are estimated using the maximum likelihood estimation procedures in SHAZAM. The primary coefficient of interest is β_4, the coefficient on time to delivery (*Time*) in the variance equation.

The parameter estimates of equations (10) and (11) are reported in tables 3. The parameter estimate of time to delivery in the cattle weight variance equation (table 3) is positive, indicating that time to delivery has a positive effect on the error variance.

Contract price

The effects of the contract weight, weight slide, price slide, and time to delivery on the contract price are derived from a hedonic regression equation. Feeder cattle hedonic regressions have been used by Turner, Dykes, and McKissick, Bailey, Peterson, and Brorsen, and Bailey, Brorsen, and Fawson. Our equation is

$$P_0 = \alpha_0 + \alpha_1 \gamma + \alpha_2 \delta + \alpha_3 y_0 + \alpha_4 y_0^2 + \alpha_5 Time + \alpha_6 Time^2 + \alpha_7 \gamma \cdot \hat{\sigma}_v + \alpha_8 \delta \cdot \hat{\sigma}_v + \sum_{i=9}^{K1} \alpha_i Olc_i + \sum_{i=K1+1}^{K2} \alpha_i Omc_i + \varepsilon \tag{12}$$

[4] For the 1993 data, the t-ratio and p-value are 3.167 and 0.0015 respectively.

where ε has mean zero and variance

$$\begin{aligned}\sigma_\varepsilon^2 = \exp(&\beta_0 + \beta_1 Y_0 + \beta_2 Y_0^2 + \beta_3 Head + \beta_4 Head^2 + \beta_5 Time + \beta_6 Time^2 + \beta_7 Futures \\ &+ \beta_8 Futures^2 + \beta_9 D_1 + \beta_{10} D_3 + \beta_{11} D_4 + \beta_{12} West + \beta_{13} South + \beta_{14} Upper \\ &+ \beta_{15} Wcoast + \beta_{16} Year88 + \beta_{17} Year89).\end{aligned} \tag{13}$$

The variable p_0 is the contract price, $\hat{\sigma}_\upsilon$ is the predicted value of σ_υ , δ is the weight slide, γ is the price slide, *Futures* is the nearby futures price, *Olc* is other lot characteristics, *Omc* is other market conditions, *Head* is the number of head, and all other variables are defined as previously. The mean and variance equations of this regression model are estimated using maximum likelihood. The estimated mean equation is used to plot the contract price against base weight, weight slide, and time to delivery.

In the contract price equation (table 4), the parameter estimates of the price slide variables are all positive. The base weight was used in equation (12) in quadratic form. The parameter estimate of the base weight is negative while that of the square of the base weight is positive. Figure 1 shows the effect of the base weight on the contract price. As expected, the contract price decreases as base weight is increased. The effect of time to delivery on the contract price is plotted in figure 2. The contract price increases with small values of time to delivery and decreases otherwise. In the actual data set, most of the values of time to delivery are within the range where the contract price increases. This explains why Bailey, Brorsen, and Fawson found that time to delivery has a positive effect on the contract price.

The effect of the weight slide on the contract price is shown in figure 3. The contract price decreases when the weight slide is increased. This result was expected since the base weight and the weight slide must have the same effects.

Comparing the actual price slide with the model's predictions

To see if in reality the price slide is set at the value that makes the seller want to provide an unbiased estimate of cattle's weight (according to the analytical model), an estimate of the weight discount is needed. The quadratic in (12) was approximated linearly, and the coefficient of base weight was taken as an estimate of the weight discount. This value is –0.038 cents/lb^2, or –0.00038 \$/lb^2. On the other hand, the average value of the price slide is 5.3 cents/cwt. or 0.00053 \$/lb. So the slide is around 1.4 times greater than the absolute value of the weight discount. This result had been suggested by the necessary condition given in equation (8); that the slide is expected to be bigger than the weight discount. But when plotting equation (9), as seen in figure 4, the analytical model indicates that a bigger difference among these values is needed, compared to what the data shows, to guarantee unbiased estimates of weight.

Since the model predicts that the price slides used at SLA are not big enough to avoid unbiased estimates of cattle weight, we would expect to see this difference in the data. In fact, as seen in table 2, actual weights are slightly larger than base weights.

Conclusions

Feeder cattle sold through video auctions and by private treaty are often for future delivery. Because delivery weights are not known when cattle are contracted, sellers must estimate them. Since sellers and buyers have asymmetric information about cattle weights, contracts need to be structured to provide sellers with an incentive to not misrepresent their estimates of average delivery weights.

The usual approach to dealing with weight uncertainty is to adjust the original contract price by a price slide. Producers underestimate actual weights, so the present system does lead to a little bias. According to the model, a higher value for the price slide is expected to make the bias statistically insignificant.

Contract prices increase with time to delivery. This is probably due to the fact that as time to delivery increases, the uncertainty about cattle weights increases which in turn increases the value of the implicit option created by the price slide. Higher price slides are associated with higher contract prices.

One possible drawback of the model is that it assumes that both, buyer and seller will have the same standard deviation of their estimates of weight. But little could be done without making some kind of assumptions on the probability distributions of weights for buyer and seller. However, a basic conclusion from both the analytical and empirical models, is that the price slide should be set higher than the weight discount and not equal to it as has been suggested.

Table 1. Summary Statistics of Selected Variables, Video Cattle Auction Data, 1987-1989

Variable	Units	Mean	Minimum	Maximum	Standard Deviation
Head offered		155.0	19.0	2250.0	132.2
Head delivered		153.1	14.0	1980.0	129.3
Base weight	pounds	631.2	240.0	1200.0	140.8
Actual weight	pounds	634.7	158.1	1244.6	143.4
Contract price	$/cwt.	82.4	51.5	130.0	10.6
Difference in number of head		-1.7	-1925.0	1435.0	77.6
Difference in weight	pounds	3.5	-381.9	385.1	38.7
Price slide	cents/cwt.	5.3	0.0	80.0	3.7
Weight slide	pounds	15.6	-25.0	40.0	7.4
Time to delivery	days	37.7	1.0	290.0	36.5

Note: The number of observations is 3119.

Table 2. Parameter Estimates of the Cattle Weight Variance Equation, Feeder Cattle Auction Data, 1987-1989

Variable	Parameter Estimate	Standard Error
Mean equation		
Intercept	4.7861*	1.8190
Steers	7.5208*	1.3060
Year88	-1.5834	1.8610
Year89	-6.4764*	1.9240
D_1	0.4099	1.9090
D_3	-7.9019*	1.7550
D_4	-3.4734**	2.0230
West	1.4832	2.0830
South	3.8760*	1.9600
Upper	-1.1749	5.7010
WCoast	4.1391	2.8100
Variance equation		
Intercept	4.8502*	0.4648
Base weight	0.0048*	0.0015
Base weight squared	-0.0021*	0.0011
Time	0.0039*	0.0007
Year88	0.0179	0.0706
Year89	-0.1806*	0.0762
D_1	0.1400*	0.0752
D_3	0.3143*	0.0695
D_4	0.0905	0.0894
West	0.2621*	0.0779
South	-0.2460*	0.0993
Upper	-0.4261**	0.2674
WCoast	-0.3396*	0.1452
Estimated loglikelihood	-15684.5000	

Note: Asterisks denote significance at the 5 percent level

Table 3. Parameter Estimates of the Contract Price Equation, Video Cattle Auction Data, 1987-1989

Variable	Parameter Estimate	Standard Error
Mean equation		
Intercept	10.3400	15.3800
Futures price	2.4539*	0.4008
Futures price squared	-0.0109*	0.0026
Steers	4.4599*	0.2879
Head	0.0012*	0.0005
Base Weight	-0.11471*	0.0047
Head squared	-0.0005**	0.0003
Base weight squared	0.0000764*	0.0035
English-Exotic-Cross	-0.7040*	0.3470
English-Cross	-0.6731*	0.3498
Exotic-Cross	-1.2781*	0.3773
Angus	0.9993	0.7197
Dairy	-10.1170*	0.5075
Medium Heavy	-1.6031*	0.4028
Medium Flesh	-1.5601*	0.3833
Light-Medium Flesh	-1.8281*	0.4177
Large Frame	4.5034*	1.5470
Medium-Large Frame	3.6222*	1.5480
Medium Frame	1.5903	1.5840
No Horn	0.2962	0.4784
Some Horn	-0.4757*	0.1163
D_1	0.8801*	0.1650
D_3	2.0416*	0.3159
D_4	1.1826*	0.2501
West	0.0790	0.1998
South	-4.5778*	0.2901
Upper	2.2601*	0.4592
WCoast	-2.3772*	0.2928
LSW	-1.1652*	0.1245
Truck	-0.4893	0.4111
Unmixed	0.8959*	0.4669
Time	0.0229*	0.0029
Miles	-0.0127*	0.0002

Table 3. Continued

Price Slide (*Pslide*)	0.0634*	0.0175
Weight Slide (*Wslide*)	-0.0270*	0.0147
Year88	1.1773*	0.2239
Year89	2.7880*	0.3422
Time squared	-0.00009*	0.0000
Wslide $\bullet \hat{\sigma}_v$	0.0047*	0.0015
Pslide $\bullet \hat{\sigma}_v$	0.0282*	0.0037
Variance equation		
Intercept	18.5030*	7.5400
Base weight	-0.0250*	0.0015
Base weight squared	0.0164*	0.0011
Head	-0.0011*	0.0003
Head squared	0.0002	0.0002
Time	-0.0053*	0.0017
Time squared	0.000006	0.0000
Futures	-0.1781	0.2002
Futures squared	0.0011	0.0013
West	-0.1408*	0.0781
South	0.1419	0.0995
Upper	-0.7824*	0.2690
WCoast	-0.4865*	0.1458
D_1	0.0117	0.0944
D_3	0.1506	0.0994
D_4	0.1706	0.1131
Year88	-0.2471*	0.0958
Year89	-0.2976*	0.1168
Estimated loglikelihood	-7775.6000	

Note: Asterisks denote significance at the 5 percent level

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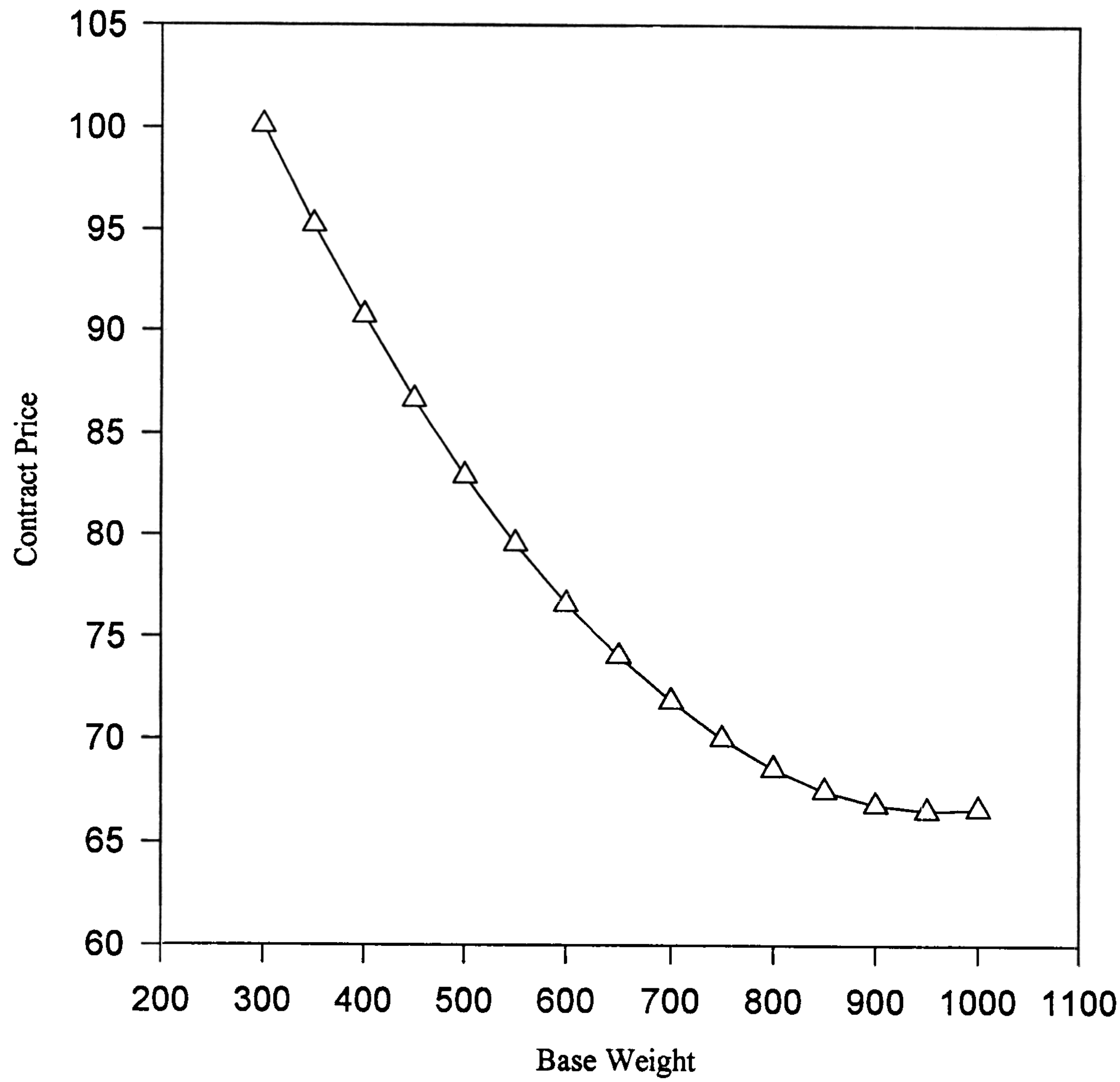

Figure 1. The effect of cattle weights on the contract price

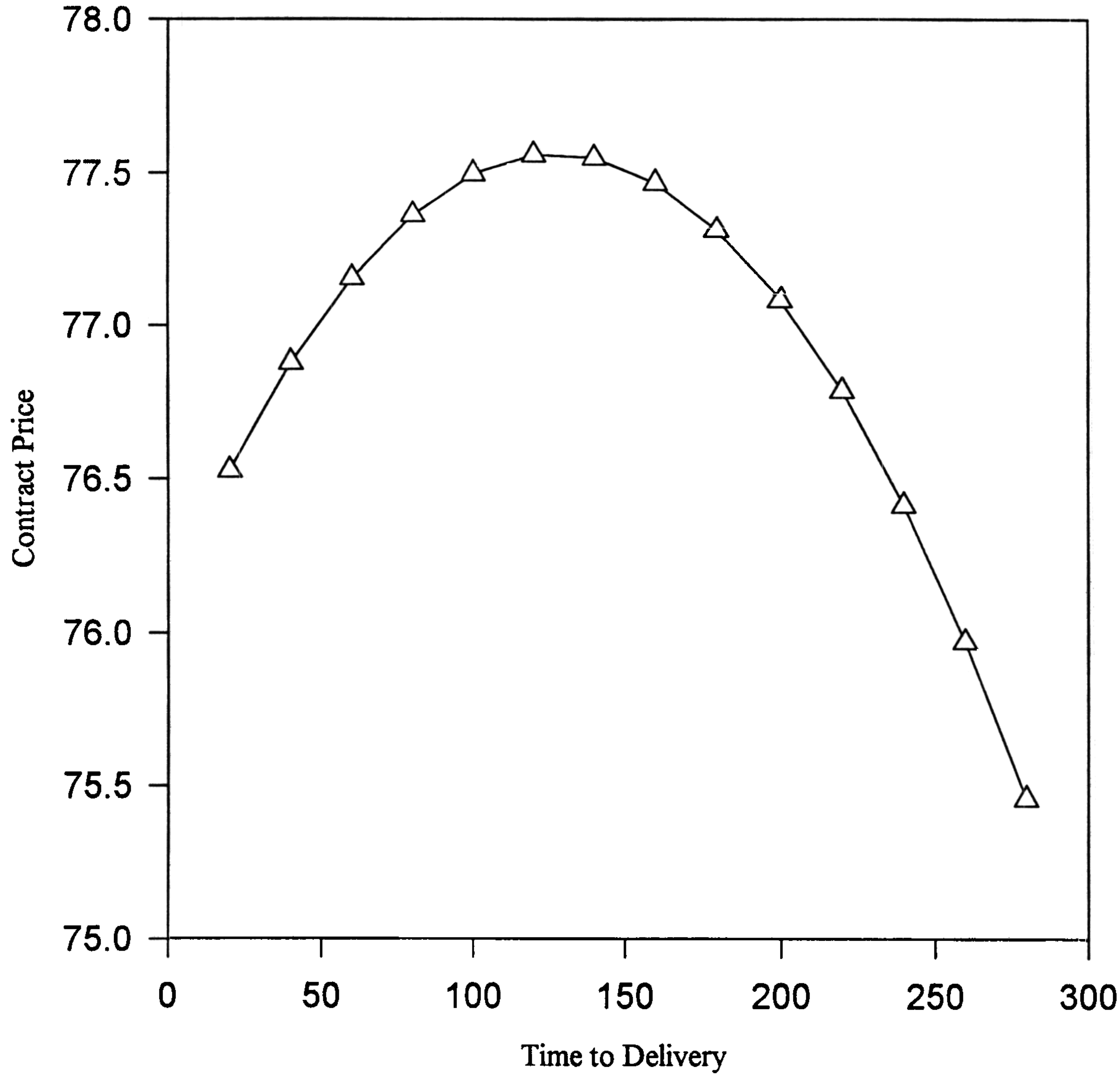

Figure 2. The effect of time to delivery on the contract price

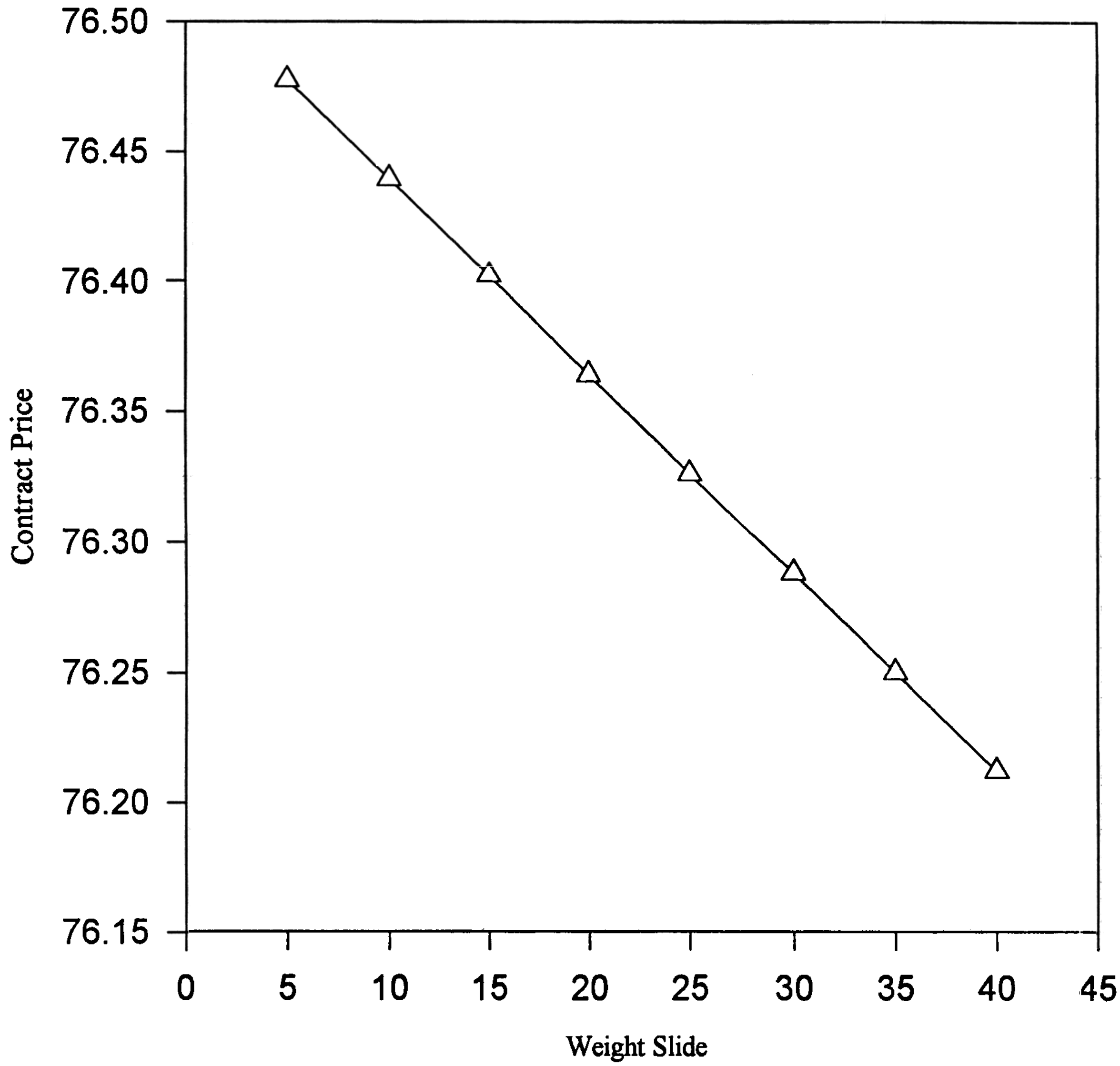

Figure 3. The effect of cattle weight slides on the contract price

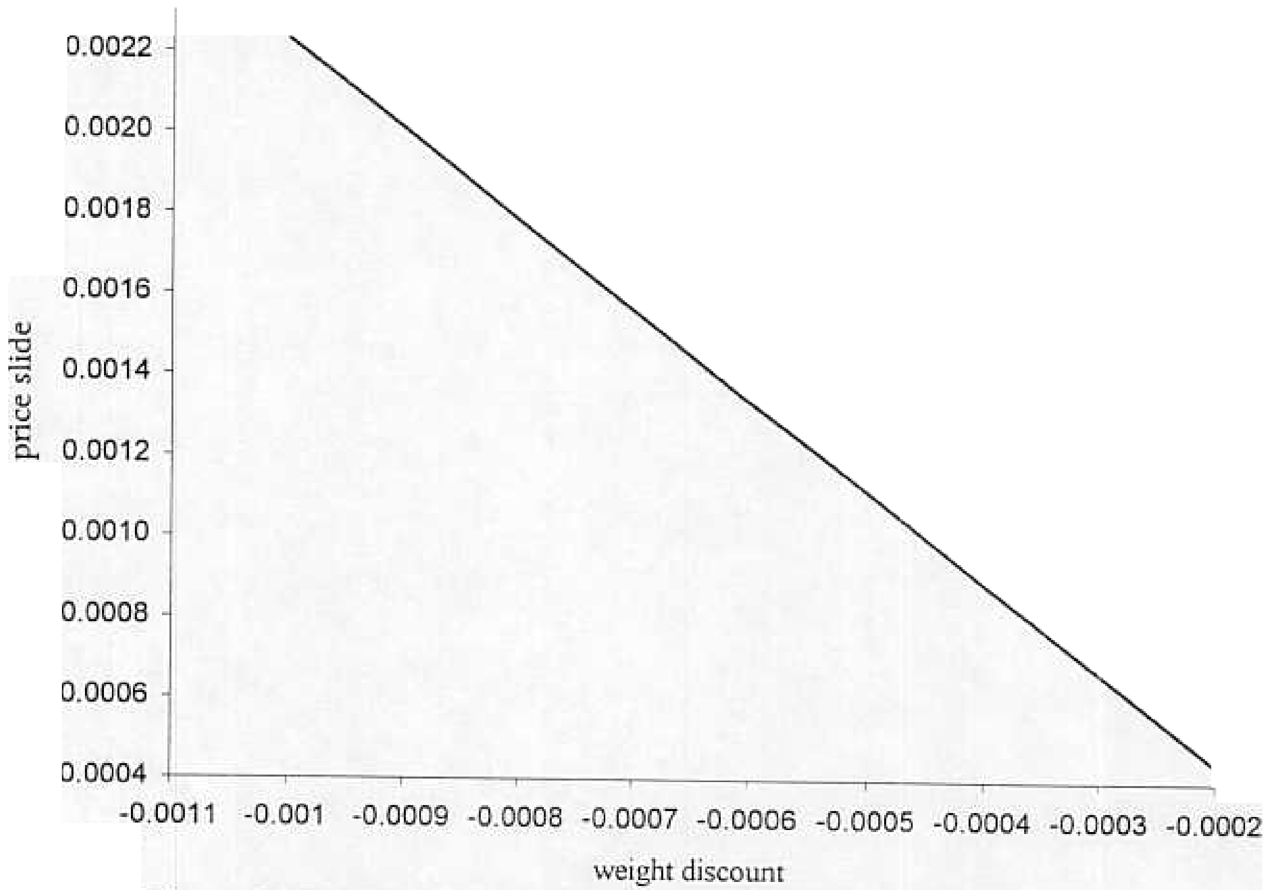

Figure 4. The Price Slide as a Function of Weight Discount as Predicted by the Model