NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

Formula Pricing of Feeder Pigs

by

John D. Lawrence and Jennifer Schmidt

Suggested citation format:

Lawrence, J. D., and J. Schmidt. 1992. "Formula Pricing of Feeder Pigs." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

Formula Pricing of Feeder Pigs

John D. Lawrence and Jennifer Schmidt[1]

Increasingly feeder pigs are sold directly from producer to finisher and are not traded through an organized market with centralized price determination. A variety of reasons supports this trend, however, animal health concerns and marketing efficiency are two primary reasons. As a result, auction market receipts have declined to the point of concern over how representative feeder pig quality and the resulting spot market price are for use in pricing direct trade pigs. While auction market prices may still serve as a base for direct trade price negotiations, state budget cuts have reduced or eliminated government price reporting of auction markets. Buyers and sellers are then left to their own accord to find an auction price from which to begin negotiations. A feeder pig price formula based on easily observable variables would simplify price negotiations.

There is also growing interest in longer term feeder pig supply and pricing agreements. An increasing number of contract finishers require a steady supply of high quality pigs to fill multiple production units and may contract to buy all of the pigs from a given farrowing facility. Likewise, feeder pig producers, and their lenders, are looking for pricing agreements that remove some of the variability in feeder pig prices. A formula price that buffers the wide feeder pig price variations or offers guaranteed minimum prices would be of particular interest in long term contractual arrangements.

Feeder pig pricing formulas are not a new economic or marketing concept. Formulas based on $20/cwt market hogs, $1.00/bu corn and $15/head feeder pigs are quite prevalent in the literature. Early formulas were based on current cash hog prices (Futrell) and seldom accounted for important input costs such as corn price or overhead cost that also impact feeding profits (Bitney). The obvious problem with formulas based on current barrow and gilt prices is that the finished hog will not sell at current prices but rather at prices approximately four months in the future. More recent formulas have used current prices for futures contracts that expire in four months which offer an easily observable forecast of expected selling prices of the finished hog (Skadberg). Although some formulas attempt to incorporate feed and overhead costs into feeder pig prices, they are often charged with being too complicated to be useful.

Another short fall of formula prices for feeder pigs is that the calculated formula price often does not match the observed spot market price. Although the buyer and seller know at the time the formula is agreed upon that it will differ from the spot market price, a formula that greatly under or over prices pigs will strain a trading arrangement. Thus, the question is whether a formula should reflect the actual spot market feeder pig price or what it "should" be given available information. This question is further complicated by requiring that the formula be simple enough to practical.

This work examines two basic types of feeder pig pricing formulas. First, is regression analysis of historic data to model what spot market prices have been given the economic environment at the time. And second, partial budgeting is used to evaluate what price buyers and sellers may accept given expected selling prices for barrows and gilts and observed input prices. The results are compared to spot market prices and by the impact each would have on returns for both the finisher and feeder pig producer.

---

[1] Assistant Professor and Graduate Research Assistant at Iowa State University. Paper Presented at the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago Mercantile Exchange, April 20-21, 1992.

Regression Analysis

The demand for feeder pigs by buyers is dependent on the potential profit he or she can make by finishing them. Expected profits are based on the expected selling price and the cost of inputs required to feed the pigs to slaughter weight. The buyer must forecast cost of production and selling prices in order to determine an acceptable purchase price. Although total cost of production must be covered in the long run, the short run decision of whether or not to finish feeder pigs depends on the variable cost of production. The live hog futures contract price (HFP) that expires near the time hogs are expected to be marketed and adjusted for the expected basis offers producers an easily observable price forecast. Interest rates (INT) are set at the time the pigs are purchased feed prices (corn (CCP) and soybean meal (SBMP)) are observable. Thus, expected profits can be expressed as

$$E(\pi) = f\ (HFP, CCP, SBMP, INT).$$

This analysis uses weekly average prices of U.S., 1-2, 40-50 pound feeder pigs at Iowa auctions; U.S., 1-2, 230-250 pound barrows and gilts in Iowa - Southern Minnesota direct trade; North Central Iowa corn; Decatur, Illinois soybean meal (USDA Market News), and live hog futures prices for the four month out contract (Chicago Mercantile Exchange). Monthly average interest rates were used (Iowa State University Estimated Livestock Returns). The data are for the 1975 - 1990 period and are summarized in Table 1. The regression models were estimated over the January 1975 through December 1985 period which encompasses two complete hog cycles. Results were compared out of sample, January 1986 through December 1990, a third complete hog cycle.

Table 1: Summary Price Statistics of Price Key Variables, 1975-1990

Variable	Average	Std. Dev.	Minimum	Maximum
Feeder Pig (head)	42.60	10.20	20.69	67.67
Feeder Pig (Cwt)	94.66	22.67	45.98	150.38
Cash Hog (Cwt)	46.99	7.17	27.60	66.06
Hog Futures (Cwt)	46.55	6.22	30.20	60.50
N.C. Iowa corn (bu)	2.32	0.48	1.11	3.37
Soybean Meal (ton)	179.18	36.53	103.00	320.00
Interest Rate (%)	11.82	2.77	8.25	19.00

As may be expected with time series analysis, the data suffered from serially correlated error terms. Thus, the Cochrane-Orcutt (C-O) procedure of correcting for autocorrelation was used to estimate the model (Equations 1 and 2). However, the primary objective of this analysis is to find a formula that feeder pig buyers and sellers can use to establish a transaction price. Although the C-O model accurately estimates actual feeder pig prices, it requires a great deal of information (current prices and previous errors) making it impractical for most buyers and sellers. The models were also estimated using ordinary least squares (OLS) which resulted in unbiased but inefficient parameter estimates (Equations 3, 4, and 5). However, OLS models require less information and are easier to use than C-O models.

Upon analysis it was found that soybean meal prices and interest rates did not significantly impact feeder pig prices and are not included in the following equations. Comparisons to actual prices are shown in Table 2.

Feeder pig price per hundredweight =

1)	65.02 + 0.86*HFP - 5.47*CCP (11.38) (0.16) (3.34)	rho=0.945	r^2=0.93
2)	15.42 + 0.67*HFP - 7.92*CCP + 1.40*CHP (11.75) (0.15) (3.06) (0.18)	rho=0.915	r^2=0.94
3)	-6.16 + 2.10*HFP (4.76) (0.10)	DW=0.25	r^2=0.44
4)	32.85 + 2.73*HFP - 27.90*CCP (4.14) (0.08) (1.41)	DW=0.54	r^2=0.70
5)	37.45 + 2.63*HFP - 28.43*CCP + 7.79*D1 - 3.53*D2 (4.03) (0.08) (1.34) (1.22) (1.32)	DW=0.35	r^2=0.71

Values in parentheses are standard errors.

Equation 1 explains 93% of the variation in feeder pig prices using the hog futures price and cash corn price and the coefficients have the expected sign. The coefficient on CCP is significant at the 90% level, but not the 95%. The graph on the following page illustrates the relationship between actual feeder pig prices and feeder pig prices generated by Equation 1 using one step ahead forecasting. Equation 2 incorporates current cash hog prices into the price of pigs. While current prices have no impact on the profit potential of pigs purchased today, they do have a significant impact on their price. In fact, the coefficient is twice that of hog futures price and more highly significant. This result suggests that finishers rely at least partly on naive expectations when buying pigs. It also may reflect the impact of cash flow on purchasing decisions as higher cash hog prices generate larger cash flows and a greater demand for feeder pigs. The model tracks actual spot market prices quite well, but requires the estimation error from the previous period which most farmers would not have on record.

Although serial correlation nullifies testing the significance of coefficients in the OLS models, HFP and CCP remain intuitively the key variables. Equation 3 is the simplest formula but explains less than half of the variation in feeder pig prices. The constant is not likely significantly different from zero yielding a single variable formula. It has a lower mean price and considerably less variation than the spot market (Table 2). The two variable OLS model (Equation 4) has an r^2 of 0.70 and the coefficients have the expected sign. This formula over estimates price relative to the spot market and is slightly less variable. This equation seems to be a practical compromise between the accuracy of Equation 2 and the simplicity of Equation 3. The final OLS model includes dummy variables to capture the seasonal nature of feeder pig prices. Feeder pig prices typically are above the annual average price February through May (D1) and below average October through December (D2). The coefficients have the expected signs, but the added variables did not greatly improve the predictive accuracy of the model.

A common complaints of feeder pig producers is that the spot market is extremely variable. Table 1 confirms this concern as the minimum to maximum price range was greater than the average price. A method of reducing this variability would be to place an upper and lower boundary or border on the OLS formula price. A minimum border was set equal to the feeder pig producer's estimated total cost of production. The maximum border was set to cover the finisher's expected feed cost and 90% of operating cost but no overhead cost. If the lower border was higher than the upper border the difference was split between the buyer and seller. The borders selected had little impact on average prices or variability (Table 2). The number of times that the borders were binding are also listed.

Feeder Pig Prices

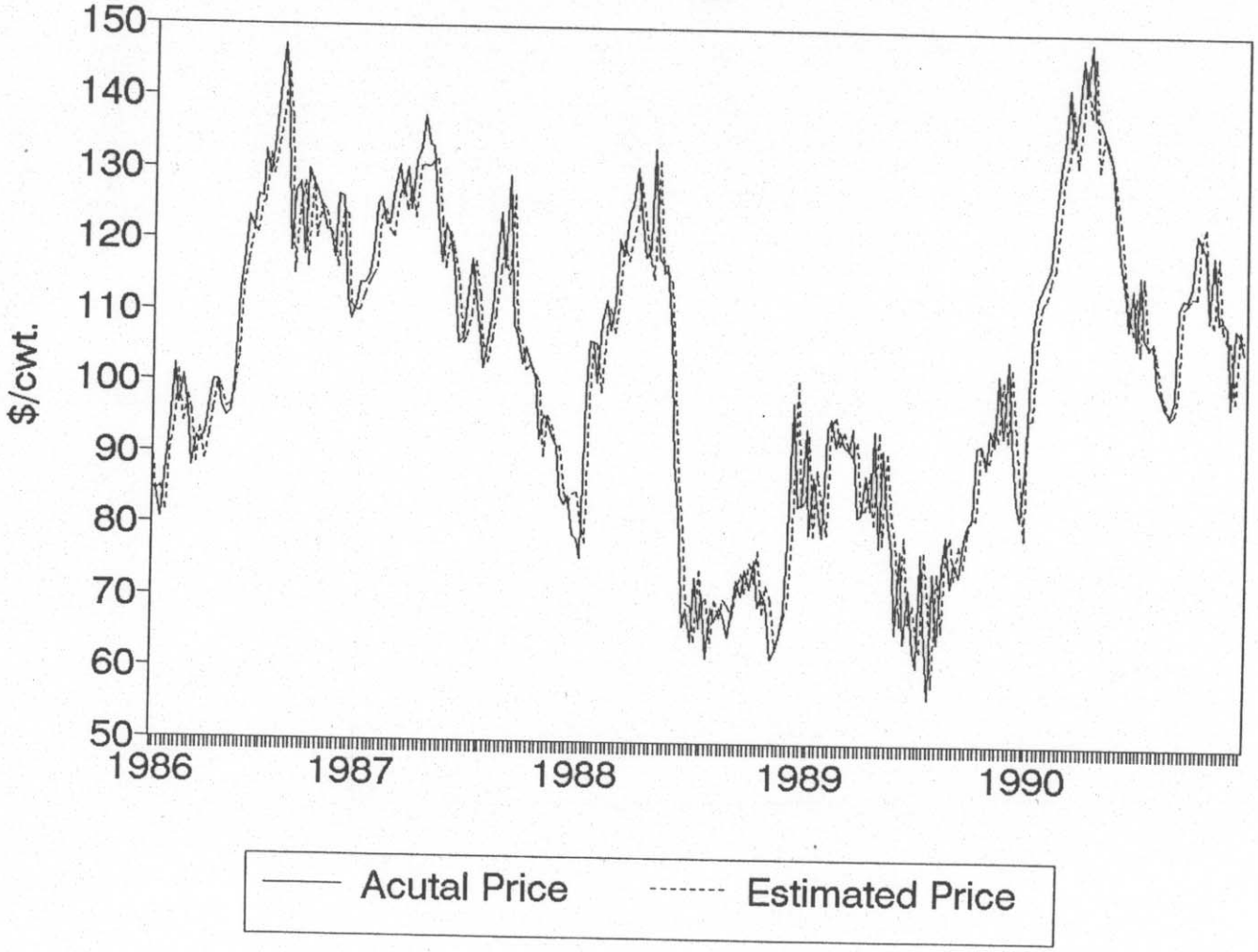

Table 2: Summary of Actual Feeder Pig Prices and Alternative Formula

	Average	Std. Dev.	Minimum	Maximum
Actual Price	101.99	21.81	56.40	148.62
Autocorrelated	101.74	20.81	59.97	149.17
One Variable OLS	98.21	8.78	79.99	125.35
Two Variable OLS	104.54	16.73	66.54	152.37
Seasonal Adjusted	110.37	16.78	73.04	158.39
One Variable OLS With Border	96.53	10.43	74.06	125.35
Boundary Hit	Upper	73	Lower	70
Two Variable OLS With Border	103.95	16.57	74.06	152.37
Boundary Hit	Upper	64	Lower	22
Should Pay	82.63	31.94	16.58	155.99
Cost Plus	101.05	6.13	90.40	119.89
Profit Share	86.35	14.76	58.28	117.22

Partial Budgeting

An alternative to trying to duplicate what spot market prices have been is to develop a formula that is agreeable to both the buyer and seller based on cost of production and profit objectives. While the resulting formula uses the same variables as the regression analysis, it focuses on what prices "should be" rather than what prices have been.

Iowa State University Swine Enterprise Records from feeder pig producers and finishers were used to estimate cost of production budgets (Table 3). Protein supplement price was assumed to be 1.75 times soybean meal price for both pig producers and finishers.

Table 3: Feeder Pig Production and Finishing Budgets

Inputs per Head	**Feeder**	**Finisher**
Corn (bu)	3.30	10.50
Supplement (lbs)	53.00	125.00
Operating cost w/labor	$17.00	$22.00
Overhead cost	$8.00	$7.00

The maximum a finisher should be willing to pay for feeder pigs is the residual of expected revenues less expected cost of production and his or her profit objective. Hog futures price adjusted for expected basis multiplied by a 240 pound market weight served as expected gross revenue. Corn and supplement prices at the time the pig was purchase were used, and the profit objective was $5.00 per head. The resulting price a finisher "should" pay was $19.36/cwt lower than the spot market price (Table 2) and more variable due to a lower minimum. The maximum price was only slightly higher than the highest spot market price, but the minimum is nearly $40/cwt lower than the spot minimum.

The flip-side of the coin would be a formula that guarantees that the feeder pig producer will cover his or her cost of production and receive an acceptable profit. This formula is essentially cost plus pricing. It uses the budget values in Table 3 and calculates a feeder pig price based on corn and supplement price at the time the pigs are sold and adds a $5.00 per head profit. This price is $0.94/cwt below the spot market (Table 2), but much more stable. Prices range less than $30/cwt from high to low compared to the $92.22 range in the spot market.

A third formula is one that shares the actual profit determined after that hogs are sold between the feeder pig producer and the finisher. The procedure employed here assumes a constant known deathloss and animal performance. However, the importance of these production variables on profit enhances these results. It assumes that the buyer enters an agreement that allows open records to the other party and that any necessary price adjustments are promptly paid. This formula assumes that actual ex post profits are split in proportion to the inputs supplied by each party (valued at pig purchase date) to finish the hog to market weight. Given the budgets in Table 3 the seller supplies 37% of the inputs and the buyer supplies 63%. Ex post profits value corn and supplement at the simple average price of prices during the pig purchase and hog sale weeks. This formula resulted in lower average and maximum prices, less variability, and a higher minimum price relative to the spot market (Table 2).

Impact on Buyer and Seller Returns

While average prices and variability are of concern, the more important question is how are profits effected under the different pricing arrangements. Feeder pig producer and finisher returns from spot market prices and the previously discussed formulas were compared over the 1986-1990 period. The yardstick is return to labor, overhead, and management and the results are summarized in Table 4.

The spot market provided the buyer a 28% higher return and a 41% wider range of returns than the seller. The budgets indicate similar labor and overhead costs for each. Comparing the pricing alternatives shows that profit sharing and paying what the finisher "should" pay produced the greatest return to the buyer. With the exception of the seasonally corrected OLS model, the other formulas generated returns similar to the spot market for the buyer. The seller received the greatest returns from the seasonally adjusted OLS and the two variable OLS model. The "should pay" formula produced the smallest and most variable returns to the seller. Cost plus pricing generated a slightly lower return than the spot market, but with no variability. Profit sharing cut seller returns by more than 50%.

It is doubtful that any one formula will satisfy both buyer and seller. However, when compared to the spot market, a few may deserve consideration. The first is the one variable OLS model. In addition to being the simplest formula, it offers the buyer a $1.75 higher return at slightly higher risk (down side risk increases by $2.16). The seller forgoes $1.70 average profit but reduces his or her down side risk to a -$0.32 per head. The profit share and cost plus formulas may also be possible if the terms are negotiated to make it attractive enough to the other party. That is, the buyer must give the seller a larger percent of the ex post profit to attract a compromise. Likewise, the seller may be willing to give up part of the "plus" to maintain the certain return.

Summary

Feeder pig buyers and sellers seeking an alternative to the increasingly thinly traded spot market have many alternatives from which to chose. The formulas put forth here are meant to be neither exhaustive or perfect solutions, but rather may serve as starting points for negotiation. Buyers and sellers should examine the impact of possible pricing formulas in their own operation relative to their own cost of production. The appropriate formula will depend on the needs of the parties and whether it is a one time sale or an ongoing agreement. Formulas would appear to work well in an ongoing agreement where the cost of a too high or too low price estimation will be offset on a later group. A one time sale should approximate the spot market price as there will not be another chance to make up a pricing error.

The sluggish nature with which feeder pig prices react to current market information and the resulting correlated error terms may also cause problems with formula pricing agreements. Formulas that do not incorporate the error will consistently under price pigs relative to the spot market for several weeks at a time before over pricing them for an extended period of time. Both parties must recognize that on average the errors will cancel out, but it may require patience. However, formulas that do incorporate previous errors lack in practically what they gain in accuracy.

The formulas described here and the comparison to actual spot market prices has two inherent problems. First, the regression analysis and comparisons are based on auction market prices which may not be representative of direct trade pigs. In fact, buyers and sellers trade directly because they believe that the pigs they trade are of higher quality (less stress, higher health status, etc.) than auction market pigs. Thus, the price derived by the regression formulas may need to be adjusted upward just as direct trade pigs sell at a premium to auction pigs. The partial budget formula are based on specific estimated production parameters. The production track record of the pigs on an individual's farm should be incorporated into the price negotiation process to more accurately reflect the value of the pigs to the buyer.

The second problem is that auction reporting by government agencies is declining. This lack of reporting is one of the reasons why producers may find formulas attractive as they are based on readily observable data. However, if feeder pig prices are no longer reported it will not be possible to update the formulas estimated here. Thus, formulas based on reported prices are a only short term substitute for reported prices. Just as the formulas offered by Futrell and others became outdated, these formulas may also need revision in a few years. Without a dependable feeder pig price series, formula updating will not be possible.

Table 4: Returns per Head to Labor, Overhead, and Management by Pricing Method

Buyer	Average	Std. Dev.	Minimum	Maximum
Actual Market	18.55	16.82	-20.69	62.39
One Variable OLS	20.30	20.29	-22.85	65.72
With Border	21.08	19.27	-19.74	64.46
Two Variable OLS	17.35	18.70	-20.68	67.33
With Border	17.63	18.43	-19.74	64.46
Should Pay	27.59	15.88	-7.55	73.95
Cost Plus	18.97	23.40	-31.96	64.67
Profit Share	25.84	14.60	-6.03	54.41
Autocorrelated	18.66	17.44	-21.30	63.69
Seasonal Adjusted	14.63	18.63	-21.88	63.99
Seller	**Average**	**Std. Dev.**	**Minimum**	**Maximum**
Actual Market	13.42	11.87	-11.14	37.41
One Variable OLS	11.72	5.26	-0.32	24.42
With Border	10.97	6.31	-4.76	24.42
Two Variable OLS	14.57	9.81	-11.01	39.25
With Border	14.31	9.62	-4.76	39.25
Should Pay	4.71	16.24	-31.52	39.54
Cost Plus	13.00	0.00	13.00	13.00
Profit Share	6.39	8.47	-12.05	22.90
Autocorrelated	13.31	11.37	-9.13	35.53
Seasonal Adjusted	17.19	9.84	-8.08	41.96

References

Bitney, Larry L., "Feeder Pig Pricing Formulas," University of Nebraska Cooperative Extension Service. Presented at the Feeder Pig Expo, February 1976.

Futrell, Gene A., "Feeder Pig Pricing Formulas," Iowa State University Cooperative Extension Service, M-1130, May 1972.

Skadberg, J. Marvin, "Feeder Pig Pricing Formulas," Iowa State University Cooperative Extension Service, December 1979.