METHODOLOGY FOR EVALUATING FORWARD PRICING ALTERNATIVES FOR AGRICULTURAL PRODUCTS—AN EXAMPLE ON FINISHING FEEDER PIGS

By

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Abstract

The short duration of agricultural commodity options has provided limited opportunity for evaluation. Microcomputer programs incorporating price and basis forecasts, along with the distribution of forecast errors, can help assess current forward pricing alternatives.
The introduction of agricultural options on a pilot basis in 1984 has expanded the alternatives for farmers in forward pricing. The traditional volatility of agricultural commodity prices makes the decision of when to sell or forward price a very crucial one. Yet farmers have not made extensive use of forward pricing instruments.

A survey of 750 Midwestern corn producers during the 1983 crop year indicated only minimal use was made of futures markets (Harwood, Hoffman and Leath). Only 35 farmers (less than 5 percent) had hedged corn prior to planting; 54 (7 percent) hedged during the growing season and 25 (3 percent) hedged stored grain. Including special trading schemes, a total of 71 farmers (9.5 percent) used futures as a forward pricing tool.

Forward contracting, which is an indirect use of futures, was much more common. From a low of 12 percent in Michigan and Kansas to a high of 61 percent in Iowa did farmers use this method to establish harvest prices. On corn sold out of on-farm storage, forward contracts typically represented 30-50 percent of sales.

Two major drawbacks for farmers to hedge are that: (1) they relinquish the opportunity to benefit from an unexpected sharp rise in prices; and (2) they are subject to margin calls from brokers. Options address both of these concerns in that they allow farmers to participate in bull markets and establish a maximum on the cash obligation. Options provide a means to establish a minimum on the selling price or a maximum on the buying price (for farmers buying corn and soybean meal).
In a sense, using options to establish a minimum price on products farmers sell has a correlation with the government non-recourse loans. The major difference is that farmers would have to pay a premium to buy options while the non-recourse loan requires compliance with acreage restrictions. Because of the possibilities for forward pricing with futures and options and because of their limited use, a mandate for a pilot project to investigate this modus operandi was included in the Food Security Act of 1985. Forty counties have been selected throughout the United States for special programs for field crop producers to encourage them to make use of forward pricing instruments.

To develop educational programs for this project, substantial amounts of historical data are available to evaluate the direct use of futures for forward pricing. However, the information is limited on agricultural commodity options, available for a period of just over three years. In absence of historical data, a number of researchers have resorted to the Black options pricing model (Black). Using the Black formula, they established what option premiums would have been in the past in order to evaluate this forward pricing alternative (Hudson, Hauser and Fortenbery; Lippke and Sporleder; and others).

A major omission from these studies has been an evaluation of the alternatives given the current market outlook—which may differ from the existing level of futures prices. Also, actual premiums on options may differ from those indicated by the Black formula. The purpose of this paper is to suggest an alternative approach to evaluating forward pricing schemes.

Procedure

The first step is to develop forecasting models which are geared to the forward pricing decision. Such models would probably be designed to predict monthly prices in the marketing period. Estimation of structural parameters
would not be of prime importance. Most germane would be to incorporate information known at the time the decision is made that is relevant to the forecast. Use of modern time series techniques such as ARIMA might be appropriate if proven more accurate than traditional fundamental approaches.

The model should be developed in an ex ante context, using what information was actually known at the time the forecast was made. This is not easily accomplished. If government statistics are incorporated, the original rather than revised series should be used. Time series used in the analysis should precede the period of each forecast.

The forecasts are then compared with the actual prices to establish the probability distribution of the error of the forecast. The prices being forecast could be either cash or futures markets. A second stage is to establish a probability distribution of "basis," the difference between the cash market of interest and the relevant futures contract. As with forecasting the general level of price, forecasts of basis should be derived with an ex ante approach. The forecast of basis for each period should be estimated from what was known at or before the time the decision is made.

Having a model to forecast the level of price and its probability distribution and the "basis" and its probability distribution, one can proceed to evaluate today's forward pricing alternatives. Simulation techniques are available to estimate the expected mean and variance of the net returns from the alternatives. The choice of which alternative to follow depends on the decision maker's ability and inclination to handle risk.

Example

To illustrate this approach, an example was developed for forward pricing hogs in a feeder pig finishing operation. The feeder pigs are purchased in March
and sold as slaughter hogs in July. The operator has six alternatives:

1. Do nothing. Take chances on the cash market in July.

2. Forward contract with a livestock market agency at $2.00 per cwt. under August futures.


4. Buy August puts at a strike price of $42.

5. Buy August puts at a strike price of $46.

6. Forward contract at $2.00 under August futures and buy an August call at a strike price of $46.

A model was developed to forecast July cash hog prices (average on barrows and gilts for seven major markets). All of the independent variables are known at the time feeder pigs are purchased. They are:

1. Price of barrows and gilts in March at 7 markets.

2. The number of hogs for breeding on farms, December 1 of the previous year.

3. The number of steers over 500 pounds and heifers not for replacement purposes on farms on January 1.

The number of hogs for breeding indicates the probable supply of slaughter hogs the following summer. The steer and heifer inventory is a proxy for the prospective beef supply in July, a major competitor to pork. Indicators of the competition for poultry meat were omitted because this is largely an upward trend and taken into account by the price of hogs in March. The effect of the competition from poultry meat, declining trends in demand for red meat, and the positive effect of consumer income should largely be captured by March prices. Little further effect would be expected between March and July.
Rather than final revised data on hog and cattle inventories, the original USDA estimates were used. This imparted some error to the forecast, but was not a major factor. In one respect, the analysis did depart from the recommended ex ante approach in that the time period of the analysis was concurrent with the forecast period, i.e., 1971-1987.

The statistical properties of the equation were adequate, but not strong. The coefficients on the variables have the expected sign, although the steer and heifer inventory coefficient was not significant at the 5 percent level. The $R^2$ was .62 and the D-W was 2.22. A plot of the actual and the predicted values for the price of barrows and gilts in July is shown in Figure 1.

The standard deviation of the predicted versus the actual price for 1971-1987 was $6.24. This represents a 13.4 percent error. The maximum positive deviation was $8.80 and the maximum negative deviation was $11.66. Efforts to improve on this prediction model resulted in minimal gains. Other analytical techniques to predict monthly hog prices have had similar results (Naik and Leuthold). Monthly prices appear more difficult to forecast than quarterly or annual prices. An analysis of an annual summer survey of members of the American Agricultural Economics Association for 1978-1986 indicated a root mean square percentage error of 8.7 percent in forecasting hog prices for the calendar year ahead (Ferris).

Basis was calculated for late July relative to August futures for hog prices at the Manchester, Michigan auction market of the Michigan Livestock Exchange (Austin). For 1978 to 1986, the average cash price was $1.91 over August futures with a standard deviation of $1.18. A study of the Omaha market for 1982-1987 indicated a standard deviation in basis of $1.81 (Mintert).
Figure 1

PRICE OF BARROWS AND GILTS AT SEVEN MARKETS IN JULY
PREDICTED VS ACTUAL

ACTUAL

PREDICTED

$/CWT

YEARS

71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87
Ideally, an analysis of price level and basis should be conducted for the same market. However, such a price series was not available for the Manchester market to cover the 1971-1987 period. If we assume Manchester prices are closely correlated with the seven markets, the results of the comparison of the forward pricing alternatives should be similar. A check was made of the correlation between the price forecast error and the basis forecast error. No correlation was detected.

Taking actual cash prices, futures prices and option premiums for late February 1988 as representative for March 1988, a program was written using Micro TSP software. The program is presented in Figure 2.

The equation (line 1) predicted an average hog price of $54.63 for July. When the program is solved, the actual value of the cash hog price in July is $54.63 plus or minus a value computed by the random number generator. The distribution around the mean forecast will have the property of a standard deviation of $6.24. In July, August futures will be equal to the cash hog price minus the mean basis of $1.91 plus or minus an error term with a standard deviation of $1.18.

Because the forecast might be perceived in the current market situation to be optimistic, the forward pricing alternatives did not appear attractive. In March, August futures were $45.85 with forward contracts at $43.85. The premiums on August puts were $1.35 for a $42 strike and $3.10 for a $46 strike. A call with a strike of $46 could be purchased for $3.50. Brokerage for hedges and options was set at 50¢. In this example, the assumption was made that futures and options would be offset in mid July. Options at offset would be equal to their intrinsic value; no time value would remain.
Figure 2

Micro TSP Program for Calculating Net Price From Six Marketing Alternatives for Finishing Feeder Pigs

1: PBGJLF=107.901+.78814362*PBGMR-4.7264588D-3*NHGBE(-1)-2.3231705D-3*NSRHFE
2: VPBGJL=6.24*NRND
4: AUFTMR=45.95
5: JLFCMR=AUFTMR-2
6: VBAUJL=1.18*NRND
7: AUFTJL=PBGJL-1.91+VBAUJL
8: APT42M=1.35
9: APT46M=3.10
10: ACL46M=3.50
11: APT42J=(42-AUFTJL)*(AUFTJL<42)
12: APT46J=(46-AUFTJL)*(AUFTJL<46)
13: ACL46J=(AUFTJL-46)*(AUFTJL>46)
14: NPFC=JLFCMR
15: NPHE=PBGJL+(45.85-AUFTJL) -.50
16: NPPT42=PBGJL+APT42J-1.35-.50
17: NPPT46=PBGJL+APT46J-3.10-.50
18: NPCL46=NPFC+(ACL46J-3.50)-.50

Code

PBGJLF Forecast of price of barrows and gilts at seven markets in July, $/cwt.
PBGMR Price of barrows and gilts at seven markets in March, $/cwt.
NHGBE Original USDA estimate of the number of hogs for breeding on farms, December 1, 1,000 head
NSRHFE Original USDA estimate of the number of steers and heifers on farms, January 1, 1,000 head
VPBGJL Variation in the price of barrows and gilts in July from the forecast, $/cwt.
NRND Random number generator for a normal distribution
PBGJL Price of barrows and gilts at seven markets in July, $/cwt.
TIME Serial time, 1971, 1972, 1973, etc.
AUFTMR August hog futures in March, $/cwt.
JLFCMR Forward contract price in March for delivery of hogs in July, $/cwt.
VBAUJL Variation in the basis from the mean, $/cwt.
AUFTJL August hog futures in July, $/cwt.
APT42M Premium on August hog puts with a $42 strike, in March, $/cwt.
APT46M Premium on August hog puts with a $46 strike, in March, $/cwt.
ACL46M Premium on August hog calls with a $46 strike, in March, $/cwt.
APT42J Premium on August hog puts with a $42 strike, in July, $/cwt.
APT46J Premium on August hog puts with a $46 strike, in July, $/cwt.
ACL46J Premium on August hog calls with a $46 strike, in July, $/cwt.
NPFC Net price from forward contract on hogs, $/cwt.
NPHE Net price from hedge on hogs, $/cwt.
NPPT42 Net price from puts with $42 strike, $/cwt.
NPPT46 Net price from put with $46 strike, $/cwt.
NPCL46 Net price from call with $46 strike, $/cwt.
Results of Example

Three runs of 13 trials each were arbitrarily performed on pricing alternatives. The results of the first set of trials are presented in Table 1. In the bottom section, note that the highest mean return was from doing nothing, followed by the put with a $42 strike, and the put with a $46 strike. The hedge and the call were close with the forward contract the lowest. On the other hand, note that the degree of risk followed in about the same order from a standard deviation of $6.34 from doing nothing to $0.0 for forward contracting.

The results were similar with additional trials (Table 2). One change was made in the assumptions with the results given in the bottom section of Table 2. The expected cash price for July was set at $47.85, implying little change in August futures from the March level. This improved the position of the forward contract and hedging relative to the other alternatives.

One caveat in interpreting the results relates to the assumption that the errors in forecasting the level of price and basis are normally distributed. Further refinements of this procedure would be to generate non-normal distributions when warranted.

Conclusion

In spite of the short duration of options markets, procedures are available to assist in evaluating this new forward pricing alternative along with other tools. The procedure outlined in this paper is relatively easy to develop and use if some measure of forecast errors on level of price and basis is available. The method can be extended to other pricing alternatives including various combinations of the tools illustrated. A profit function could easily be generated with pricing of inputs and production variability assessed along with pricing of the product.
Table 1. Results of 13 Trials on Six Pricing Alternatives on Hogs

<table>
<thead>
<tr>
<th>Trials</th>
<th>PBGJL</th>
<th>NPFC</th>
<th>NPHE</th>
<th>NPPT42</th>
<th>NPPT46</th>
<th>NPCL46</th>
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<tbody>
<tr>
<td>1</td>
<td>63.88</td>
<td>43.85</td>
<td>47.54</td>
<td>62.03</td>
<td>60.28</td>
<td>55.54</td>
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<td>2</td>
<td>61.27</td>
<td>43.85</td>
<td>47.30</td>
<td>59.42</td>
<td>57.67</td>
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<td>3</td>
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<td>43.85</td>
<td>48.84</td>
<td>52.64</td>
<td>50.89</td>
<td>44.86</td>
</tr>
<tr>
<td>4</td>
<td>57.21</td>
<td>43.85</td>
<td>46.25</td>
<td>55.36</td>
<td>53.61</td>
<td>50.16</td>
</tr>
<tr>
<td>5</td>
<td>43.35</td>
<td>43.85</td>
<td>47.80</td>
<td>42.60</td>
<td>44.85</td>
<td>39.85</td>
</tr>
<tr>
<td>6</td>
<td>53.05</td>
<td>43.85</td>
<td>47.57</td>
<td>51.20</td>
<td>49.45</td>
<td>44.69</td>
</tr>
<tr>
<td>7</td>
<td>64.66</td>
<td>43.85</td>
<td>47.14</td>
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<td>56.71</td>
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<tr>
<td>8</td>
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<td>43.85</td>
<td>49.79</td>
<td>59.09</td>
<td>57.34</td>
<td>50.35</td>
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<tr>
<td>9</td>
<td>59.95</td>
<td>43.85</td>
<td>47.92</td>
<td>58.10</td>
<td>56.35</td>
<td>51.23</td>
</tr>
<tr>
<td>10</td>
<td>53.28</td>
<td>43.85</td>
<td>47.28</td>
<td>51.43</td>
<td>49.68</td>
<td>45.20</td>
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<tr>
<td>11</td>
<td>54.59</td>
<td>43.85</td>
<td>48.65</td>
<td>52.74</td>
<td>50.99</td>
<td>45.14</td>
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<tr>
<td>12</td>
<td>51.05</td>
<td>43.85</td>
<td>46.94</td>
<td>49.20</td>
<td>47.45</td>
<td>43.31</td>
</tr>
<tr>
<td>13</td>
<td>47.49</td>
<td>43.85</td>
<td>47.90</td>
<td>45.64</td>
<td>44.95</td>
<td>39.85</td>
</tr>
</tbody>
</table>

13 Observations

<table>
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<tr>
<th>Series</th>
<th>Mean</th>
<th>S.D.</th>
<th>Maximum</th>
<th>Minimum</th>
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<tr>
<td>PBGJL</td>
<td>55.785055</td>
<td>6.3439761</td>
<td>64.658970</td>
<td>43.352180</td>
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<tr>
<td>NPFC</td>
<td>43.849998</td>
<td>0.0000000</td>
<td>43.850000</td>
<td>43.850000</td>
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<tr>
<td>NPHE</td>
<td>47.762143</td>
<td>0.9122570</td>
<td>49.789520</td>
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<td>NPPT42</td>
<td>54.019399</td>
<td>6.1698021</td>
<td>62.808970</td>
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<tr>
<td>NPPT46</td>
<td>52.658647</td>
<td>1.9475449</td>
<td>61.058970</td>
<td>44.848650</td>
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<tr>
<td>NPCL46</td>
<td>47.696500</td>
<td>5.5574523</td>
<td>56.714870</td>
<td>39.850000</td>
</tr>
</tbody>
</table>
Table 2. Mean and Standard Deviation of Net Price From Six Marketing Alternatives on Hogs Under Two Price Forecasts, 39 Trials

<table>
<thead>
<tr>
<th></th>
<th>PBGJL</th>
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<th>NPHE</th>
<th>NPPT42</th>
<th>NPPT46</th>
<th>NPCL46</th>
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<tbody>
<tr>
<td><strong>$/cwt.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Cash Price Forecast for July at $54.63</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>54.25</td>
<td>43.85</td>
<td>47.62</td>
<td>52.60</td>
<td>51.09</td>
<td>46.27</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5.77</td>
<td>0</td>
<td>1.16</td>
<td>5.39</td>
<td>5.05</td>
<td>5.06</td>
</tr>
<tr>
<td><strong>Cash Price Forecast for July at $47.85</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>47.70</td>
<td>43.85</td>
<td>47.34</td>
<td>47.25</td>
<td>47.13</td>
<td>42.59</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.72</td>
<td>0</td>
<td>.86</td>
<td>4.82</td>
<td>3.20</td>
<td>3.19</td>
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</table>
This procedure could be incorporated in educational programs in a game format. The program was developed in Version 5.0 of Micro TSP which requires 384K of Ram (Hall and Lilien).

As can be seen in the example on pricing hogs, the choice of the forward pricing scheme most appropriate involves trade-offs between expected mean returns and risk. In such situations, each producer will have to weigh these attributes in making the pricing decision.
References


