The Forecasting Value of New Crop Futures: 
A Decision-Making Framework

by

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The statistical forecasting efficiency of new crop corn and soybean futures is the topic of frequent academic inquiry. However, few studies address the usefulness of these forecasts to economic agents' decision-making. Each year Central Illinois producers are faced with the decision to plant either corn or soybeans on marginal acreage. Agronomic concerns aside, these decisions hinge on the expected relative return of corn versus soybeans, and the expected return is largely a function of expected new crop prices. Do new crop futures prices reliably guide producers into the correct production decision? The results suggest that over the entire period of the analysis, futures markets provide only marginal decision-making information to the producer; however, more recent signals do appear to be useful.

Introduction

The Federal Agricultural Improvement and Reform Act of 1996 (FAIR), better known as the "Freedom to Farm Act", gives U.S. agricultural producers virtually complete control over their production and planting decisions. That is, producers no longer must maintain a "base" acreage of a particular crop to remain eligible for government support programs. Thus, they are free to allocate their entire acreage (as opposed to just "flex" acres) as relative market prices dictate (Willot, et al.). The diminishing governmental influence on production decisions magnifies the importance of market prices, and futures prices in particular, in guiding scarce resources to their optimal use and heightens the research challenge posed by Hieronymus: "How well do futures markets perform as devices for planning economic processes?" (1993, p. 18).

There is considerable evidence that U.S. producers utilize futures prices as expected output prices when making production and planting decisions (e.g., Gardner), and it has been suggested that this is both a rational and desirable alternative to using USDA or extension service forecasts (Brorsen and Irwin). Stein demonstrates that if futures prices are unbiased forecasts of realized prices, then the residual misallocation of production resources and the

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subsequent social loss is unavoidable. Many researchers have tested Stein's unbiased null hypothesis by regressing the realized harvest time price against the planting time futures price and testing that the intercept and slope coefficient are zero and one, respectively (e.g., Kenyon, et al.). The results of this method are mixed, and the procedure is generally fraught with statistical troubles including over data stationarity (see Zulauf, et al.) and statistical power (see Kahl and Tomek). Furthermore, unbiasedness does not guarantee that a forecast is either efficient or particularly useful (Granger and Newbold). Indeed, Tomek stresses that "the best available forecast today can be a poor one" (p. 6). Given this contention, it is worthwhile to investigate whether new crop futures forecasts, biased or not, provide useful decision-making information to row crop producers.

The following research employs a new method and data set to evaluate corn and soybean futures forecasts. The objective is to determine if new crop futures provide economically relevant information regarding producers' investment of acreage and resources into the production of corn versus soybeans.

Data

During the spring planting season, Central Illinois producers can sow acres in either corn or soybeans. Agronomic concerns aside, producers' planting decisions are based on the relative attractiveness of each investment. A corn/soybean producer has roughly the same fixed production cost on acreage regardless of whether he plants corn or soybeans. Thus, the crop with the greatest expected cash return (cash revenue less variable costs) is planted.

Here, we use average production costs and crop yields for a sample of Central Illinois corn and soybean producers from 1972 to 1996 from the Farm Business and Farm Management Association (FBFM) at the University of Illinois, Urbana-Champaign.\textsuperscript{1}

Variable production costs are defined to include: fertilizer, pesticide, seed, drying/handling, non-land interest, machinery repair, fuel, and hire. Assuming that Central Illinois producers know these costs at planting time, then they will utilize them in conjunction with expected cash revenue per acre to make planting decisions.

A producers' expected cash revenue per acre is a function of the expected output price times the expected quantity of production per acre. Here, the expected yield per acre is the \textit{ante} forecast from a simple linear trend regression model estimated from 1962 forward. This

\textsuperscript{1}The FBFM receives production data from a sample of Central Illinois pure grain producers (i.e., no grain fed to livestock) who farm over 260 acres of high fertility type soil. The sample size varies from a low of 101 farms in 1983 to a high of 674 in 1996 with an average sample size of 520. The data set includes fixed and variable production costs, crop acreage, and crop yields. The presented work does not utilize data from individual producers. Rather, it focuses on the sample averages from 1972 to 1996 (25 observations).
is a simplistic specification of expected yields; but, it is consistent with models utilized by
government and industry practitioners (Riley).\textsuperscript{2}

It is assumed that producers utilize new crop futures in forming expected output
prices. That is, the expected harvest-time price equals the new crop futures price plus the
expected basis. Here, the expected basis equals the average harvest-time basis for the prior
three years. This basis expectation is consistent with industry practice and prior academic
studies (see Garcia and Sanders).

In this study, it is assumed that Central Illinois producers make planting decisions on
the last day of March, and harvest occurs at the end of October. So, at planting (i.e., the end
of March), producers use new crop futures prices (December corn and November soybeans)
plus the harvest-time expected basis to determine their expected output price. The actual
output price is the harvest-time (end of October) cash price represented by Central Illinois
elevator bids to producers.\textsuperscript{3}

As an example of calculating the expected revenue and expected cash return, consider
the 1995 crop. At the end of March, December corn and November futures were trading at
$2.62 and $6.00 per bushel, respectively. Over the prior three years, the average end of
October basis was -$0.20 per bushel for corn and -$0.21 per bushel for soybeans. So, the
expected corn and soybean output prices were $2.42 and $5.79, respectively. The \textit{ex ante}
expected trend yield for Central Illinois producers was 158 bushels per acre for corn and 49.5
bushels per acre for soybeans. Thus, the expected revenue per acre for corn and soybeans
were $382.36 and $286.61, respectively. Assuming producers know their production costs
at planting time, then the expected cash return is computed as the difference between
expected cash revenue and variable cash costs. In 1995, the variable cost of production for
corn was $189 per acre, and it was $121 for soybeans. Therefore, the expected cash return
was $193.36 and $165.61 per acre for corn and soybeans, respectively. For the purposes of
this paper, we define the difference between expected corn and bean cash returns as the
relative corn return. In this example, the expected relative corn return equals $27.75 per acre
($193.36-$165.61). The relative corn return is the variable of interest throughout the

\textsuperscript{2}Alternative yield specifications were examined, including log-linear trends, quadratic
trends, and ARIMA specifications. None of these alternative specifications altered the presented
results.

\textsuperscript{3}Cash and futures price data were provided by the Office for Futures and Options
Research, University of Illinois, Urbana-Champaign.
following study. If the expected relative corn return is greater (less) than zero, then the market is signaling producers to plant corn (soybeans).4

The expected relative corn return implied by the futures market is compared to the realized relative return at harvest time. Continuing with the 1995 crop, the Central Illinois harvest prices for corn and soybeans were $3.28 and $6.67, respectively. The actual yields were 128 bushels per acre for corn and 44 bushels per acre for soybeans. Thus, the actual cash returns were $230.84 and $172.48, resulting in an actual or realized relative return to corn of $58.36. So, in this case, the signal provided by the futures market was correct, and producers benefited by $58.36 for each acre planted in corn as opposed to soybeans. Does the futures market consistently provide the correct planting signal and thereby meaningful information to the decision-maker?

Method and Results

The following empirical work focuses on the expected and actual cash returns for the average corn and soybean producer in Central Illinois. In particular, the focus is on the market's forecast of relative corn returns and the information that this provides to producers. First, the characteristics and summary statistics of the data are examined.

Summary Statistics

The summary statistics for realized and expected corn and soybean cash returns are presented in Table 1. The average expected cash return for corn is $186.87 per acre and for soybeans $177.79 per acre.5 A paired t-test fails to reject that these means are equivalent (10% level), i.e., the mean expected relative return to corn is not statistically different from zero. The mean actual returns are slightly lower for both corn and soybeans at $173.79 and $164.52, respectively. Again, a two-tailed paired t-test for a difference in these means fails to reject that they are equivalent; so, the mean actual relative corn return is not statistically different from zero.6 Both the expected and actual returns are quite volatile year-to-year with roughly $216 separating the best and worst actual returns for corn and $111 for soybeans.

4Clearly, an evaluation of this signal is a joint test of the yield, basis, and price forecasts. Various alternative basis and yield forecasts were utilized, but none of them altered the results.
5Augmented Dickey-Fuller unit root tests for stationarity revealed that only the actual corn returns failed to reject the presence of a unit root at the 10% level. Using the Phillips-Peron test, all the series rejected the presence of a unit root at the 5% level. Hence, it is concluded the return series are stationary.
6Paired t-tests were also conducted for the difference between actual and realized returns for both corn and beans. For neither crop was there a statistically significant difference between the expected and actual return.
Oddly, the expected returns for corn are not materially less volatile than the actual returns, and for soybeans the expected returns are more variable than the actual returns.

**Statistical Characteristics of the Forecast**

The first test evaluates the new crop futures’ forecast in a traditional sense. That is, the futures forecast for excess corn returns is tested for unbiasedness. Following a procedure similar to Zulauf, *et al.*, the actual relative returns are regressed on the market’s forecast.

\[
ACTUAL_t = \alpha_1 + \beta_1 EXPECTED_t + \epsilon_t
\]  

(1)

Where, \(ACTUAL_t\) = actual harvest time relative corn returns in year \(t\), and \(EXPECTED_t\) = expected relative corn returns in year \(t\). So, the actual relative corn return is regressed against the market’s forecast for relative returns. The market’s forecast is unbiased if we cannot reject the joint null hypothesis, \(H_0: \alpha_1 = 0 \text{ and } \beta_1 = 1\), using an \(F\)-test.

Estimation of equation (1), and use of misspecification tests indicated some degree of parameter instability and a statistical reduction of the residual variance after 1985. As a result, equation (1) was re-estimated after dividing the data into two periods 1972-1985 and 1986-1996. The separation of the data reflects the periods before and after the introduction of the 1985 farm legislation which marked the decline of government intervention in agricultural markets through a reduction in target prices, loan rates, and government stocks (1985 Farm Bill), and later through the introduction of more flexible acreage policies (1990 Farm Bill). The regression results are presented in Table 2, and the underlying data is displayed graphically in Figure 1. The findings are clear, and the differences in the two periods are rather surprising. For the entire data set, the findings show that the forecasts are unbiased but rather poor estimates of subsequent relative returns, suggesting that they provide relatively little information as to the actual relative corn returns.\(^7\) Examination of the results by periods indicates that the overall poor forecast performance is primarily due to the early set of observations. During the first period, although it is not possible to reject the null hypothesis of an unbiased forecaster, the \(R^2\) is practically zero. In contrast, during the second period, the variability in the actual relative returns is rather highly associated with the variability in expected relative returns.

\(^7\)Note, Equation (1) was also estimated in differences. Where, the dependent variable was the year-to-year change in \(ACTUAL_t\), and the independent variable was the markets expected change \((EXPECTED_t - ACTUAL_{t-1})\). With this specification the R-squared was greater, and we again could not reject that the forecast was unbiased.
In terms of evaluating the forecast's performance, producers must decide among two alternative investments, corn and soybeans. The decision is based primarily on output prices. Futures prices are regressed on the market return to test for unbiasedness. For instance, if the coefficient on the futures price is statistically significant and equal to the coefficient on the index, the market is considered unbiased.

The H-M test is a nonparametric test for evaluating if the relative performance of corn and soybean futures forecasts can be attributed to chance or if there is economic meaningfulness. The test is performed by first estimating a regression of the form:

$$ \text{SIGNAL}_t = \alpha + \beta \text{FINAL}_t + \epsilon_t $$

where $\text{SIGNAL}_t$ is the realized harvest time returns, $\text{FINAL}_t$ is the binary variable indicating expected returns, and $\epsilon_t$ is the error term. The null hypothesis is that $\beta = 0$, implying no economic meaningfulness.

The test results indicate that the market signal contains no economic or statistical information, as the null hypothesis is rejected for both corn and soybeans. Rejection of the null hypothesis implies that the market signal is not random, and that the relative performance of corn and soybean futures forecasts is not due to chance.

In conclusion, the H-M test provides a useful tool for evaluating the economic meaningfulness of futures forecasts. The results suggest that the market signal contains economically meaningful information for producers.
The forecasting ability also is examined with the regression test proposed by Cumby and Modest (C-M). Unlike the H-M test, C-M test is not independent of the distribution of relative returns. That is, the C-M test is influenced if the market provides the correct planting signal in years when it is especially rewarding to plant a particular crop. The C-M test is conducted by regressing the actual relative corn returns against the binary variable indicating the market’s signal to produce corn or beans. As in Equation 1, define the variable \( \text{ACTUAL} \), realized relative corn returns, and define the variable \( \text{SIGNAL} \) as in equation (2), then the following model is estimated.

\[
\text{ACTUAL}_t = \alpha_2 + \beta_3 \text{SIGNAL}_t + e_{3t}
\]  

(3)

The C-M test is basically a difference in means test. If \( \beta_3 > 0 \), then the mean actual relative corn return conditioned on the market signal (\( \alpha_2 + \beta_3 \)) is greater than the unconditional relative return (\( \alpha_2 \)). The null hypothesis that the signal has no statistical ability to guide resources into the most rewarding endeavor (\( \beta_3 = 0 \)) is tested with a two-tail t-test.

The estimation results for Equation (3) using the three different definitions of the data as previously discussed are presented in Table 4. For the entire data set, the mean unconditional relative return to corn is -$3.62 per acre (\( \alpha_2 \)), and the relative return when the market is signaling to plant corn is $16.51 per acre (\( \alpha_2 + \beta_3 \)). Although, the per acre relative return for corn is greater when the market signals to plant corn versus beans, the difference is not statistically significant (p-value = 0.353). Thus, for the entire data set, the null hypothesis is not rejected, and again it is concluded that the expected relative return does not provide statistically meaningful information in guiding resources into the production of corn versus soybeans. Dividing the data set, and performing the same analysis again identifies the difficulty the market had in forecasting realized relative returns during the first period, and its improvement during the second period. The first period is associated with an insignificant statistical relationship, and a loss in relative returns per acre when the market is signaling to plant corn. However, during the second period, \( R^2 \) increases dramatically, \( \beta_3 \) is statistically significant, and the improvement in relative returns when the market signals to plant corn is $19.20 per acre.

Summary and Discussion

This research strives to evaluate the ability of new crop futures prices to guide resources into the most profitable endeavor. Producer planting flexibility provided by FAIR makes the markets’ performance in this role increasingly important. The research moves beyond traditional tests of bias and seeks to more fully describe the decision-making value of new crop futures forecasts to agricultural producers.
Bibliography


Table 1. Summary Statistics for Expected and Actual Cash Returns

<table>
<thead>
<tr>
<th></th>
<th>Corn Expected</th>
<th>Corn Actual</th>
<th>Soybeans Expected</th>
<th>Soybeans Actual</th>
</tr>
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<tbody>
<tr>
<td>Mean*</td>
<td>186.87</td>
<td>173.79</td>
<td>177.79</td>
<td>164.52</td>
</tr>
<tr>
<td>Maximum</td>
<td>297.40</td>
<td>282.10</td>
<td>242.58</td>
<td>225.40</td>
</tr>
<tr>
<td>Minimum</td>
<td>75.80</td>
<td>66.54</td>
<td>86.13</td>
<td>113.30</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>51.26</td>
<td>54.42</td>
<td>37.94</td>
<td>30.13</td>
</tr>
</tbody>
</table>

*All numbers are in dollars per acre. Cash returns are calculated as cash revenue per acre less variable cash costs.

Table 2. Test for Bias

\[ \text{ACTUAL}_t = \alpha_1 + \beta_1 \text{EXPECTED}_t + \epsilon_t \]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coefficients</th>
<th>Adj. R²</th>
<th>F-stat.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>( \alpha_1 )</td>
<td>( \beta_1 )</td>
<td></td>
</tr>
<tr>
<td>1972-1996</td>
<td>4.9025</td>
<td>0.4803</td>
<td>0.098</td>
</tr>
<tr>
<td></td>
<td>(0.478)*</td>
<td>(1.581)</td>
<td></td>
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<tr>
<td>1972-1985</td>
<td>21.0320</td>
<td>-0.1133</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(1.085)</td>
<td>(-0.201)</td>
<td></td>
</tr>
<tr>
<td>1986-1996</td>
<td>-0.0598</td>
<td>0.9376</td>
<td>0.714</td>
</tr>
<tr>
<td></td>
<td>(-0.009)</td>
<td>(4.736)</td>
<td></td>
</tr>
</tbody>
</table>

*T-statistics in parenthesis.

**The F-statistic tests the joint null that \( \alpha_1 = 0 \) and \( \beta_1 = 1 \). The p-value is in parenthesis.
### Table 3. Henriksson-Merton Test

\[ \text{SIGNAL}_t = \alpha_2 + \beta_2 \text{FINAL}_t + \epsilon_{2t} \]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coefficients</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\alpha_2)</td>
<td>(\beta_2)</td>
</tr>
<tr>
<td>1972-1996</td>
<td>0.5000</td>
<td>0.2333</td>
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<tr>
<td></td>
<td>(3.253)*</td>
<td>(1.176)</td>
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<tr>
<td>1972-1985</td>
<td>0.8000</td>
<td>-0.2444</td>
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<tr>
<td></td>
<td>(3.564)</td>
<td>(-0.873)</td>
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<tr>
<td>1986-1996</td>
<td>0.2000</td>
<td>0.8000</td>
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<tr>
<td></td>
<td>(1.500)</td>
<td>(4.431)</td>
</tr>
</tbody>
</table>

*T-statistics in parenthesis.

### Table 4. The Cumby-Modest Test

\[ \text{ACTUAL}_t = \alpha_3 + \beta_3 \text{SIGNAL}_t + \epsilon_{3t} \]

<table>
<thead>
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<th>Sample</th>
<th>Coefficients</th>
<th>R²</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(\alpha_3)</td>
<td>(\beta_3)</td>
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<tr>
<td>1972-1996</td>
<td>-3.6233</td>
<td>20.1333</td>
</tr>
<tr>
<td></td>
<td>(-0.213)*</td>
<td>(0.948)</td>
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<tr>
<td>1972-1985</td>
<td>27.0040</td>
<td>-12.5851</td>
</tr>
<tr>
<td></td>
<td>(0.996)</td>
<td>(-0.372)</td>
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<tr>
<td>1986-1996</td>
<td>-41.9075</td>
<td>61.1061</td>
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<tr>
<td></td>
<td>(-3.556)</td>
<td>(4.136)</td>
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</table>

*T-statistics in parenthesis.
Figure 1. Actual Relative Corn Returns vs. Expected Relative Corn Returns
1972-1996, Crop Years