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

The Informational Content of Distant-Delivery Futures Contracts

by

Kristin N. Schnake, Berna Karali,
and Jeffrey H. Dorfman

Suggested citation format:

Schnake, K. N., B. Karali, and J. H. Dorfman. 2011. “The Informational Content of Distant-Delivery Futures Contracts.” Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

The Informational Content of Distant-Delivery Futures Contracts

Kristin N. Schnake, Berna Karali, and Jeffrey H. Dorfman*

Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management St. Louis, Missouri, April 18-19, 2011.

Copyright 2011 by Kristin N. Schnake, Berna Karali, and Jeffrey H. Dorfman. All rights reserved. Readers may make verbatim copies of this document for noncommercial purposes by any means, provided that this copyright notice appears on all such copies.

* Kristin N. Schanke (kschnake@uga.edu) is a master student; Berna Karali (bkarali@uga.edu) is an Assistant Professor; and Jeffrey H. Dorfman (jdorfman@uga.edu) is a Professor in the Department of Agricultural and Applied Economics at The University of Georgia.

The Informational Content of Distant-Delivery Futures Contracts

The futures markets have two main goals: price discovery and risk management. Because management decisions often have to be made on a time horizon longer than the time until expiration of the nearby futures contract, the question of distant-delivery futures contracts' ability to assist in price discovery is important. We focus on soybean and live cattle distant-delivery futures contracts and test for the informational value added to nearby contracts. Two tests for information value provide partially conflicting results due to the different information measures employed. If being able to predict the price trend is sufficient, then we find some information value in distant-delivery futures contracts, while if accurate point estimates of future spot prices are desired the results are negative. Surprisingly, we do not find the expected dichotomy between the storable (soybeans) and non-storable (cattle) commodities.

Key words: distant-delivery contract, futures markets, price discovery

Introduction and Background

One of the main goals of the futures markets is price discovery. Price discovery is driven by producers, speculators, consumers, governments, etc. Having accurate forecasts of prices one, three, five, or more months into the future is vital for profitable production decisions, purchases, and planning. Therefore, analyzing futures prices to determine if distant-delivery contracts contain informational value for price discovery is essential. If distant-delivery futures prices are just random modifications to nearby contracts then deferred futures are arbitrary and price discovery is ineffective.

The risk management feature of futures markets is utilized by producers and consumers who will take a futures position opposite of their cash market position to hedge price risk. Distant-delivery futures contracts are often utilized by farmers due to the time to harvest for commodities such as soybeans and the biological lag of live stock such as cattle. For example, a finishing firm might need to lock in a cost for soybeans for the month of June in January to avoid a 5 month period of price uncertainty. Agribusinesses rely on accurate forecasts to still have a successful year with a not-so-successful harvest or unexpectedly high commodity prices. Speculators play a huge role in price discovery and help producers hedge their risk. If futures prices are price forecasts then they provide an estimation of the supply and demand conditions in the future. The question is, how far into the future can an individual look using futures prices and still obtain valuable information? The question that we raise is whether or not these distant-delivery contracts actually incorporate additional information beyond the nearby contract or are they merely random adjustments?

A large amount of related research exists in this area. The ability of futures markets to possess the quality of price discovery has been researched in many different commodity markets. Brorsen, Bailey, and Richardson (1984) found that cotton prices are discovered within the futures market. This was determined because of the strong positive relationship between cash prices and one-period lagged futures prices, proving that cash prices are quick to incorporate information provided within the futures market. Yang and Leatham (1999) took a different approach to researching price discovery by looking at three different futures markets for the same underlying commodity, wheat. In other words, they looked at a futures-to-futures price discovery to see if the multiple markets are more likely to seek out an equilibrium price than the cash-to-cash markets. They found evidence that the futures markets possibly do help in the price discovery process, and the futures-to-futures markets are driven by an equilibrium price in the long-run, a characteristic that the cash markets do not possess. Previous work has been done to test if commodity markets behave in a random walk fashion or if they move in a systematic manner. If futures prices are random walks, then they should contain no valuable information about the future. Evidence in both directions is presented in the literature. Leuthold (1972) found mixed results in cattle futures. Bessler and Covey (1991) found that while the levels of live cattle futures prices follow random walk, their first differences do not. Dorfman (1993) generally found both corn and soybean futures to be stationary. On the other hand, McKenzie and Holt (2002) showed that live cattle, hogs, corn, and soybean meal futures contain unit roots. However, Frank and Garcia (2009) analyzed the same commodities as in McKenzie and Holt and found corn, hogs, and soybean meal futures to be stationary after accounting for structural breaks.

Henriksson and Merton (1981) proposed a nonparametric test to explore the informational content of any set of forecasts. The Henriksson-Merton test is based on whether a set of forecasts can predict directional changes better than a naïve forecast model. Thus, informational content in futures contracts implies that those futures prices can predict the direction of price movement (increase or decrease) either between the nearby contract's expiration date and now or between a distant-delivery contract's expiration date and a more nearby contract. Pesaran and Timmermann (1994) modified the Henriksson and Merton test to a generalized form allowing for more than two categories of forecast outcomes. Sanders, Manfredo, and Boris (2008) used the Henriksson-Merton test to examine short-term supply forecasts of crude oil, natural gas, coal, and electricity, released by the U.S. Department of Energy's (DOE) Energy Information Administration (EIA). Results showed that the EIA accurately predicted year-over-year increases and decreases in supply for over 70% of the quarters, and again quarter-to-quarter changes in the rate of supply growth over 70% of the time. However, the EIA's forecasts only performed statistically better than the naïve no-change forecasts for coal.

Vuchelen and Gutierrez (2005) proposed a direct test which looks specifically at forecast optimality and the informational content of multiple horizon forecasts compared to the last observation. Originally, this test looked at growth rates, and then was applied to commodity and livestock forecasts in futures markets. For instance, Sanders, Garcia, and Manfredo (2008) applied this direct test to investigate the informational content of deferred futures prices of live cattle and hogs. They discovered that the distant-delivery contracts of hogs compared to live cattle are far more rational and provide valuable incremental information steadily throughout the twelve-month horizon. Additional information on prices of live cattle was seen to diminish substantially beyond the eight-month horizon. The authors stated several reasons to account for this, one of them being the long beef production cycle. Cattle on Feed (COF) report, the primary supply data released by the USDA, only provides good information six months ahead since cattle are in feedlot for approximately six months. Hogs, on the other hand, have a shorter production cycle with the Hogs and Pigs Report (HPR) distributed quarterly. Thus, more timely information is available for hog producers.

Sanders and Manfredo (2009) concluded that price forecasts for petroleum based products (crude oil, gasoline, and diesel fuel) provided unique information through the first three quarters. The natural gas and electricity forecasts were found to have surprisingly helpful information throughout all four quarters. This, however, was not the case for coal which had no helpful information in any of the forecasts. This direct test for incremental content has also been applied to other areas such as USDA production forecasts. Sanders and Manfredo (2008) showed that only the turkey and milk production forecasts exhibited rational additional information at each horizon while four other commodities tested (beef, pork, broilers, and eggs) did not provide unique information along the multiple-horizon production forecasts.

In futures markets multiple contracts with increasingly distant expiration dates trade simultaneously. Since price discovery is one of the main goals of the futures markets, we address the question of whether these distant-delivery futures contracts contain informational value for price discovery beyond that found in the more nearby contracts. We focus on live cattle and soybean futures contracts and employ both the direct test of forecast accuracy proposed by Vuchelen and Gutierrez (2005) and the Henriksson and Merton (1981) directional ability test as modified by Pesaran and Timmermann (1994) to test for incremental information added beyond nearby-delivery futures prices.

Given that distant-delivery contracts generally trade with much lower volumes than the nearby contract, it will be interesting to determine whether the distant-delivery contracts provide additional information into the (future) price discovery process. We expect incremental information in all three nearby futures contracts (one-, three-, and five-month out) for live cattle because the biological lag associated with live stock means that market cannot move immediately to equilibrium (since animals cannot go to slaughter until they are finished). Therefore, we expect to see price discovery value in distant contracts since those futures prices represent a supply and demand equilibrium at a future date. However, for a storable commodity like soybeans, future supply and demand equilibria are linked to the current market conditions through the ability to shift the timing of sales. So we do not expect to find information value in the distant-delivery futures prices for soybeans.

Methodology of the Information Value Tests

We study the informational content of distant-delivery futures contracts by using two different tests which look at quite distinct measures of information content to determine if the nearby and distant-delivery futures contracts add valuable information to the current spot market price. The first test is the Vuchelen and Gutierrez (2005) direct test where we use the last actual price as a benchmark to estimate incremental information between forecast periods. This test is based on measuring the accuracy of the futures prices as a forecast of spot prices at a specified future date. The second test is a directional analysis test developed by Henriksson and Merton (1981) which focuses on the ability to make correct predictions of the direction of price movement (up or down) from one period to the next.

The Vuchelen and Gutierrez Direct Test

The test that Vuchelen and Gutierrez (2005) developed uses a regression framework to measure whether futures prices improve one's ability to forecast spot prices at a future date. The test is based on decomposing the current futures price (F_t^{t+1}) into one part representing the current spot price and a second part that represents the forecast change from that price ($F_t^{t+1} - S_t$):

$$F_t^{t+1} = S_t + (F_t^{t+1} - S_t). \tag{1}$$

It is the second term on the right hand side of (1) that represents the potential information in the futures price. Equation (1) can be expanded to a two-step ahead forecast (F_t^{t+2}) by adding consecutive adjustments to the benchmark:

$$F_t^{t+2} = S_t + (F_t^{t+1} - S_t) + (F_t^{t+2} - F_t^{t+1}). \tag{2}$$

Again, the adjustments added to the last spot price observation are known as the information content of the forecast that ideally provides valuable additional information beyond the last realization (Vuchelen and Gutierrez 2005). These fundamental equations are the basis of the Vuchelen and Gutierrez direct test.

The traditional equation used to evaluate forecasting efficiency of futures prices is:

$$S_{t+1} = \alpha + \beta F_t^{t+1} + u_{t+1}, \tag{3}$$

where u_{t+1} is the error term. By substituting either equation (1) or (2) into equation (3), Vuchelen and Gutierrez (2005) developed their direct test on informational content of one-step ahead forecast. We adapt their formula here for the fact that our data is nonstationary and, thus, we need to work in terms of rates of return in the spot and futures price series. So, with data transformed into rates of return we arrive at an equation to test the information value of a one-step-ahead forecast of

$$\ln\left(\frac{S_{t+1}}{S_t}\right) = \theta + \delta \ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + u_{t+1}. \tag{4}$$

For two-step ahead (three-month out) forecasts, equation (4) becomes:

$$\ln\left(\frac{S_{t+3}}{S_t}\right) = \theta + \delta \ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + \omega\left[\ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right) - \ln\left(\frac{F_t^{t+1}}{S_t}\right)\right] + u_{t+3}. \tag{5}$$

Similarly, for three-step ahead (five-month out) forecasts we obtain

$$\ln\left(\frac{S_{t+5}}{S_t}\right) = \theta + \delta \ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + \omega\left[\ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right) - \ln\left(\frac{F_t^{t+1}}{S_t}\right)\right] +$$
$$\eta\left[\ln\left(\frac{F_t^{t+5}}{F_t^{t+3}}\right) - \ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right)\right] + u_{t+5}. \tag{6}$$

The consecutive adjustments show the quality and the information content found in deferred futures contracts. In equation (4), the search for informational content focuses on the parameter λ. If $\lambda \neq 0$ then the nearby (one-month out) futures contract provides additional information beyond the current cash price. In equation (5), if $\omega \neq 0$ then the three-month out futures contract adds valuable information beyond the one-month out futures contract. Similarly, in equation (6) $\eta \neq 0$ implies the five-month out futures contract adds value to price discovery by adding incremental information beyond the one- and three-month out futures contracts.

Equation (4) can be estimated efficiently using ordinary least squares (OLS); however, due to overlapping forecast errors, equations (5) and (6) should not be estimated by OLS. OLS will still yield unbiased parameter estimates but the standard errors will be biased and inconsistent. Serial correlation arises when k, the forecast horizon, is farther than one period ahead. For multiperiod forecast horizons, actual values or spot prices are not yet known prior to the forecast, and therefore the corresponding forecast errors are not yet known either. This causes serially correlated error terms (Brown and Maital, 1980) which must be handled. A common econometric technique to correct for overlapping data is to apply generalized least squares (GLS). The GLS method essentially eliminates the serial correlation in the error terms. This technique requires strict exogeneity between the regressors and the error terms. However, strict exogeneity clearly does not hold for multiperiod forecast horizons.

An alternative method to correct for inconsistent standard errors due to overlapping forecast horizons was developed by Hansen (1979) and Hansen and Hodrick (1980). Hansen and Hodrick begin by estimating:

$$y_{t+k} = x_t\beta + u_{t,k}, \tag{7}$$

where $u_{t,k}$ is the forecast error at time t for k-step-ahead forecast. They prove that for sample size T and OLS estimator $\hat{\beta}_T$, $\sqrt{T}(\hat{\beta}_T - \beta)$ converges in distribution to a normally distributed random vector with mean zero and covariance matrix Θ,

$$\Theta = R_x(0)^{-1}\gamma R_x(0)^{-1}, \tag{8}$$

$$\gamma = \sum_{j=-k+1}^{k-1} R_u(j)R_u(j), \tag{9}$$

where

$$R_u(j) = \mathrm{E}\left(u_{t,k}u_{t+j,k}\right), \tag{10}$$

and

$$R_x(j) = \mathrm{E}\left(x_t' x_{t+j}\right). \tag{11}$$

Here we follow Hansen and Hodrick (1980) and obtain coefficient estimates via OLS but adjust our variance-covariance matrices of the error terms from the two-step (three-month out) and three-step ahead (five-month out) forecast equations. We first stack the T observations into a matrix $X_T = [X_1 \quad \cdots \quad X_T]'$ and then form a $T \times T$ symmetric matrix $\hat{\Omega}_T$ as follows for our two step-ahead (three-month out) forecast:

$$\hat{\Omega}_T = \begin{bmatrix} \hat{R}_u^T(0) & \hat{R}_u^T(1) & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) & 0 & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & 0 & \cdots & \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) \\ 0 & 0 & 0 & 0 & 0 & \cdots & 0 & \hat{R}_u^T(1) & \hat{R}_u^T(0) \end{bmatrix}$$

where $\hat{R}_u^T(0) = \frac{1}{T}\sum_{t=1}^{T} \hat{u}_{t,2}^T \hat{u}_{t,2}^T$ and $R_u^T(1) = \frac{1}{T}\sum_{t=2}^{T} \hat{u}_{t,2}^T \hat{u}_{t-1,2}^T$. Similarly, for the three-step ahead (five-month out) forecasts the variance-covariance matrix estimator is:

$$\hat{\Omega}_T = \begin{bmatrix} \hat{R}_u^T(0) & \hat{R}_u^T(1) & \hat{R}_u^T(2) & 0 & 0 & \cdots & 0 & 0 & 0 & 0 \\ \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) & \hat{R}_u^T(2) & 0 & \cdots & 0 & 0 & 0 & 0 \\ \hat{R}_u^T(2) & \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) & \hat{R}_u^T(2) & \cdots & 0 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & 0 & \cdots & \hat{R}_u^T(2) & \hat{R}_u^T(1) & \hat{R}_u^T(0) & \hat{R}_u^T(1) \\ 0 & 0 & 0 & 0 & 0 & \cdots & 0 & \hat{R}_u^T(2) & \hat{R}_u^T(1) & \hat{R}_u^T(0) \end{bmatrix}$$

where $\hat{R}_u^T(0) = \frac{1}{T}\sum_{t=1}^{T} \hat{u}_{t,3}^T \hat{u}_{t,3}^T$, $\hat{R}_u^T(1) = \frac{1}{T}\sum_{t=2}^{T} \hat{u}_{t,3}^T \hat{u}_{t-1,3}^T$, and $\hat{R}_u^T(2) = \frac{1}{T}\sum_{t=3}^{T} \hat{u}_{t,3}^T \hat{u}_{t-2,3}^T$. Noting that

$$T(X_T' X_T)^{-1} = \hat{R}_x^T(0)^{-1}$$

and similar to equation (9)

$$T^{-1}(X_T' \hat{\Omega}_T X_T) = \sum_{j=-k+1}^{k-1} \hat{R}_u^T(\mathrm{j})\, \hat{R}_x^T(\mathrm{j}),$$

Hansen and Hodrick conclude that

$$\hat{\Theta}_{\mathrm{T}} = T(X_T' X_T)^{-1} X_T' \hat{\Omega}_T X_T (X_T' X_T)^{-1}, \quad (12)$$

which is a consistent estimator for the asymptotic covariance matrix and what we employ to operationalize the Vuchelen and Gutierrez test.

Henriksson and Merton Test

This test simply analyzes the correct prediction of the direction of change in the variable being studied (Pesaran and Timmermann, 1992). In our research we are looking at the directional accuracy of nearby and deferred futures prices. The observed forecast accuracy of futures prices in predicting the direction of movement in the spot market can be transformed into probabilities, with P_{ij} being the probability of the event that the realized return movement falls in category i and the predicted return movement falls in category j. When the probabilities of m categories are represented in a contingency table, it takes on the form of a matrix which we call P:

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ P_{21} & P_{22} & \cdots & P_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix}. \quad (13)$$

Each row of P measures the probability of correct and various incorrect forecasts of the times when actual price movement fell into category i. The main diagonal of P holds the probabilities of correct forecasts. We will have categories for price movements of up, down, and no change, so our P matrix is 3 x 3. Using this contingency table Pesaran and Timmermann (1992) derive a non-parametric procedure for testing the null hypothesis H_0^* of no market timing (no incremental information in our study):

$$H_0^*: \quad \sum_{i=1}^{n}\left(\hat{P}_{ii} - \hat{P}_{i0}\hat{P}_{0i}\right) = 0.$$

It is a standard result for the maximum likelihood estimator of $P_{ij}(\hat{P}_{ij})$ that

$$\sqrt{n}(\hat{P} - P_0) \sim N\left(0, \Psi_0 - P_0 P_0'\right), \tag{14}$$

where P_0 is the $m^2 \times 1$ column vector equal to vec(P), $\hat{P}$ is the estimated value of vec(P), and Ψ_0 is a $m^2 \times m^2$ diagonal matrix which has P_0 as its diagonal elements. The test of H_0^* is based on the statistic:

$$S_n = \sum_{i=1}^{n}\left(\hat{P}_{ii} - \hat{P}_{i0}\hat{P}_{0i}\right), \tag{15}$$

where $\hat{P}_{ij} = n_{ij}/n$, $\hat{P}_{i0} = n_{i0}/n$, and $\hat{P}_{0i} = n_{0i}/n$ are the estimates of the forecast outcome probabilities, with n_{ij} representing the number of observations where the realized price movement falls in category i and the predicted price movement falls in category j, n_{i0} representing the number of observations where the realized price movement falls in category i and the predicted price movement varies, and n_{0i} representing the number of observations where the realized price movement varies and the predicted price movement falls in category i.
Under H_0^*:

$$\sqrt{n}S_n \sim N(0, V_s), \tag{16}$$

where

$$V_s = \left(\frac{\partial f(\mathrm{P_0})}{\partial P}\right)'\left(\Psi - P_0 P_0'\right)\left(\frac{\partial f(\mathrm{P_0})}{\partial P}\right), \tag{17}$$

and

$$\frac{\partial f(\mathrm{P})}{\partial \mathrm{P_{ij}}} = 1 - P_{0i} - P_{i0}, \text{ for } i = j$$
$$\text{-}\, P_{j0} - P_{0i}, \text{ for } i \neq j.$$

Thus, the test statistic can be written as:

$$Z_n = \sqrt{n}V_S^{-1/2}S_n \sim N(0,1), \tag{18}$$

which is a standard normal Z-statistic. Pesaran and Timmermann (1994) recommend a one-sided test since only positive values of the test statistic provide evidence of incremental information. However, one can define significant, negative test statistics as showing information value since a reliably incorrect forecast is also valuable.

Data

We focus our tests on live cattle and soybean futures contracts traded at the Chicago Mercantile Exchange (CME) Group. Live cattle futures have a contract size of 40,000 pounds priced in cents per pound. The deliverable product must be 55 percent Choice, 45 percent Select, and Yield Grade 3 live steers. Delivery months are February, April, June, August, October, and December. Contracts expire on the last business day of the delivery month. Live cattle contracts are subject to a daily price limit of three cents per pound above or below the previous day's settlement price. For live cattle cash prices, we use the daily closing prices of the Texas-Oklahoma average from the USDA.[1]

The standard soybean contract size is 5,000 bushels of No. 2 yellow soybeans at par, No.1 yellow soybeans at a six cent premium, and No.3 yellow soybeans at a six cent discount. Contracts are priced in cents per bushel. Delivery months are January, March, May, July, August, September, and November. Contracts expire on the last business day prior to the fifteenth calendar day of each delivery month. Daily price limits are 70 cents per bushel, which is expandable when the market closes at limit bid. For cash price series, we use the closing price of Central Illinois No. 1 yellow soybeans acquired from the USDA.[2]

We record the daily closing cash prices one month prior the nearby contract's expiration date to represent current cash price. Then we use the daily closing prices of the first three nearby contracts on the same day to represent one-, three-, and five-month ahead forecasts. For live cattle, even-month futures contracts are used, resulting in a sample period of January 19, 1990 - September 30, 2008. The first price observations for live cattle, for instance, include cash price and settlement prices of February, April, and June 1990 contracts observed on January 19, 1990. Because we only use odd delivery months for soybeans (skipping the August contract to make the delivery months fall on every other month), our sample period for this commodity starts on February 21, 1990, and extends to October 14, 2008, recording prices every other month. For example, the first data point in our sample includes cash price and settlement prices of March, May, and July 1990 soybean contracts on February 21, 1990. The total number of observations is 113 for each commodity. Descriptive statistics are in Table 1.

Previous research with distant-delivery futures contracts has avoided storable commodities, such as soybeans, because storage cost and opportunity cost must be considered to make a fair comparison between nearby and distant prices. Sanders, Garcia, and Manfredo (2008) touch on this issue stating that the Vuchelen and Gutierrez direct test is less straightforward due to the explicit storage relationship between futures contracts within a crop year. Accordingly, we adjust our soybean price series for opportunity and storage costs. This is accomplished by computing an adjustment factor, similar to the one presented in Zulauf, Zhou, and Roberts (2006). We multiply current cash price by a daily interest rate and by the proportion of the year between that day and

[1] An alternative cash price series is the five-area weighted average which includes Texas/Oklahoma/New Mexico, Kansas, Nebraska, Colorado, and Iowa/Minnesota feedlots. However, we expect the basis effect due to this difference in data to be minor.

[2] Since we are using No.1 yellow soybeans, we are introducing a constant basis increase of six cents. As shown in the discussion of the information value tests, this constant basis will not affect the results of our tests for information value.

either the one, three, or five month-out futures contract expiration dates to calculate the opportunity cost. Next, we add the one-time fixed storage cost and the variable storage cost (if necessary). Fixed cost covers storage for any length of time from harvest through December. The additional variable cost is a pro-rated daily charge starting from January 1st until the futures contract expiration. The fixed storage cost applies for the dates between September and December 31st (after harvest) and variable storage cost applies for the dates between January and August (before the next harvest). Storage cost rates were obtained from Darrel Good (2011) and are shown in Table 2. Interest rates are the three-month U.S. Treasury Bill rates obtained from the St. Louis Federal Reserve Bank. After adjustment for opportunity and storage costs, the futures returns can be compared to one-, three-, and five-month out cash returns.

Data Preparation for the Vuchelen and Gutierrez Direct Test

We perform the Augmented Dickey-Fuller (ADF) test with 12 lags to check for stationarity in our price data. The null hypothesis of the ADF test is that a unit root is present. Table 3 presents the results of the ADF test performed on the unadjusted price data. All p-values are greater than 0.05, showing the presence of a unit root. Table 4 reports the results of the ADF test performed on the soybean price series adjusted for opportunity and storage costs. Again, the adjusted prices show the existence of a unit root as well.

Since the price series for cattle and soybeans clearly have unit roots, we convert our price series to rates of return. For example, let S_t be the spot price at time t and F_t^{t+1} be the one-month out futures price at time t. Then the rates of returns are $ln\ (F_t^{t+1}/S_t)$ and $ln\ (S_{t+1}/S_t)$ with S_{t+1} representing the cash price one-month out. This transforms our data into workable stationary data (Hansen and Hodrick 1980).

Thus, the variables of interest for our study become $ln\ (S_t/S_{t-1})$ for current cash return, $ln\ (S_{t+1}/S_t)$ for one-month out cash return, $ln\ (S_{t+3}/S_t)$ for three-month out cash return, $ln\ (S_{t+5}/S_t)$ for five month out cash return, $[\ln\ (F_t^{t+1}/S_t) - \ln\ (S_t/S_{t-1})]$ for the value added with one-month out futures, $[\ln\ (F_t^{t+3}/F_t^{t+1}) - \ln\ (F_t^{t+1}/S_t)]$ for the value added with three-month out futures, and $[\ln\ (F_t^{t+5}/F_t^{t+3}) - \ln\ (F_t^{t+3}/F_t^{t+1})]$ for the value added with five-month out futures. Table 5 presents ADF test results for the rates of return series. Now the tau-statistics are statistically significant with p-values reported as less than 0.0001, resulting in rejection of the null hypothesis of a unit root. Thus, we can use these series consisting of rates of return in our regression equations.

Data Preparation for Henriksson and Merton Test

To perform the Henriksson and Merton (1981) test as modified by Pesaran and Timmermann (1992) we use three categories: movement up, movement down, and no change. The probabilities of the nine possible events can be arranged into a matrix as in (13), where we use the ordering 1 = up, 2 = down, and 3 = no change.

We compute the direction of one-month ahead forecast movement by comparing the price of one-month out futures contract to cash price a month prior to expiration, and the direction of one-month actual movement by comparing cash price on the expiration day to the cash price a month before. For three-month out forecast movement, we compare the price of the three-month out contract to the price of the one-month out contract, and for the direction of three-month out actual movement, we compare the three-month out cash price to the one-month out cash price. Similarly, we compare the five-month out futures price to the three-month out futures price, and the five-month out cash price to the three-month out cash price.

Results

Vuchelen and Gutierrez Direct Test

Table 6 shows the regression results for the Vuchelen and Gutierrez direct test for both live cattle and soybeans. The one-month out futures contract for live cattle reported a significant t-value of 3.68, strong evidence that one-month out futures contracts provide valuable information. This is to be expected since the forecast horizon is only one month and the highest volume of trading is done within this contract. The one-month out soybean futures contract shows a similar result with a significant t-value of 3.17. The results for the three-month out futures contracts for both live cattle and soybeans were statistically insignificant with t-values of 0.46 and 0.43 respectively, implying that there is no valuable additional information beyond the one-month out futures contracts. The same proved to be true for the five-month out futures contracts for both commodities. Live cattle reported a t-value of 0.30 and soybeans reported a t-value of 0.35, both suggesting no additional information in the five-month out futures contracts beyond the three-month out contracts. The live cattle results are somewhat surprising since the biological lags inherent in the industry made us expect distant delivery futures contracts to provide valuable information about future market prices.

Henriksson and Merton Test

The probability matrices for the one-month, three-month, and five-month out forecasts for live cattle are shown below, denoted as $P1_{LC}$, $P3_{LC}$, and $P5_{LC}$, respectively Specifically we compute:

$$P1_{LC} = \begin{bmatrix} 0.345 & 0.142 & 0 \\ 0.168 & 0.266 & 0 \\ 0.053 & 0.027 & 0 \end{bmatrix} \quad P3_{LC} = \begin{bmatrix} 0.337 & 0.195 & 0 \\ 0.186 & 0.266 & 0 \\ 0.009 & 0.009 & 0 \end{bmatrix} \quad P5_{LC} = \begin{bmatrix} 0.283 & 0.239 & 0.009 \\ 0.186 & 0.230 & 0 \\ 0.018 & 0.009 & 0 \end{bmatrix}.$$

The diagonals of the matrices represent the probabilities of correct forecasts for each category of price movement. The sum of the diagonal of $P1_{LC}$ shows a 61.1% probability of a correct forecast for the one-month ahead live cattle futures, while $P3_{LC}$ shows a 60.3% probability of a correct forecast for the three-month ahead futures, and $P5_{LC}$ shows a 51.3% probability of a correct forecast for the five-month ahead futures. This gives us some indication of the likely test results using the formal statistic derived by Pesaran and Timmermann (1994).

The probability matrices for soybeans are reported the same way:

$$P1_{S} = \begin{bmatrix} 0.575 & 0.142 & 0 \\ 0.336 & 0.080 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad P3_{S} = \begin{bmatrix} 0.354 & 0.186 & 0 \\ 0.266 & 0.195 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad P5_{S} = \begin{bmatrix} 0.399 & 0.150 & 0 \\ 0.257 & 0.195 & 0 \\ 0 & 0 & 0 \end{bmatrix}.$$

The sum of the diagonal of $P1_S$ yields a 65.5% probability of a correct forecast, $P3_S$ shows a 54.9% probability of a correct forecast, and $P5_S$ implies a 59.4% probability of a correct forecast.

We report the Z-statistics from the Henriksson-Merton tests in Table 7. Both live cattle and soybeans report statistically significant Z-statistics of 3.434 and 2.959 for one-month out forecasts. This result, which matches the results from the Vuchelen-Gutierrez test, shows valuable information being added to the spot price by the futures contracts one-month out. Results are different however with the three-month out forecasts between live cattle and soybeans. The test on three-month out futures contracts for live cattle has a Z-statistic of 2.385 which shows additional information added to the one-month out contracts. Three-month out futures contracts for soybeans report a Z-statistic of 0.860 which is statistically insignificant, suggesting no valuable informational content added beyond the one-month horizon. The five-month out futures contracts for soybeans provided an interesting result. With a statistically significant Z-statistic of 1.754, we see valuable information beyond the three-month out futures contracts. This result, as well as the three-month out futures contracts for live cattle differs from the results found with the Vuchelen-Gutierrez test. The five-month out live cattle futures contracts displayed no additional value with a Z-statistic of 0.632.

Discussion of Combined Results

Based on these results, we conclude that the one-month out forecasts for both live cattle and soybeans possess the ability to predict price movements in the spot market. We can further conclude that the three-month out soybean and five-month out cattle contracts do not contain valuable information for price discovery. However, our findings for the three-month out cattle and five-month out soybeans contracts are conflicting. The Henriksson-Merton test finds information in these two distant-delivery contracts while the Vuchelen-Gutierrez test does not.

The conflict can be explained by remembering that the tests are not measuring information in the same dimension. The Henriksson-Merton test is looking at the ability to predict the direction of price revisions, while the Vuchelen-Gutierrez test is searching for the ability to make an accurate point forecast. If the forecast is a downward price movement of one cent, and the actual price movement is upward one cent, that would be an incorrect forecast for the Henriksson and Merton test, but is likely to be seen as very valuable in the Vuchelen and Gutierrez sense. The opposite could happen as well. The futures price could forecast an increase of forty cents, but the actual spot price only increases two cents. This forecast will show information within our directional price movement test (Henriksson and Merton test), but likely will show little incremental information within our price-point estimate test (Vuchelen and Gutierrez test) because this forecast was very inaccurate in a mean-squared error sense. Because the test philosophies vary, the results can differ.

Conclusions and Implications

Hedgers, speculators, farmers, processors, and consumers all rely on the futures markets to hedge risk or make financial decisions based on future prices. But if the futures markets give no insight as to what the future prices will be by simply making random adjustments to nearby futures prices and do not add valuable information that leads to price discovery, then reliance on (distant-delivery) futures contracts is ill-advised. To test the informational value of deferred futures contracts in price discovery, we applied Vuchelen-Gutierrez and Henriksson-Merton tests to live cattle and soybeans futures markets. Nearby contracts were seen by both tests to contain value toward price discovery. Since the first nearby contract is traded more heavily than distant-delivery contracts, this result is to be expected. The three- and five-month out futures contracts had mixed results from both tests. The Vuchelen-Gutierrez test shows no valuable information beyond the one-month out futures contracts for both commodities while the Henriksson-Merton test shows valuable information in the three-month out futures contracts for live cattle and in the five-month out futures contracts for soybeans.

These results make it evident that reliance on distant-delivery soybean and live cattle futures contracts can be misleading. If a grain farmer is deciding what to plant based on deferred futures contract prices, and these prices are simply random adjustments to spot prices and hold no value toward price discovery then the farmer may be misled. Given that the Henriksson and Merton test did show information added by some distant-delivery futures contracts in the sense of predicting directional price movements, deferred futures contracts for soybeans and live cattle may not be reliable for point price estimates but may still be useful for less-precise, strategic management purposes where knowing the direction of price trends suggests actions that should be taken. Changes in crop-acreage allocation decisions, adjustments in herd size, and hedging based on future input purchase requirements are all examples of situations where just knowing the price trend can inform decision making.

References

Bessler, D.A. and T. Covey (1991). Cointegration: Some Results on U.S. Cattle Prices.Journal of Futures Markets, 11:4, 461-474.

Brorsen, B.W., D. Bailey, and J.W. Richardson (1984). Investigation of Price Discovery and Efficiency for Cash and Futures Cotton Prices. Western Journal of Agricultural Economics, 9:1, 170-176.

Brown, B.W. and S. Maital (1981). What do Economists know? An Empirical Study of Experts' Expectations. Econometrica, 49, 491-504.

Dorfman, J. H. (1993). Bayesian Efficiency Tests for Commodity Futures Markets. American Journal of Agricultural Economics 75:5, 68-75.

Frank, J. and P. Garcia (2009). Time-varying Risk Premium: Further Evidence in Agricultural Futures Markets. Applied Economics, 41:6, 715-725.

Good, Darrel. Personal Communication, February 23, 2011.

Hansen, L.P. and R.J. Hodrick (1980). Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis. Journal of Political Economy, 88, 829-853.

Henriksson, R.D. and R.C. Merton (1981). On Market Timing and Investment Performance. II. Statistical Procedure for Evaluating Forecasting Skills. The Journal of Business, 54, 513-533.

Leuthold, R.M. (1972). Random Walk and Price Trends: The Live Cattle Futures Market. Journal of Finance, 27:4, 879-889.

McKenzie, A.M. and M.T. Holt (2002). Market Efficiency in Agricultural Futures Markets. Applied Economics, 34:12, 1519-1532.

Pesaran, M.H. and A. Timmermann (1992). A Simple Nonparametric Test of Predictive Performance. Journal of Business and Economics Statistics, 10:4, 461-465.

Pesaran, M.H. and A.G. Timmermann (1994). A Generalization of the Non-parametric Henriksson-Merton test of Market Timing. Economics Letters, 44, 1-7.

Sanders, D.R. and M.R. Manfredo (2004). Forecasting Commodity Price with Future Contract Prices. The Journal of Business Forecasting, 29-32.

Sanders, D.R. and M.R. Manfredo (2005). Forecast Encompassing as the Necessary Condition to Reject Futures Market Efficiency: Fluid Milk Futures. American Journal of Agricultural Economics, 87, 610-620.

Sanders, D.R., P. Garcia, and M.R. Manfredo (2008). Information Content in Deferred Futures Prices: Live Cattle and Hogs. Journal of Agricultural and Resource Economics. 33, 87-98.

Sanders, D.R., M.R. Manfredo, and K. Boris (2008). Accuracy and Efficiency in the U.S. Department of Energy's Short-term Supply Forecasts. Energy Economics. 30, 1192-1207.

Sanders, D.R. and M.R. Manfredo (2008). Multiple Horizons and Information in USDA Production Forecasts. Agribusiness, 24, 55-66.

Sanders, D.R., M.R. Manfredo, and K. Boris (2009). Evaluating Information in Multiple Horizon Forecasts: The DOE's energy price forecasts. Energy Economics, 31, 189-196.

Vuchelen, J., and M.-I. Gutierrez (2005). A Direct Test of the Information Content of the OECD Growth Forecasts. International Journal of Forecasting, 21, 103-117.

Yang, Y. and D.J. Leatham (1999). Price Discovery in Wheat Futures Markets. Journal of Agricultural and Applied Economics, 31:2, 359-370.

Zapata, H.O and T.R. Fortenbery (1995) Stochastic Interest Rates and Price Discovery in Selected Commodity Markets. Review of Agricultural Economics, 18:4, 643-654.

Zulauf, C.R., H. Zhou, and M.C. Roberts (2006). Updating the Estimation of the Supply of Storage. The Journal of Futures Markets. Vol. 26, No. 7, 657-676.

Table 1. Descriptive Statistics

		Current Cash	1-Month Out Cash	3-Month Out Cash	5-Month Out Cash	1-Month Out Futures	3-Month Out Futures	5-Month Out Futures
Live Cattle (Cents per pound)	Mean	75.56	75.35	75.36	75.49	75.84	75.74	75.45
	Median	74.00	74.00	74.00	74.00	74.63	73.65	72.30
	Minimum	57.00	57.00	57.00	57.00	58.88	59.93	61.30
	Maximum	100.05	101.19	101.19	101.19	99.25	106.30	109.03
	Standard Deviation	10.24	10.53	10.58	10.55	10.25	10.56	10.62
Soybeans (Cents per bushel)	Mean	631.64	640.32	645.14	647.04	645.73	647.17	647.21
	Median	581.00	578.00	574.00	576.00	590.50	596.75	606.00
	Minimum	406.50	401.50	426.00	426.00	429.25	438.75	433.50
	Maximum	1517.50	1552.50	1552.50	1552.50	1560.00	1540.00	1531.00
	Standard Deviation	186.89	192.15	194.62	195.68	192.65	191.49	186.65

Notes: Descriptive statistics are generated with raw price series data from January 19, 1990 – September 30, 2008 for live cattle and February 21, 1990 – October 14, 2008 for soybeans.

Table 2. Soybean Storage Costs

Period	Fixed Cost (per bushel)	Monthly Variable Cost (per bushel)
1989 - 2006	$0.13	$0.020
2007	$0.16	$0.026
2008 - 2010	$0.18	$0.030

Notes: Data obtained from Good (February 23, 2011). Fixed cost expressed as a one-time fee applied for the dates between September and December 31st (after harvest). Variable cost is a pro-rated daily charge starting after January 1st and ending August 31st (before the next harvest).

Table 3. Stationarity Tests for Price Series

	Augmented Dickey-Fuller Test						
	Cash	1-Month Out Cash	3-Month Out Cash	5-Month Out Cash	1-Month Out Futures	3-Month Out Futures	5-Month Out Futures
Live Cattle	0.16 (0.7322)	0.04 (0.6927)	-0.09 (0.6495)	-0.24 (0.5990)	0.24 (.7541)	0.35 (0.7848)	0.43 (0.8038)
Soybeans	-0.81 (0.3627)	-0.52 (0.4900)	-0.31 (0.5726)	-0.44 (0.5202)	-0.67 (0.4248)	-0.55 (0.4750)	-0.46 (0.5124)

Notes: Augmented Dickey-Fuller test performed on raw data. Tau statistics and their p-values (in parenthesis) are shown. The null hypothesis of a unit root can be rejected with p-values less than 0.05.

Table 4. Stationarity Tests for Soybean Prices Adjusted for Opportunity and Storage Costs

	Augmented Dickey Fuller Test				
	Current Cash Adjusted	1-Month Out Cash Adjusted	3-Month Out Cash Adjusted	1-Month Out Futures Adjusted	3-Month Out Futures Adjusted
Soybeans	-0.81 (0.3629)	-0.52 (0.4882)	-0.31 (0.5705)	-0.67 (0.4250)	-0.56 (0.4732)

Notes: Augmented Dickey-Fuller test performed on adjusted data. Tau statistics and their p-values (in parenthesis) are shown. The null hypothesis of a unit root can be rejected with p-values less than 0.05. The current cash adjusted is current cash price with one month of opportunity and storage costs added to allow for comparison to the one-month out cash and futures prices. The one-month out cash (futures) adjusted is one-month out cash (futures) price with two months of opportunity and storage costs added to allow for comparison to the three-month out cash (futures) prices. The three-month out cash (futures) adjusted is three-month cash (futures) price with two months of opportunity and storage costs added to allow comparison to the five-month out cash (futures) prices.

Table 5. Stationarity Tests of Rates of Return Series (Adjusted Soybean Prices)

	Augmented Dickey-Fuller Test						
	Current Cash Returns	1-Month out Cash Return	3-Month out Cash Returns	5-Month out Cash Returns	1-Month out Futures Return	3-Month out Futures Return	5-Month out Futures Return
Live Cattle	-7.56 (<.0001)	-9.08 (<.0001)	-10.49 (<.0001)	-9.10 (<.0001)	-6.39 (<.0001)	-9.52 (<.0001)	-10.19 (<.0001)
Soybeans	-6.66 (<.0001)	-6.26 (<.0001)	-7.17 (<.0001)	-6.62 (<.0001)	-5.21 (<.0001)	-4.21 (<.0001)	-9.83 (<.0001)

Table 6. Results for Vuchelen and Gutierrez Direct Test

	Live Cattle			Soybeans		
	1-Month k=1 (Eq. 4.4)	3-Month k=2 (Eq. 4.5)	5-Month k=3 (Eq. 4.6)	1-Month k=1 (Eq. 4.4)	3-Month k=2 (Eq. 4.5)	5-Month k=3 (Eq. 4.6)
Intercept	-0.007	-0.001	0.002	-0.025	0.003	-0.004
(θ)	(0.004)	(0.079)	(0.107)	(0.007)	(0.176)	(0.288)
	[-1.54]	[-0.02]	[0.02]	[-0.35]	[-0.01]	[-0.01]
Cash	0.818	0.961	1.258	0.917	2.407	4.465
(δ)	(0.189)	(3.173)	(5.503)	(0.236)	(5.848)	(11.238)
	[4.33]*	[0.30]	[0.23]	[3.88]*	[0.41]	[0.40]
1 Month	0.592	0.911	1.339	0.736	2.350	4.349
(λ)	(0.189)	(2.728)	(4.714)	(0.232)	(5.730)	(10.815)
	[3.68]*	[0.33]	[0.28]	[3.17]*	[0.41]	[0.40]
3 Months		1.036	1.192		1.638	3.068
(ω)		(2.242)	(3.220)		(3.849)	(8.103)
		[0.46]	[0.37]		[0.43]	[0.38]
5 Months			0.822			2.065
(η)			(2.781)			(5.983)
			[0.30]			[0.35]

Notes: We report coefficients, (standard errors), and [t-values]. Equation (4.4) is estimated for one-month ahead forecasts which is $\ln(S_{t+1}/S_t) = \theta + \delta\ln(S_t/S_{t-1}) + \lambda[\ln(F_t^{t+1}/S_t) - \ln(S_t/S_{t-1})] + u_{t+1}$. Equation (4.5) is estimated for three-month ahead future contracts which is $\ln(S_{t+3}/S_t) = \theta + \delta\ln(S_t/S_{t-1}) + \lambda[\ln(F_t^{t+1}/S_t) - \ln(S_t/S_{t-1})] + \omega[\ln(F_t^{t+3}/F_t^{t+1}) - \ln(F_t^{t+1}/S_t)] + u_{t+3}$. Equation (4.6) is estimated for five-month ahead forecasts which is $\ln(S_{t+5}/S_t) = \theta + \delta\ln(S_t/S_{t-1}) + \lambda[\ln(F_t^{t+1}/S_t) - \ln(S_t/S_{t-1})] + \omega[\ln(F_t^{t+3}/F_t^{t+1}) - \ln(F_t^{t+1}/S_t)] + \eta[\ln(F_t^{t+5}/F_t^{t+3}) - \ln(F_t^{t+3}/F_t^{t+1})] + u_{t+5}$.

Table 7. Results for Henriksson and Merton Test

Z-statistic (p-value)	1-Month out	3-Month out	5-Month out
Live Cattle	3.434*	2.385*	0.632
	(0.000)	(0.009)	(0.264)
Soybeans	2.959*	0.860	1.754*
	(0.002)	(0.195)	(0.040)

Notes: Z-statistics and their p-values (in parentheses) are shown.