THE INFORMATIONAL CONTENT OF DISTANT-DELIVERY FUTURES CONTRACTS

by

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(Under the Direction of Berna Karali and Jeffrey H. Dorfman)

ABSTRACT

The futures markets have two main goals, which are price discovery and risk management. We focus on soybean and live cattle distant-delivery futures contracts to discover the informational value added to nearby contracts which assists in price discovery. By employing a direct test proposed by Vuchelen and Gutierrez (2005) and then comparing those results to a nonparametric test presented by Henriksson and Merton (1981), the research shows that beyond the one-month out futures contracts for both soybeans and live cattle no information is added when using the Vuchelen and Gutierrez test. The Henriksson and Merton test shows that the three-month out live cattle and five-month out soybean contracts add additional information beyond the one-month out live cattle and three-month out soybean contracts respectively.

INDEX WORDS: Distant-Delivery Contract, Futures Markets, Price Discovery

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B.S.A., The University of Georgia, 2009

A Thesis Submitted to the Graduate Faculty of The University of Georgia

in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2011

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May 2011

DEDICATION

I would like to dedicate this work to my mom and dad. They are selfless loving parents who have always put their kids first. I would also like to dedicate this to my sisters, Angie and Courtney, for they are both my heroes. I could not have done this without the loving support of my wonderful family.

ACKNOWLEDGEMENTS

I would like to thank Dr. Jeffrey H. Dorfman for igniting my interest in agricultural economics, and Dr. Berna Karali for her amazing help and guidance throughout this whole process. I am very lucky to have been able to work with her. I cannot thank her enough.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

Futures markets have two main purposes: price discovery and risk management. Risk management is utilized by producers and consumers who will take a position opposite of their cash market position to hedge price risk. For example, a feed purchasing manager for a live cattle producing firm uses futures trading as a risk management tool to protect his/her cash position against rising soybean prices by taking an opposite position in the futures markets. These businesses rely on accurate forecasts to still have a successful year with a not-so-successful harvest or unexpectedly high corn or soybean prices. Speculators play a huge role in price discovery and help the live cattle producer hedge his risk. Price forecasts provide an estimation of the supply and demand conditions in the future. The question is, how far into the future can an individual look and still obtain-valuable information within the forecast horizon?

It is evident that forecasting is vital to companies, governments, and ultimately to all producers and consumers. 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 live cattle. For example, a finishing firm might need to lock in a minimum buying price for soybeans for the month of June in January leaving a 5 month period of uncertainty. 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?

We do expect incremental information in all three nearby futures contracts (one-, three , and five-month out) for live cattle. This conclusion is to be expected because of the biological lag associated with live stock. Looking five months into the future, the supply of cattle that will be mature is known since those cattle are already on the feedlot growing. Therefore, we expect to see price discovery within all horizons because the futures prices should represent a supply and demand equilibrium. However, for soybeans, since it is a storable commodity, the distant-delivery futures contracts do not represent the same supply and demand equilibrium. Due to the possibility of storage, a farmer can either choose to sell the soybeans or store them for as long as he or she likes, which causes the supply to always be unknown.

Problem Statement

Since price discovery is one of the main goals of the futures markets, we address the question of whether distant-delivery futures contracts contain informational value for price discovery. We focus on live cattle and soybean futures contracts to test whether they provide valuable information beyond naïve forecasts.

Objectives

We employ a direct test proposed by Vuchelen and Gutierrez (2005) to test the incremental information added beyond nearby-delivery futures prices. We then compare those results to a nonparametric test presented by Henriksson and Merton (1981), which examines whether a set of forecasts can predict directional changes better than a naïve forecast model. 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.

CHAPTER II

LITERATURE REVIEW

Price Discovery

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, and even five months into the future is vital for profitable production decisions, purchases, and planning. Therefore, researching 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 and spot prices then distant futures are arbitrary and price discovery is ineffective.

A large amount of research exists in this area. Some earlier studies show a relationship between cash prices and futures prices varying largely with the type of markets (commodity or livestock) and the time frame of the data. Zapata and Fortenbery (1995) focused on the reason for these discrepancies across markets by examining mainly the corn and soybean markets within the United States. They found that it is essential to consider interest rates in the cointegration model because having a third stochastic variable such as interest rates which affects the relationship of cash and futures prices and is not accounted for within the modeling would bias the results of two markets which is actually operating efficiently. They concluded that more research should be done due to the assumptions made within the modeling (omitting storage costs and the indefinable convenience yields).

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. This proves 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 do possibly 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. This result shows that "the futures markets provided informed prices that cannot be embodied in cash markets".

Previous work has been done to test if commodity markets behave in a random walk fashion or if they move in a systematic manner. Evidence in both direction is presented in the literature. Leuthold (1972) found that by applying the same data to statistical and mechanical filter tests he could compare the results with validity claiming that the shortcoming of previous research is the lack of applying identical data to both tests. Leuthold then applied the same live cattle futures markets data to a statistical analysis and a mechanical filters test discovering that the spectral analysis indicated that there was a stochastic process within some of the contracts tested but not with others. On the other hand, the mechanical filters test showed serious doubt as to if the live cattle futures prices behave randomly. This gives reason to believe that profitable trading is possible even after Leuthold accepted the random walk hypothesis of the statistical analysis. He explained this conflict within the results by the fact that statistical analysis looks at time periods of fixed length while the mechanical filters test allows the time period to vary. This allows the mechanical test to pick up on short-run trends in the data that the spectral analysis cannot detect.

A simple approach expressed by Sanders and Manfredo (2004) is forecasting prices based on historical basis ratios. Sanders and Manfredo applied this method to retail diesel fuel and heating oil. Diesel fuel does not have futures contracts; however, the two products are physically similar, and historically their prices track closely together, creating a price relationship that is comparable. Using historical futures prices for heating oil and past diesel fuel prices to establish a basis ratio, they forecasted what diesel fuel prices would be in the future, despite the lack of a futures market for diesel fuel. The historical basis makes for an easy-to-prepare forecast and can be easily updated.

Vuchelen and Gutierrez Direct Test

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 by far more rational and provide valuable incremental information steadily throughout the twelve-month horizon. Additional information on prices of live cattle were 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.

Similar research was conducted by Sanders and Manfredo (2009) investigating the quarterly price forecasts in the Short-Term Energy Outlook (STEO) by specifically looking at crude oil, retail gasoline, retail diesel fuel, natural gas, coal, and electricity price forecasts. Their research focused on the “overall understanding of the performance and value of the Energy Information Administration (EIA’s) energy price forecasting efforts, especially the value of forecasts beyond the one-quarter horizon.” They 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). Their results showed that only turkey and milk exhibited rational additional information at each horizon while four other commodities tested (beef, pork, broilers, and eggs) did provide unique information along the multiple-horizon production forecasts.

Henriksson and Merton Test

Henriksson and Merton (1981) proposed a nonparametric test to further explore the informational content of distant-delivery futures prices. 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 distant-delivery futures contracts implies that those futures prices can predict the direction of price movement (increase or decrease) between the nearby contract's expiration date and the distant-delivery contract's expiration date.

Pesaran and Timmermann (1994) modified the Henriksson and Merton test to a generalized form and applied it to "an investment strategy based on switching the funds between two assets, a stock market index and bonds" which includes transactions costs. They found evidence that the test reveals market timing skills with statistically significant values when applying zero transactions costs, low transaction cost, and high transaction costs.

Greer (2003) applied both Pesaran-Timmermann and Henriksson-Merton test towards evaluating directional accuracy of long-term interest rates forecasts. His results suggested that the forecasts would be of value to users, however not by much. His sample of forecasts barely beat flipping a coin for directional forecasting by three percent.

In Sanders, Manfredo, and Boris (2008), the Henriksson-Merton test was performed on the short-term supply forecasts of crude oil, natural gas, coal, and electricity, distributed by the U.S. Department of Energy's (DOE) Energy Information Administration (EIA). Then, within a two-by-two contingency table (Pesaran and Timmermann, 1994), the results were analyzed along with a naïve no-change forecast. 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 did not perform statistically better than the naïve no-change forecasts besides coal.

We further this line of research by applying the modified Henriksson and Merton test to futures markets, specifically to distant-delivery futures prices of soybeans and live cattle. We then compare those results to Vuchelen and Gutierrez test results.

CHAPTER III

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 at 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. 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.

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 at 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 closing price of Central Illinois No. 1 yellow soybeans acquired from the USDA. Since we are using No.1 yellow soybeans, we are introducing a constant basis increase of six cents. This will be reflected within the intercept of the Vuchelen and Gutierrez equations. Again, since this is a constant increase it will not affect the results of the Henriksson and Merton test.

We are studying the informational content of one-, three-, and five-month ahead futures contracts. To this end, 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 soybeans contracts on February 21, 1990. Total number of observations is 113 for each commodity. Descriptive statistics of live cattle and soybeans price series are presented in Table 3.1.

Table 3.1 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.

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). Thus, we multiply current cash price by a daily interest rate and by the proportion of the year between that day and 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. Note that in our study, 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 rates, obtained from Darrel Good (2011) are shown in Table 3.2. Interest rates used are the three-month U.S. Treasury Bill rates obtained from the St. Louis Federal Reserve Bank.

Table 3.2 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).

Using the method described above, we compute adjusted current cash, one- and three-month out cash and futures prices. Because now they include interest and storage costs for the relevant period, they can be compared to one-, three-, and five-month out cash and futures prices.

Data Preparation for Vuchelen and Gutierrez Direct Test

Time series data is considered to be stationary when the mean and variance are constant over time and the value of the covariance between two time periods depends only on the lag of the two periods. Therefore, when the covariance is calculated, the dates of the lag between the two values should make no difference; that is they are time invariant. Stationary time series data will be mean reverting, which means that it will fluctuate with generally constant amplitude around its mean. Thus, a stationary process will not diverge too far away from its mean because of the finite variance.

For the purpose of forecasting, it is essential that time series data be stationary; otherwise, the data cannot be compared to other time periods. If there is a unit root then the data are only useful for that time period. Therefore, we perform the Augmented Dickey-Fuller (ADF) test with 12 lags to check for stationarity. The null hypothesis of the ADF test is that a unit root is present. Table 3.3 presents the results of the ADF test performed on the raw data organized in the way described above. All p-values are greater than 0.05, showing the presence of a unit root.

Table 3.3 Stationarity Test of Price Series

	Augmented Dickey-Fuller Test						
τ (p-value)	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 3.4 reports the results of the ADF test performed on the soybean price series adjusted for opportunity and storage costs. As seen in the table, the adjusted prices show the existence of a unit root as well.

Table 3.4 Stationarity Test for Soybean Prices Adjusted for Opportunity and Storage Costs

τ (p-value)	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.

Since all p-values presented in Tables 3.3 and 3.4 are greater than 0.05, the null hypothesis of a unit root cannot be rejected. Our results reveal nonstationary data. To adjust for this problem, 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. We compute rates of returns as $\ln(F_t^{t+1}/S_t)$ 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 3.5 presents the ADF test results for the new data transformed into rates of return. Here 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.

Table 3.5 Stationarity Test of Rates of Return Series (Adjusted Soybean Prices)

τ (p-value)	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)

Notes: Augmented Dickey-Fuller test performed on return series. 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. Soybean prices are adjusted for opportunity and storage costs.

Data Preparation for Henriksson and Merton Test

To perform the Henriksson and Merton test, we again must transform the data. The H-M test looks specifically at the direction of the forecast and not the magnitude to judge accuracy (Henriksson and Merton 1981). Because our data are transformed into returns, an accurate forecast of the direction of revision in a series consists simply in correctly forecasting the signs of the returns. Pesaran and Timmermann (1992, 1994) generalized the H-M test to allow for more than two categories. Let a_t denote the actual (realized) movement of returns and f_t denote its forecast. With this definition, there are essentially three instances of a correct forecast in our study: if the forecast predicts an upward movement $(f_t > 0)$ and the realized value is also an upward movement ($a_t > 0$), if the forecast is a downward movement ($f_t < 0$) and the realized value acts accordingly ($a_t < 0$), or if the forecast is no movement ($f_t = 0$) followed by a no-change actual value ($a_t = 0$). For clarity, the events are transformed to probabilities:

$P_{11} = Prob\ (a_t > 0, f_t > 0)$, $P_{12} = Prob\ (a_t > 0, f_t < 0)$, $P_{13} = Prob\ (a_t > 0, f_t = 0)$,

$P_{21} = Prob\ (a_t < 0, f_t > 0)$, $P_{22} = Prob\ (a_t < 0, f_t < 0)$, $P_{23} = Prob\ (a_t < 0, f_t = 0)$,

$P_{31} = Prob\ (a_t = 0, f_t > 0)$, $P_{32} = Prob\ (a_t = 0, f_t < 0)$, $P_{33} = Prob\ (a_t = 0, f_t = 0)$.

We then represent these probabilities as a contingency table (Pesaran and Timmermann, 1994). The information in the contingency table below is the basis for the H-M test of informational content in distant-delivery futures contracts.

Table 3.6 Probability of Forecasted Movements in Relation to Actual Movements

Actual Movement	Forecast Movement			
	$f_t > 0$	$f_t < 0$	$f_t = 0$	Row sum
$a_t > 0$	P_{11}	P_{12}	P_{13}	$P_{10}(n_{10})$
$a_t < 0$	P_{21}	P_{22}	P_{23}	$P_{20}(n_{20})$
$a_t = 0$	P_{31}	P_{32}	P_{33}	$P_{30}(n_{30})$
Column sum	$P_{01}(n_{01})$	$P_{02}(n_{02})$	$P_{03}(n_{03})$	1(n)

Notes: The diagonal, P_{11}, P_{22}, and P_{33}, consists of correct forecasts which contain valuable information and demonstrate forecast ability.

In order to compute these probabilities, we need to find out the number of correct and incorrect forecast directions for each category. For this purpose, 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.

CHAPTER IV

METHODOLOGY

We study the informational content of distant-delivery futures contracts by using two different models. The first model 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. Next, we use a directional analysis model developed by Henriksson and Merton (1981) to study the correct predictions of price movements from one period to the next.

Vuchelen and Gutierrez Direct Test

Vuchelen and Gutierrez (2005) developed "a simple general regression test that allows a direct comparison of a forecast with a benchmark forecast." That benchmark is the last realization. In equation (4.1), the one-step ahead forecast (F_t^{t+1}) is the sum of an adjustment made to the most recent observation (S_t) or the benchmark:

$$F_t^{t+1} = S_t + (F_t^{t+1} - S_t). \quad (4.1)$$

Equation (4.1) can be expanded to a two-step ahead forecast (F_t^{t+2}) by adding consecutive adjustments to the benchmark:

$$F_t^{t+2} = S_t + (F_t^{t+1} - S_t) + (F_t^{t+2} - F_t^{t+1}). \quad (4.2)$$

The adjustments added to the last 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:

$$S_{t+1} = \alpha + \beta F_t^{t+1} + u_{t+1}, \tag{4.3}$$

where u_{t+1} is the error term. By substituting equations (4.1) and (4.2) into equation (4.3), Vuchelen and Gutierrez (2005) developed their direct test on informational content of one-step ahead forecast (adjusted for rates of return):

$$\ln\left(\frac{S_{t+1}}{S_t}\right) = \theta + \delta \ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + u_{t+1}. \tag{4.4}$$

In equation (4.4), the one-step ahead actual value $\ln\left(\frac{S_{t+1}}{S_t}\right)$, is equal to the forecasted adjustment $\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right]$ plus the previous period's value. In our research, we use cash prices of commodities to represent actual values and the prices of one-month, three-month, and five-month out futures contracts to represent one-, two-, and three-step ahead forecasts. Again, all variables are transformed to rates of return to adjust for stationarity. For two-step ahead (three-month out) forecasts, equation (4.4) becomes:

$$\ln\left(\frac{S_{t+3}}{S_t}\right) = \theta + \delta \ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + \omega\left[\ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right) - \ln\left(\frac{F_t^{t+1}}{S_t}\right)\right] + u_{t+3}, \tag{4.5}$$

where $\ln\left(\frac{S_t}{S_{t-1}}\right)$ is the current cash price, $\ln\left(\frac{S_{t+3}}{S_t}\right)$ is the cash price realized in month $(t+3)$, $\ln\left(\frac{F_t^{t+1}}{S_t}\right)$ and $\ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right)$ are the prices in month t of futures contracts that expire in one month $(t+1)$ and three months $(t+3)$, respectively. Similarly, for three-step ahead (five-month out) forecasts we obtain

$$\ln\left(\frac{S_{t+5}}{S_t}\right) = \theta + \delta\ln\left(\frac{S_t}{S_{t-1}}\right) + \lambda\left[\ln\left(\frac{F_t^{t+1}}{S_t}\right) - \ln\left(\frac{S_t}{S_{t-1}}\right)\right] + \omega\left[\ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right) - \ln\left(\frac{F_t^{t+1}}{S_t}\right)\right] + \eta\left[\ln\left(\frac{F_t^{t+5}}{F_t^{t+3}}\right) - \ln\left(\frac{F_t^{t+3}}{F_t^{t+1}}\right)\right] + u_{t+5}. \tag{4.6}$$

The consecutive adjustments show the quality and the information content found in deferred futures contracts. In equation (4.4), the informational content lies within 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 (4.5), if $\omega \neq 0$ then the three-month out futures contract adds valuable information beyond the one-month out futures contract. Similarly, if in equation (4.6) $\eta \neq 0$ then the five-month out futures contract adds value to price discovery by adding incremental information beyond the three-month out futures contracts.

Equation (4.4) can be estimated using OLS; however, due to overlapping forecast errors, equations (4.5) and (4.6) 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 the inability to rule out one of the major assumptions of OLS: serially uncorrelated error terms (Brown and Maital, 1980).

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, this assumption does not hold for multiperiod forecast horizons. A solution is to impose a structure to the covariance matrix to account for the correlation between multiperiod forecast errors and the regressors.

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

$$y_{t+k} = x_t\beta + u_{t,k}, \tag{4.7}$$

where $u_{t,k}$ is the forecast error at time t for k-step-ahead forecast. They recognize the issue in estimating β when $k > 1$ due to the overlapping forecast errors. Hansen (1979) also addresses the fact that Generalized Least Squares (GLS) cannot be used because the assumption of strict exogeneity is not satisfied.

Hansen and Hodrick (1980) start off by letting Δ_t be an information set generated by current and all past values of y_t and x_t. Next let $v_t = y_t - E(y_t|\Delta_{t-1})$ and $w_t = x_t' - E(x_t'|\Delta_{t-1})$. Here v_t and w_t are one-step-ahead forecast errors for y_t and x_t using the information set Δ_{t-1} . Next they assume that

$$E\left[\binom{v_t}{w_t}(v_t'w_t')|\Delta_{t-1}\right] = \Lambda, \tag{4.8}$$

a matrix of constants independent of the elements in Δ_{t-1}. With this assumption, Hansen (1979) further explains that $\sqrt{T}(\hat{\beta}_T - \beta)$ converges in distribution to a normally distributed random vector with mean zero and covariance matrix Θ, where T is the sample size and $\hat{\beta}_T$ is the OLS estimator,

$$\Theta = R_x(0)^{-1}\gamma R_x(0)^{-1}, \tag{4.9}$$

$$\gamma = \sum_{j=-k+1}^{k-1} R_u(j)R_u(j), \tag{4.10}$$

where

$$R_u(j) = \mathrm{E}(u_{t,k}u_{t+j,k}), \tag{4.11}$$

and

$$R_x(j) = \mathrm{E}(x_t'x_{t+j}). \tag{4.12}$$

Hansen explains that it is necessary to obtain consistent estimators of $R_u(j)$ and $R_x(j)$ for j = -k +1,…, k-1, for the confidence regions to be asymptotically justified. Because x_t is ergodic for j ≥0,

$$\hat{R}_x^T(j) = \frac{1}{T}\sum_{\mathrm{t=j+1}}^{\mathrm{T}} x_t'x_{t-j} \rightarrow R_x(j) \text{ almost surely.} \tag{4.13}$$

Hansen (1979) thus shows that, for j ≥ 0,

$$\hat{R}_u^T(j) = \frac{1}{T}\sum_{\mathrm{t=j+1}}^{\mathrm{T}} \hat{u}_{t,k}^T\hat{u}_{t-j,k}^T \rightarrow R_u(j) \text{ almost surely,} \tag{4.14}$$

where $\hat{u}_{t,k}^{T}$ is the OLS residual for observation t with sample size T. He then uses the fact that $R_u(j) = R_u(-j)$ and $R_x(j) = R'_x(-j)$ to achieve a consistent estimator of the asymptotic covariance matrix Θ.

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 $\widehat{\Omega}_T$ as follows for our two step-ahead (three-month out) forecast:

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

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

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

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

Noting that

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

and similar to equation (4.10)

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

Hansen and Hodrick conclude that

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

which is a consistent estimator for the asymptotic covariance matrix.

Henriksson and Merton Test

This test simply analyzes the correct prediction of the direction of the variable being researched (Pesaran and Timmermann, 1992). In our research we are looking at the directional accuracy of nearby and deferred futures prices. For example, we first compare the one-month out futures to the cash price, then the three-month out futures to the one-month out futures, and finally the five-month out futures to the three-month out futures to determine if there was a predicted up, down, or no change movement. We then look at the actual price movements from the current cash price to the one-month out cash price, from the one-month out cash price to the three-month out cash price, and from the three-month out cash price to the five-month out cash price to compare whether the forecasted directional movements were the same as the actual movements. Recall that the directional movements are transformed to 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:

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

Using this contingency table Pesaran and Timmermann (1992) derive a new non-parametric procedure for testing the null hypothesis H_0^* of no market timing (no incremental information in our study):

$$H_0^* = \sum_{i=1}^{n}\left(\hat{P}_{ii} - \hat{P}_{i0}\hat{P}_{0i}\right) = 0. \tag{4.15}$$

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

$$\sqrt{n}(\hat{P} - P_0) \sim N(0, \Psi_0 - P_0 P_0'), \tag{4.16}$$

where $\hat{P}$ is a $m^2 \times 1$ column vector that consists of estimated values of P matrix, P_0 is the $m^2 \times 1$ column vector that consists of true values of the vectorized P matrix, 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^* can be based on the statistic:

$$S_n = \sum_{i=1}^{n}\left(\hat{P}_{ii} - \hat{P}_{i0}\hat{P}_{0i}\right), \tag{4.17}$$

where $\hat{P}_{ij} = n_{ij}/n$, $\hat{P}_{i0} = n_{i0}/n$, and $\hat{P}_{0i} = n_{0i}/n$, 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^*:

$$\sqrt{n}S_n \sim N(0, V_s), \tag{4.18}$$

where

$$V_s = \left(\frac{\partial f(\mathrm{P_0})}{\partial P}\right)'(\Psi - P_0 P_0')\left(\frac{\partial f(\mathrm{P_0})}{\partial P}\right), \tag{4.19}$$

and

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

$$- P_{j0} - P_{0i}, \text{ for } i \neq j. \tag{4.20}$$

Thus, the test statistic can be written as:

$$Z_n = \sqrt{n}V_S^{-1/2}S_n \sim N(0,1), \tag{4.21}$$

which is a standard normal Z-statistic. Once the test statistic Z_n is calculated from equation (4.21), Pesaran and Timmermann (1994) explain that only a one-sided test is necessary since only positive and statistically significant values of the test statistic provide evidence of incremental information.

CHAPTER V

RESULTS

Vuchelen and Gutierrez Direct Test

Table 5.1 shows the regression results for the Vuchelen and Gutierrez direct test for both soybeans and live cattle. The one-month out futures contract for live cattle reported a significant t-value of 3.68 which provides evidence that one-month out futures contracts provide valuable additional information. This implies that nearby futures contracts hold value toward price discovery. 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 similar results with a significant t-value of 3.17. On the contrary, 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 futures contracts. Since no additional information is seen beyond the one-month futures contracts for both live cattle and soybeans, it is reasonable to conclude that there is no value added toward price discovery by the three- and five-month out futures contracts.

Table 5.1 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 $ln(S_{t+5}/S_t) = \theta + \delta ln(S_t/S_{t-1}) + \lambda[ln(F_t^{t+1}/S_t) - ln(S_t/S_{t-1})] + \omega[ln(F_t^{t+3}/F_t^{t+1}) - ln(F_t^{t+1}/S_t)] + \eta[ln(F_t^{t+5}/F_t^{t+3}) - ln(F_t^{t+3}/F_t^{t+1})] + u_{t+5}$.

Henriksson and Merton Test

Recall P the contingency matrix which is represented as:

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

We focus on the diagonal probabilities since they represent correct forecasts with P_{11} representing the probability of the event $(f_t > 0, a_t > 0)$, P_{22} representing the probability of $(f_t < 0, a_t < 0)$, and P_{33} representing the probability of $(f_t = 0, a_t = 0)$. We report the probability matrices for the one-month out forecast, three-month out forecast, and five-month out forecast for both live cattle and soybeans. $P1_{LC}$ represents the price movements of one-month ahead live cattle futures contracts vs. the actual price movements. Similarly, $P3_{LC}$ and $P5_{LC}$ represent the price movement of three-month and five-month ahead live cattle futures contracts vs. the actual price movements for those horizons. Specifically the contingency tables are found as:

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

We focus on the diagonals in all three matrices since it represents the correct forecasts. The sum of the diagonal of $P1_{LC}$ shows a 0.611 or a 61.1% probability of a correct forecast for the one-month ahead live cattle futures forecast. The diagonal of $P3_{LC}$ shows a 0.603 or a 60.3% probability of a correct forecast for the three-month ahead live cattle futures forecast. The diagonal of $P5_{LC}$ shows a 0.513 or a 51.3% probability of a correct forecast for the five-month ahead live cattle futures forecast. The one- and three-month ahead forecasts show significant information with a forecast better than a naïve no-change forecast.

The probability matrices for soybeans are reported the same way with

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

The sum of the diagonal of $P1_S$ is .655, implying a 65.5% probability of a correct forecast for the one-month ahead soybean futures forecast. The diagonal for $P3_S$ shows a 54.9% probability of a correct forecast for the three-month ahead soybean futures forecast. The diagonal for $P5_S$ implies a 59.4% probability of a correct forecast for the five-month ahead soybean futures forecast. The one- and five-month ahead forecasts show significant information with a forecast better than a naïve no-change forecast.

We report the Z-statistic from the Henriksson and Merton test in Table 5.2. Only positive and statistically significant values show valuable additional informational content. Both live cattle and soybeans report statistically significant Z-statistics of 3.434 and 2.959 for one-month out forecasts. This result, which is similar to the results from Vuchelen and 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 forecast between live cattle and soybeans. Three-month out futures contracts for live cattle show a Z-statistic of 2.385 which shows additional information added to the one-month out contracts by the three-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 is different from the results found with the Vuchelen and Gutierrez (2005) test. The five-month out live cattle futures contracts displayed no additional value with a Z-statistic of 0.632. Therefore, 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 similar to the results in the Vuchelen and Gutierrez direct test. However, the Henriksson and Merton test finds that the three-month out forecasts for live cattle as well as the five-month out forecasts for soybeans provide additional informational value unlike what was found with the Vuchelen and Gutierrez direct test.

Table 5.2 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.

The two tests have contradicting results within the three- and five-month out future contracts. It is important to remember, however, that the tests are not one and the same. While Henriksson and Merton are comparing the actual price movements of cash prices to the forecasted movements to assess the quality of forecasts and estimate informational content, Vuchelen and Gutierrez are trying to best fit the forecasted price line through the realized cash prices. If the forecasted price falls close enough to the realized cash price to be significant then the Vuchelen and Gutierrez test shows valuable information from the nearby contract. Keep in mind that the forecasted price could be a downward price movement of one cent, and the actual price could be an upward price movement of one cent. While this forecast is incorrect in price movement for the Henriksson and Merton test, it is still fairly accurate and therefore still has valuable information in the Vuchelen and Gutierrez sense. In reality this forecast is near the actual price, but since the Henriksson and Merton test is judging the ability of correct price movements alone, it is an incorrect forecast and therefore contains no valuable information. This would cause the Vuchelen and Gutierrez direct test to have significant information but the Henriksson and Merton test would fail to show additional valuable information. The opposite could happen as well. The forecasted price suggests an increase of twenty cents, but the actual price recorded only showed an increase of two cents. This forecast will show information within our directional price movement test (Henriksson and Merton test) since it was an upward price movement forecast and did record an actual upward movement, but this forecast will show no incremental information within our price-point estimate test (Vuchelen and Gutierrez test) because in reality this forecast was incorrect by a substantial eighteen cents. To this end, our results will vary.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Hedgers, speculators, farmers, producers, 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 without adding valuable information that leads to price discovery, then reliance on distant-delivery futures contracts is ill-advised. To test informational value of deferred futures contracts in price discovery, we applied Vuchelen and Gutierrez and Henriksson and Merton tests to live cattle and soybeans futures markets. First, 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. Vuchelen and Gutierrez test shows no valuable information beyond the one-month out futures contracts for both commodities while the Henriksson and Merton 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 will be mislead in the case of the Vuchelen and Gutierrez direct test. However, the Henriksson and Merton test did show information added to nearby futures contracts in the simple sense of directional price movements within forecasts. To this end, deferred futures contracts for soybeans and live cattle may not be reliable for point price estimates but more accurate for directional price movements.

REFERENCES

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.

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

Greer, M., (2003). Directional Accuracy Tests of Long-term Interest Rate Forecasts. International Journal of Forecasting, 19, 291-298.

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.

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.