Analysis of the Relation of Corn and Soybeans Futures and ETF Prices

Stoyu I. Ivanov
San Jose State University

Abstract: In this study I examine the relation between corn and soybeans exchange traded funds and their respective futures contracts. Considering that the exchange traded funds for these commodities track an index based on a basket of the futures instruments a natural link exists between exchange traded funds and futures contracts. This is the first study, to the best of my knowledge, to examine this relation by using cointegration methodology and provide a Vector Error Correction Model of the relation between these two prices.

Introduction

The United States produces half of the world's corn and a third of the world's soybeans. It is not surprising that there were surprise and significant price adjustments in grains prices when the US Department of Agriculture announced on January 13, 2010 that the harvest would be better than anticipated (Flood, 2010). The press was filled at that time with discussions of how fast futures prices dropped and adjusted to the new information. Futures prices are most often used in such discussions. Considering the importance of derivative markets this is not surprising. What is surprising is the lack of recent studies examining the relations between the different corn and soybeans instruments. This study attempts to fill this void in the literature by considering the major recent innovations in these markets. Most of the earlier studies conducted in the area of agricultural commodities, such as by Garbade and Silber (1983) and Mattos and Garcia (2004) to name a few, focus on the price discovery forces in the cash and futures commodity markets. These studies have as a main objective of identifying which market is dominating in the price discovery. The majority of the studies find that the futures market leads the cash market in terms of price discovery. These studies do not examine

the recent developments in commodity markets, such as the introduction of the Exchange Traded Funds (ETFs), which might provide a natural investment alternative to investing in the cash commodity market.

The ETFs are a recent innovation, which has exploded in popularity. An ETF is similar to an index mutual fund in that it is legally organized as an open ended fund or unit investment trust which tracks an index. However, ETFs are different from index funds in that they trade continuously throughout the day and allow for an in-kind creation and redemption of ETF securities, which has tax benefits. The majority of ETFs are based on financial indexes; however commodities ETFs have attracted interest recently. Corn and soybeans ETFs have been introduced in 2006 in the United Kingdom but are not yet available in the United States. Commodity ETFs are present in the United States but only for oil and precious metals. The interesting aspect of the majority of commodity ETFs is that they are not designed to track the underlying cash price of the commodity but rather track the futures price of the commodity. Thus naturally establishing a link between the futures and ETF prices. This is the first study to the best of my knowledge of formally examining the relation between the corn and soybeans ETF and futures prices with a cointegration methodology, considering that for all investment purposes the trade-off these days is between the ETF and futures instruments rather than between the cash and futures markets.

The Futures Contracts and ETF Securities for Corn and Soybeans, Data and Methodology

I use daily data similar to Garbade and Silber (1983) and Mattos and Garcia (2004). Corn and soybeans futures data are from: http://pitrading.com and corn and soybeans daily ETF prices data are from: http://uk.moneycentral.msn.com. Garbade and Silber (1983) develop and empirically test a theoretical model of simultaneous price dynamics in the cash and futures markets for wheat, corn, oats, orange juice, copper, gold and silver. However, the authors do not follow cointegration methodology, which has become popular in price discovery recently. Mattos and Garcia (2004) is an example of a recent study in examining the simultaneous price dynamics of the cash and futures markets by employing a cointegration methodology. The authors study the price discovery in the cash and futures corn, cotton, live cattle, soybeans, sugar and coffee commodities in Brazil. Both studies conclude that the dominating market is the futures market. I approach the question of dominant market from a new perspective, the introduction of the new security ETF. With the introduction of the ETF security, which has small denomination and thus appearing to be more accessible to individual investors, the ETF might be a close substitute to the cash market for all practical investment purposes.

The Corn Futures contract, with ticker symbol C, is an E-mini contract, which is one fifth of the regular size futures contract.[1] In the analysis to follow I use the nearby contract price. The contract size of the futures contract is 5,000 bushels, with deliverable grades of the commodity: #2 Yellow corn quality at the contracted price, #1 Yellow grain quality at a 1.5 cent/bushel premium, and #3 Yellow grain quality at a 1.5 cent/bushel discount of the contracted price. The futures contract is traded on the CME Globex (Electronic Platform) and has delivery months January, March, May, July, August, September and November. Similarly, the Soybeans Futures contract is an E-mini, traded on the CME Globex (Electronic Platform) with a ticker symbol S, with contract size of 5,000 bushels and the same delivery months.[2] The deliverable grades are: #2 Yellow soybeans grain quality at contract price, #1 Yellow grain quality at a 6 cent/bushel premium, #3 Yellow grain quality at a 6 cent/bushel discount.

The corresponding ETF securities are traded on the London Stock Exchange (LSE) however they are denominated in US Dollars. Currently there are no corn or soybeans ETFs traded in the United States. Despite the fact that the two securities are traded in different countries they are comparable because the currency denomination of the futures contracts and the ETFs is the same, the US Dollar. Both ETF securities are managed by the same company ETF Securities Ltd. The Corn ETF has a ticker symbol CORN, and has an investment objective of tracking the DJ-AIG Corn Sub-Index[SM].[3] The corn ETF has an inception date September 27, 2006 and has management fee of 49 basis points. The Soybeans ETF has a ticker symbol SOYB and has an investment objective of tracking the DJ-AIG Soybeans Sub-Index[SM], has the same inception date as the corn ETF and the same management fee of 49 basis points.

What is important to recognize is that both the DJ-AIG Corn Sub-Index[SM] and the DJ-AIG Soybeans Sub-Index[SM] are designed to track a basket of the underlying commodities futures contracts.[4] Thus, the corn and soy ETFs that I use in this study do not follow the cash price of the commodity but rather are linked to the futures price of the commodity. In this study I attempt to quantify the relation between the futures and ETF security prices based on the cointegration methodology, which relies on this natural association between the futures and ETF securities.

The presence of natural association between the futures and ETF prices suggests cointegration based on the Granger representation theorem as discussed in Engle and Granger (1987). The Granger representation theorem states that if two series are integrated of order one there might be a natural combination of them, which will not be integrated. The presence of natural association and cointegration in turn calls for the

---

[1] Detailed description of the corn futures contract is available on the Chicago Mercantile Exchange's website: http://www.cmegroup.com/trading/commodities/grain-and-oilseed/corn_contract_specifications.html.

[2] Detailed description of the soybeans futures contract is available on the Chicago Mercantile Exchange's website: http://www.cmegroup.com/trading/commodities/grain-and-oilseed/soybean_contract_specifications.html.

[3] Detailed description of the corn and soybeans ETFs is available at: http://www.etfsecurities.com.

[4] Detailed description of the different sub indexes is available on the following website: http://www.djindexes.com

identification of a Vector Error Correction Model (VECM) of formally representing the linkage between the two prices. The VECM that I use in the study is:

$$\Delta p_t = \beta(z_{t-1} - b) + \phi_1 \Delta p_{t-1} + \phi_2 \Delta p_{t-2} + \ldots + u_t ,$$ (1)

where p_t is the 2x1 vector of prices and z_t is the stationary difference between the price considered dominant and the other price, and $(\beta z_{t-1} - b)$ is the error correction term, and u_t is the common error term. Therefore, the VECM in equation (1) for the corn and soybeans futures and ETF prices can be expressed as:

$$\Delta FUTURES_t = \beta_1 (z_{1,t-1} - b_1) + \phi_1 \Delta FUTURES_{t-1} + \phi_2 \Delta ETF_{t-1} + \ldots + u_{1t}$$ (2)
$$\Delta ETF_t = \beta_2 (z_{2,t-1} - b_2) + \phi_1 \Delta FUTURES_{t-1} + \phi_2 \Delta ETF_{t-1} + \ldots + u_{2t}$$

This analysis is standard in examining relation among variables and identifying in which market price discovery occurs, as used in Mattos and Garcia (2004).
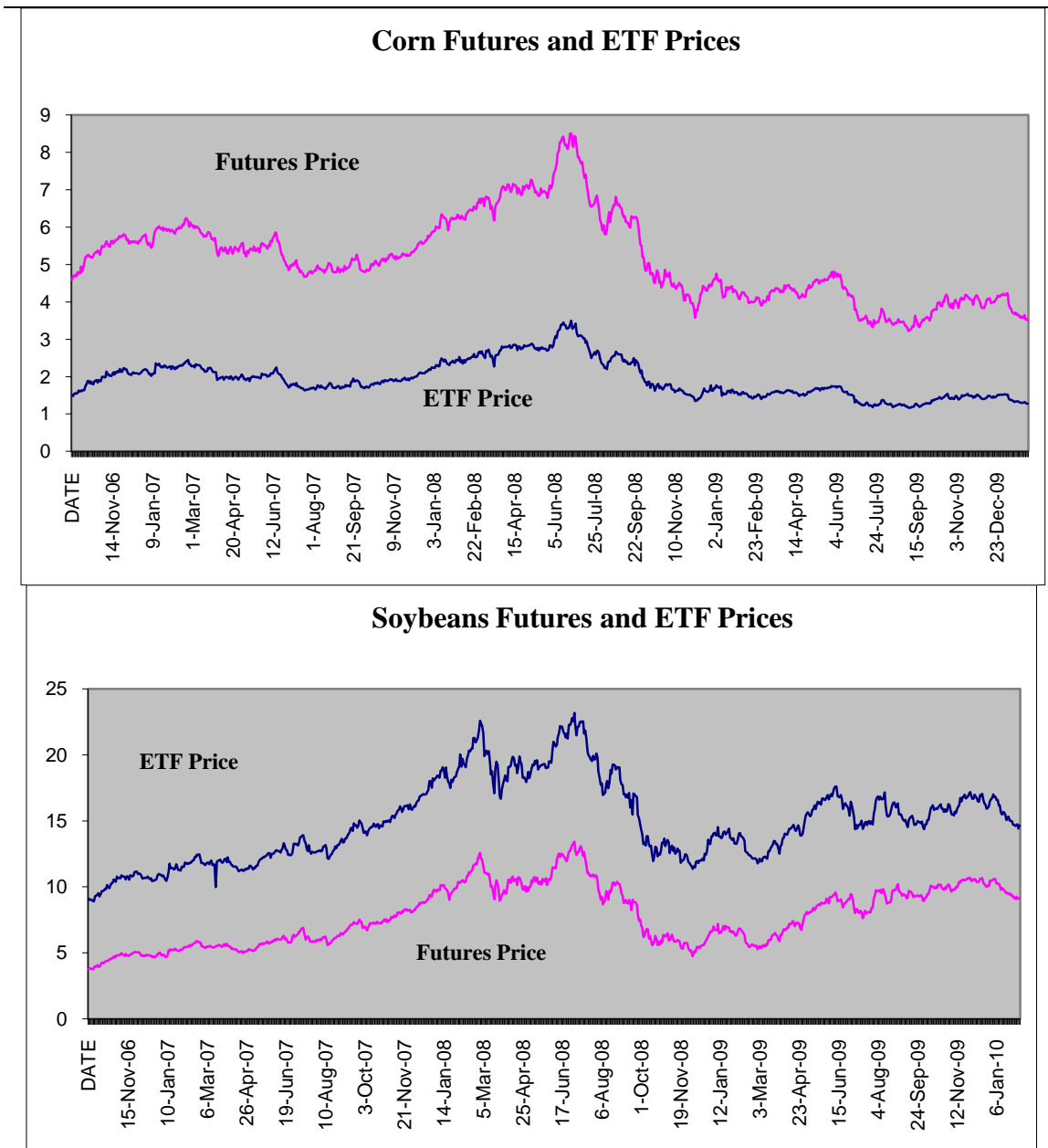
Analysis

Summary statistics for the ETF and futures prices in the period September 27, 2006 to February 05, 2010 are presented in Table 1. The period is determined by the time of inception of the ETF and the last available date of prices for the two instruments. Figure 1 shows the ETF and futures prices dynamics in the period and suggests presence of unit roots in the series.

Table 1. Summary Statistics of Commodities ETF and Futures Prices for the period September 27, 2006 – February 05, 2010. ADF is Augmented Dickey Fuller Unit Root Test, Zero Mean Model, Lag length is set at 5.

	N	Mean	StdDev	Min	Max	ADF p-value
Corn Futures	857	5.1614	1.1328	3.2250	8.5100	0.6038
Corn ETF	857	1.9298	0.4945	1.1700	3.5000	0.6121
Soy Futures	850	7.8227	2.2346	3.7525	13.4125	0.7304
Soy ETF	850	14.9365	3.0678	8.9100	23.1800	0.7030

Following the Engle-Granger cointegration methodology as discussed in Enders (2004) I test for stationarity in the corn and soybeans futures and ETF prices first. Results of the tests are also presented in Table 1. The Augmented Dickey Fuller (ADF) test fails to reject the null hypothesis of unit root in each price series for the zero mean, single mean and trend model specification. In the table only zero mean results are reported. The Phillips-Perron Unit Root Test also indicates presence of unit roots (results not reported but are available upon request).

Figure 1. Corn and Soybeans ETFs and Futures Prices

Corn Futures and ETF Prices

Soybeans Futures and ETF Prices

Considering that the corn and soybeans ETF and futures prices have unit roots cointegration might be present based on the design of the ETF security to track a basket of futures contracts and the Granger representation theorem as discussed in Engle and Granger (1987). Therefore, I test for cointegration among the futures and ETF commodity prices. I employ the Johansen Cointegration Test. Results of the test are presented in Table 2. Results of the cointegration test suggest rejection of lack of no cointegrating vector and failure to reject at most one cointegrating vector between the futures and ETF prices for corn. For soybeans, the cointegration test failed to reject no cointegration and single cointegrating vector between the futures and ETF prices.

Table 2. Johansen Cointegration Test Results (Prices)

	Corn		Soybeans	
H0: Rank=	Trace Statistic	5% Critical Value	Trace Statistic	5% Critical Value
0	12.3578	12.21	5.7378	15.34
1	0.6252	4.14	0.3717	3.84

The presence of a cointegration among the prices calls for the identification of a relation among these variables via a Vector Error Correction Model (VECM). VECM estimation results are presented in Table 3.

Table 3. Vector Error Correction Model Results (Prices)

		Corn		Soybeans	
		Estimate	p-value	Estimate	p-value
Δ Futures	ETF(t-1)	-0.0654	0.1085	0.0090	0.0518
	Futures(t-1)	0.0243	0.1085	-0.0167	0.0518
	ΔETF(t-1)	-0.0465	0.6456	0.0156	0.6463
	ΔFutures(t-1)	0.0907	0.0488	0.0276	0.5524
	ΔETF(t-2)	-0.1884	0.1085	-0.0789	0.0518
	ΔFutures(t-2)	0.0435	0.4403	0.0596	0.3297
	ΔETF(t-3)	-0.0551	0.6282	-0.0797	0.0431
	ΔFutures(t-3)	0.0771	0.1821	0.1474	0.0197
	ΔETF(t-4)	-0.0793	0.3682	-0.0857	0.0039
	ΔFutures(t-4)	0.1257	0.0162	0.1322	0.0156
Δ ETF	ETF(t-1)	-0.0599	0.0001	0.0094	0.0001
	Futures(t-1)	0.0226	0.0001	-0.0182	0.0001
	ΔETF(t-1)	-0.7042	0.0001	-0.6743	0.0001
	ΔFutures(t-1)	0.3756	0.0001	1.2275	0.0001
	ΔETF(t-2)	-0.4811	0.0001	-0.4628	0.0001
	ΔFutures(t-2)	0.2488	0.0001	0.7974	0.0001
	ΔETF(t-3)	-0.2853	0.0001	-0.2768	0.0001
	ΔFutures(t-3)	0.1739	0.0001	0.5056	0.0001
	ΔETF(t-4)	-0.1213	0.0019	-0.2327	0.0001
	ΔFutures(t-4)	0.1384	0.0001	0.3113	0.0001

The VECM residuals need to be tested for White noise to ensure that the series are cointegrated. The traditional statistics theory calls for the use of stationary series in the analysis. When series to be analyzed is not stationary traditional statistical theory suggests differencing. In contrast, the cointegration theory is based on the idea that because the series individually are integrated processes if combined the series will create a system, which has stationary characteristics. Thus, I test for stationarity and

white noise for the residuals of the VECM by using ADF, Durbin Watson, Normality and Autoregressive Conditional Heteroskedasticity (ARCH) tests. ADF test rejects the null hypothesis of unit root in residuals, the Durbin Watson test fails to reject null hypothesis of no autoregressive errors, the Normality test fails to reject null hypothesis of normality in errors and the ARCH test fails to reject non-ARCH in the residuals (results are not reported but are available upon request).

Therefore, the long run relationship between the ETF and futures price can be represented as equations (2) based on the VECM estimates in the table. For corn the long run relationship is:

$$\Delta p_t = \begin{pmatrix} -0.0654 & 0.0243 \\ -0.0599 & 0.0226 \end{pmatrix} p_{t-1} + \begin{pmatrix} -0.0465 & 0.0907 \\ -0.7042 & 0.3756 \end{pmatrix} \Delta p_{t-1} + \begin{pmatrix} -0.1884 & 0.0435 \\ -0.4811 & 0.2488 \end{pmatrix} \Delta p_{t-2}$$
$$+ \begin{pmatrix} -0.0551 & 0.0771 \\ -0.2853 & 0.1739 \end{pmatrix} \Delta p_{t-3} + \begin{pmatrix} -0.0793 & 0.1257 \\ -0.1213 & 0.1384 \end{pmatrix} \Delta p_{t-4}$$

The long run relationship for soybeans ETF and futures prices can be represented as:

$$\Delta p_t = \begin{pmatrix} 0.0090 & -0.0167 \\ 0.0094 & -0.0182 \end{pmatrix} p_{t-1} + \begin{pmatrix} 0.0156 & 0.0276 \\ -0.6743 & 1.2275 \end{pmatrix} \Delta p_{t-1} + \begin{pmatrix} -0.0789 & 0.0596 \\ -0.4628 & 0.7974 \end{pmatrix} \Delta p_{t-2}$$
$$+ \begin{pmatrix} -0.0797 & 0.1474 \\ -0.2768 & 0.5056 \end{pmatrix} \Delta p_{t-3} + \begin{pmatrix} -0.0857 & 0.1322 \\ -0.2327 & 0.3113 \end{pmatrix} \Delta p_{t-4}$$

These models indicate that the prices of the ETFs tend to react to any changes in the prices of the corn and soybeans futures contracts. This means that the ETF securities are well designed and do a good job of tracking the underlying asset, which in this case is a basket of futures contracts on the corn and soybeans commodities. Corn and soybeans ETFs are not yet available in the United States, however as this study indicates, such securities being well designed might expand the investment opportunity set and might be popular with investors.

Conclusion

In this study I examine the relation between corn and soybeans exchange traded funds and their respective futures instruments. The corn and soybeans ETF securities examined in this study are traded on the London Stock Exchange but are denominated in US Dollars. Currently there are commodity ETFs such as oil, gold, silver and other precious commodities but there are no corn or soybeans ETFs traded in the United States. Considering that the exchange traded funds for these commodities track an index based on a basket of the futures instruments by design a natural link exists between exchange traded funds and futures contracts. This is the first study, to the best

of my knowledge, to examine this relation by using cointegration methodology and provide a Vector Error Correction Model of the relation between these two prices. The results of the Vector Error Correction model indicate that the ETFs do a good job of responding to the changes in the underlying asset and thus are well designed. These securities might be a good addition to the investment opportunity set available to US investors, considering that they are not traded in the US.

References

Brockman, Paul and Yiuman Tse (1995) Information Shares in Canadian Agricultural Cash and Futures Markets, Applied Economics Letters, vol. 2, No. 10, pp 335-338.

Enders, Walter (2004) Applied Econometric Time Series, Wiley Series in Probability and Statistics, Second Edition, John Wiley& Sons, New Jersey.

Engle, Robert, and C. W. J. Granger (1987) Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica, Vol. 55, No. 2, pp. 251-276.

Flood, Chris (2010) Grain prices dip after forecast for record crops, Financial Times, Wednesday, January 13, 2010, pp. 22.

Garbade, Kenneth D. and William L. Silber (1983) Price Movements and Price Discovery in Futures and Cash Markets, The Review of Economics and Statistics, Vol. 65, No. 2 (May, 1983), pp. 289-297.

Mattos, Fabio, and Philip Garcia (2004) Price Discovery In Thinly Traded Markets: Cash And Futures Relationships In Brazilian Agricultural Futures Markets, Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, St. Louis, MO. [http://www.farmdoc.uiuc.edu/nccc134].

Stoyu I. Ivanov
Accounting and Finance Department
College of Business, BT958
One Washington Square
San José, CA 95192-0066
Phone: (408) 924-3934
Email: ivanov_s@cob.sjsu.edu