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PRICE ASYMMETRY IN SOUTH AFRICAN FUTURES MARKETS FOR AGRICULTURAL COMMODITIES

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Abstract

This paper tests the existence of price asymmetry in South African futures markets for white and yellow maize, wheat and sunflower seeds using a dynamic price asymmetry model. The sum of coefficients test and the speed of adjustment test are used to determine whether or not prices move up in the same fashion as they move down, over daily and weekly data frequencies. Out of the four commodity futures markets studied over varying data frequencies, only daily wheat is price asymmetric. Wheat daily prices respond faster to price decreases than to price increases. The implication of the results is that past prices do affect current prices and contain information. Hence, the weak-form efficient market hypothesis appears to be contradicted for wheat futures market. Another important implication of the results is that implementing policies accounting for asymmetric behavior through price limit and margin policies will improve the functioning and stability of wheat futures market in South Africa.

1. INTRODUCTION

The futures market is a market in which futures contracts on underlying commodities are traded for hedging and speculative purposes. The deregulation of agricultural markets in South Africa led to the establishment of a futures market for agricultural products, which was opened in January 1995. The new Marketing of Agricultural Products Act (Act No 47 of 1996) in South Africa has created an environment in which farmers, traders and processors are able to react positively to transparent prices which are market related (SAFEX, 2004). Agricultural futures markets serve several important functions, such as risk management, price discovery, and forward pricing (Sheldon, 1987). Futures' trading is one mechanism for managing the effects of price instability resulting from the production, marketing and purchase of a given commodity.

Economists around the world have studied vertical and spatial price relationships, and the behavior of price changes in futures markets using asymmetry tests. Price asymmetry results in futures markets have a number of

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important implications as outlined by Gravelines and Boyd (1999). Firstly, traditional models in time series may be slightly biased when forecasting future prices, because they assume price symmetry. Secondly, asymmetry results may imply that the weak-form efficient markets hypothesis appears to be contradicted, thus indicating that past prices do affect current prices and do contain information. Lastly, if persistent asymmetry is found in futures markets, market regulators and policy makers may wish to use asymmetric information to improve the functioning and stability of futures markets through improved price limit and margin policies. Implementing policies accounting for asymmetric behavior may help avoid market crashes and sudden unexpected price adjustments adversely affecting market participants.

There is a dearth of published work in South Africa on the performance of futures markets for agricultural commodities, probably because the Agricultural Marketing Division began trading futures only in mid-1996. Agricultural commodities currently being traded at the South African Futures Exchange (SAFEX) markets are white and yellow maize, wheat, sunflower seed and soybean, and were introduced in 1996, 1997, 1999, and 2002, respectively (SAFEX, 2004). Wiseman *et al* (1999) focused on testing the efficiency of the South African futures market for white maize. To our knowledge, there is no published literature on the asymmetric behavior of price changes in futures markets for agricultural commodities in South Africa. It is not yet known whether agricultural commodity futures in South Africa are price asymmetric or not. This study is an attempt to fill this gap and contribute to a body of knowledge in this area. The objective of this study is, therefore, to test for price asymmetry in South African futures markets for white and yellow maize, wheat and sunflower seed. Commodities are tested over daily and weekly prices, providing a common foundation to make comparisons between different commodities and frequencies of data.

The remainder of the paper proceeds as follows: Section 2 discusses the asymmetry theory. Section 3 outlines the methodology of the study. The empirical results of the study are presented in Section 4. Section 5 summarizes the results of the study and draws relevant conclusions.

2. ASYMMETRY THEORY

The concept of price asymmetry is not new as alluded to by Punyawadee *et al* (1991), and Gravelines and Boyd (1999). For example, the Keynesian model assumes nominal wages are "sticky" downward due to labour contracts. The implication is that wages are easy to raise but difficult to lower and behave asymmetrically. For the case of commodity markets, according to Alban (1990):

"A rising market is a mirror image of a declining market in the financial sectors. But not so in commodities, which decline at a much greater rate than they rise."

The theory of futures markets assumes that changes in futures prices are based on revised expectations about factors determining future prices. Due to the competitiveness of most futures markets, prices in futures markets are assumed to follow a "random walk" (Sheldon, 1987; Hudson *et al*, 1987). The first difference is then simply a random series with no systematic differences between price increases and price decreases. However, human behaviour is not always rational. "Speculative bubbles" are example of irrational human behaviour. "Speculative bubbles" would occur when the market over or under reacts to new information (Smidt, 1968) and cause prices to increase contrary to rational behaviour (Kindleberger, 1989). For example, individuals may realize that the price today is abnormally high, but still bid the price even higher because they do not want to miss out on potential capital gains from the price increase in the future. The "bubble" will eventually burst and the price drops rapidly.

Gravelines and Boyd (1999) argue that traders sometimes act psychologically as a group because, under certain circumstances, traders copy each other. Individuals can also become attached to their assets and increase their investment over time for psychological and emotional reasons. Under these circumstances, they are reluctant to sell and only sell if they are able to receive a price higher than the price they are willing to pay. This reluctance to sell may be due to factors such as the "endowment effect" as explained by Kahneman *et al* (1990). If prices of assets decrease sales will begin and this will cause more sales, exerting more pressure on prices to fall even further. This downward pressure on prices and counter reaction to the attachment of assets and the endowment effect can result in large liquidity very quickly.

3. METHODOLOGY

3.1 Price asymmetric model

This paper uses a dynamic price asymmetry model similar to that used by Bailey and Brorsen (1989) to test for price asymmetry in South African futures markets for agricultural commodities. The study regresses futures price changes (FC) as the dependent variable, against both positive (PFC) and negative (NFC) lagged price changes within the same series, which are independent variables. The model estimated is as follows:

$$\ln(FC_t) = \alpha_0 + \sum_{i=1}^{n} \beta_i \ln(PFC_{t-i}) + \sum_{i=1}^{n} \gamma_i \ln(NFC_{t-i}) + e_t \qquad (1)$$

where $\ln(FC_t)$ are the logarithmic futures price changes of the commodity in question at time *t*, $\ln(PFC_{t-i})$ are lagged positive logarithmic futures price changes observed *i* period prior to *t*, and $\ln(NFC_{t-i})$ are lagged negative logarithmic futures price changes observed *i* period prior to *t*. α_0 is the intercept, and β_i and γ_i represent the individual coefficients of the i^{th} lagged positive and negative changes of $\ln(FC_t)$, respectively. The variable e_t is a random error term. The number of lags is represented by n. The lag length is chosen for each equation separately by the Akaike Information criterion (AIC) method. AIC is a guide to the selection of the number of terms in an equation. The procedure is to select a model with the largest penalized maximized log-likelihood function or the specification with the lowest value of AIC (Hossain, 2002).

It is common in the statistical analysis of prices of financial securities, including futures contracts, to apply a logarithmic transformation to the data series (Fortenbury and Zapata, 1993). Aulton *et al* (1997) give a number of reasons why it is desirable to use the logarithmic transformation of the future price series for analytical purposes. For example, a logarithmic transformation will often succeed in stabilizing the variance of the observed series. Two common asymmetry hypotheses are tested. The first hypothesis tests whether the aggregate impact of past price increases and decreases on current price changes are the same (the sum of coefficients test):

$$H_0 : \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_i$$

$$H_1 : \sum_{i=1}^{n} \beta_i \neq \sum_{i=1}^{n} \gamma_i \tag{2}$$

The rejection of the null hypothesis (asymmetry) is reflected by a difference between the coefficients for price increases and decreases in equation (1). Coefficients can differ in two respects. The first is when the positive and negative coefficients of the same lag period have different magnitudes but same sign. The second way that asymmetry can be present is when the signs of the coefficients are different for price increases and decreases. The second hypothesis tests whether the speed of adjustment is the same for both price increases and decreases:

$$H_0 : \beta_i = \gamma_i$$

$$H_1 : \beta_i \neq \gamma_i \tag{3}$$

The speed of adjustment test involves a joint test for pairs of coefficients. Rejection of the null hypothesis indicates that the rate of adjustment differs for positive and negative price changes. It is then necessary to inspect coefficient values and individual t-statistics to describe the differences in the adjustment process. The asymmetry tests are conducted using the standard likelihood ratio F-test, which uses the sum of squared errors with and without imposing the restrictions being tested.

3.2 Data sets

The data sets used in this study consist of daily and weekly closing futures prices for four agricultural commodities traded at the South African Futures Exchange markets-white and yellow maize, wheat and sunflower seed. The data is obtained directly from SAFEX. Data ranges from 1996 (for white and yellow maize), 1997 (for wheat) and 1999 (for sunflower seeds), with data continuing through 2003 for each commodity. A nearby series is used for each commodity. The weekly data are constructed by choosing the Friday (or the last business day) of each week in the daily series. The natural logarithmic differences used in equation (1), for each commodity are rescaled by multiplying them by 100 in order to avoid computational error from small values.

4. EMPIRICAL RESULTS

Eight equations are estimated in total for the four commodities, using ordinary least squares. Autocorrelation is not a significant concern since first differences are being used. For the eight equations estimated, lags average 3.75 days for the daily data and 1.50 weeks for the weekly data. Many commodity prices, at least when sampled at high frequencies, have a tendency to contain stochastic trends or unit roots (Ardeni, 1989; Baillie and Myers, 1991; Goodwin and Schroeder, 1991; Goodwin, 1992). The augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are common methods for testing unit roots, and are used here. Dickey-Fuller is appropriate for a series generated by an autoregressive process of order one, AR(1). If, however, F_t follows an AR(p) process where $p>1$, the error term in the standard DF test will be autocorrelated. Autocorrelated errors will invalidate the use of the DF distribution which is based on the assumption that the error term is white noise.

The augmented Dickey-Fuller (ADF) test includes additional difference terms to account for this problem (Dickey and Fuller, 1981; Gujarati, 1995; Townsend, 1998). The logarithm of daily white and yellow maize futures prices were tested for a unit root using the augmented Dickey-Fuller test in the following model:

$$\ln(FC_t) = \delta + \Phi t + \rho \ln(F_{t-1}) + \sum_{i=1}^{k} \lambda_i \ln(FC_{t-i}) + v_t \qquad (4)$$

where $\ln(FC_t)$ = first difference of logarithm of futures price; t = trend; δ, Φ, ρ, λ_i = coefficients and v_t = an error term.

H_0: ρ = 0 (Non-stationary or unit root)
H_1: ρ < 0 (Stationary or no unit root)

To test the significance of the estimated ρ coefficients, the Dickey-Fuller unit root test computes the tau statistic (τ) for each estimated coefficient, in exactly the same way as a student's t statistic is calculated. But the estimated τ values do not follow the same distribution as student`s t. The statistical significance of the estimated τ values must be assessed by comparing them with critical values derived for the τ distribution tabulated in Dickey and Fuller (1981). If the estimated τ value is less than the critical value in absolute terms, then the null hypothesis of the existence of unit root cannot be rejected.

Phillips and Perron (1988) propose an alternative non-parametric method of controlling for autocorrelation in the error term when testing for a unit root. The PP method estimates the non-augmented DF test equation and modifies the t-ratio of the coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic (Eviews, 2002). The PP test is based on the statistic:

$$Z_t = t_\rho \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{N(f_0 - \gamma_0)(Se(\hat{\rho}))}{2 f_0^{1/2} S} \qquad (5)$$

where ρ = coefficient estimator, t_ρ = the t ratio of ρ, $Se(\hat{\rho})$ = coefficient standard error, S = standard error of the test regression, N = sample size, γ_0 = error variance= $(N-K)S^2/N$ and f_0 = an estimator of the residual spectrum at frequency 0. However, it has been documented in the literature that the Phillips-perron suffers from severe size distortions when there are negative moving-average errors (Phillips and Perron, 1988; DeJong *et al*, 1992).

To increase the robustness of the tests this study adopts both methods for testing a unit root. The results of Augmented Dickey-Fuller and Phillips-Perron tests for a unit root for the logarithmic futures price series for each commodity are presented in Table 1. If the two tests reinforce each other then we can have more confidence in the results. As expected all logarithmic futures price series have unit root. Given that all logarithmic futures price series are integrated of order one, I(1), it is then logical to impose differencing and test for price asymmetry in South African futures markets for agricultural commodities over daily and weekly prices.

Table 1: ADF and PP unit root tests for logarithmic commodity futures prices

Commodity	Daily statistics		Weekly statistics	
	τ statistic	Z_t statistic	τ statistic	Z_t statistic
White maize	-1.88	-1.90	-2.37	-2.17
Yellow maize	-1.93	-1.98	-2.44	-2.19
Wheat	-1.84	-2.46	-2.11	-1.99
Sunflower seed	-1.33	-1.24	-1.34	-1.32

Note: Critical values: τ_{ct} = -3.41 and Z_t = -3.41 at the 5% level of probability.

One possible statistic related to asymmetry may be the mean size of percentage price changes. This is given by logarithmic price differences in Table 2. However, inspection of Table 2 generally shows no evidence of difference in the size between mean percentage positive and negative price changes. A t-test is used to verify any statistical differences between the means for positive changes and negative changes. All of the commodities fail to reject the null hypothesis of equal means. The implication is that South African futures markets for white maize and yellow maize, wheat and sunflower seeds may be price symmetric.

Table 2: Numbers and means of logarithmic price increases and decreases for various commodity futures markets across various time horizons

Price	Increases		Decreases		No change	
	Number	Mean	Number	Mean	Number	t-statistic
White maize						
Daily (n = 1986)	755	1.5520	748	-1.5295	483	0.2866
Weekly (n = 406)	178	3.5797	182	-3.3276	46	0.7267
Yellow maize						
Daily (n = 1986)	721	1.4410	716	-1.3812	549	0.8192
Weekly (n = 406)	182	3.2038	173	-3.0840	51	0.4009
Wheat						
Daily (n = 1572)	433	1.1689	410	-1.0951	729	0.3396
Weekly (n = 321)	134	2.0734	110	-2.0063	77	0.2348
Sunflower seed						
Daily (n = 1023)	393	1.2522	366	-1.1386	264	1.4863
Weekly (n = 262)	108	2.6395	83	-2.5261	17	0.2766

Note: Logarithmic differences in this table can be interpreted as the percentage change in price.

Table 3: Daily price asymmetry tests in South African futures markets for agricultural commodities

		Independent variables[a, b]												
Commodity	**Intercept**	**PFC_{t-1}**	**PFC_{t-2}**	**PFC_{t-3}**	**PFC_{t-4}**	**PFC_{t-5}**	**NFC_{t-1}**	**NFC_{t-2}**	**NFC_{t-3}**	**NFC_{t-4}**	**NFC_{t-5}**	**Sum F-value[c]**	**Identical F-value[d]**	**R^2**
White maize	-0.028 (-0.409)	0.084 (0.777)	0.084* (2.199)	-0.077* (-1.998)	0.037 (0.967)	0.085* (2.230)	0.118* (3.154)	-0.051 (-1.358)	-0.006 (-0.157)	0.014 (0.377)	0.012 (0.319)	0.075	1.736	0.014
Yellow maize	0.022 (0.389)	0.109* (2.932)	-0.041 (-1.093)	-0.038 (-1.009)	-	-	0.126* (3.487)	-0.027 (-0.742)	-0.073* (-2.033)	-	-	0.005	0.151	0.018
Wheat	0.300* (5.371)	-0.793* (-26.521)	0.193* (3.646)	-0.017 (-0.313)	-0.050 (-0.953)	-	0.209* (3.860)	0.001 (0.020)	-0.050 (-0.913)	0.009 (0.282)	-	146.949*	81.621*	0.313
Sunflower seed	0.047 (0.724)	0.215* (4.131)	0.004 (0.078)	0.053 (1.010)	-	-	0.136* (2.530	0.034 (0.625)	0.088 (1.652)	-	-	-0.117	0.302	0.041

Notes: [a]t-values are in parenthesis.

[b]PFC_{t-i} = positive futures price changes lagged *i* days and NFC_{t-i} = negative futures price changes lagged *i* days.

[c]F-test of $H_0 : \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_i$

[d]F-test of $H_0 : \beta_i = \gamma_i$

*Denotes significant at the 5% level of probability.

The results of the aggregate impact test and the speed of adjustment test for daily and weekly prices are presented in Tables 3 and 4, respectively. The hypothesis that the total impact of past price increases is same as past price decreases is accepted for all commodities but daily wheat. The implication is that white and yellow maize, and sunflower seed futures markets are price symmetric while wheat futures market is price asymmetric. The hypothesis that the coefficients for each lag will be the same for past price increases as for past price decreases is rejected for daily wheat and accepted for white and yellow maize, and sunflower seed. Daily wheat prices seem to respond faster to price decreases (one day) than to price increases (two days).

Table 4: Weekly price asymmetry tests in South African futures markets for agricultural commodities

	Independent variables[a, b]							
Commodity	**Intercept**	**PFC_{t-1}**	**PFC_{t-2}**	**NFC_{t-1}**	**NFC_{t-2}**	**Sum F-value[c]**	**Identical F-value[d]**	**R^2**
White maize	-0.159 (-0.465)	0.119 (1.432)	0.151 (1.831)	0.076 (0.875)	0.041 (0.489)	0.844	0.605	0.025
Yellow maize	0.461 (1.681)	-0.087 (-1.078)	-	0.164 (1.815)	-	2.972	2.972	0.090
Wheat	0.171 (0.939)	0.054 (0.628)	-	0.057 (0.608)	-	-0.003	-0.003	0.003
Sunflower seed	0.535 (1.430)	0.082 (0.795)	-0.035 (-0.341)	0.435* (3.317)	-0.209 (-1.588)	0.570	1.930	0.068

Notes: [a]t-values are in parenthesis.

[b]PFC_{t-i} = positive futures price changes lagged *i* weeks and NFC_{t-i} = negative futures price changes lagged *i* weeks.

[c]F-test of $H_0 : \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_i$

[d]F-test of $H_0 : \beta_i = \gamma_i$

*Denotes significant at the 5% level of probability.

5. SUMMARY AND CONCLUSIONS

To our knowledge, there is no published work on the asymmetric behaviour of price changes in futures markets for agricultural commodities in South Africa. This study is an attempt to fill this gap and contribute to a body of knowledge in this area. The study tested for price asymmetry in South African futures markets for white and yellow maize, wheat and sunflower seed. Commodities were tested over daily and weekly prices, providing a common foundation to make comparisons between different commodities and frequencies of data. Price asymmetry was examined through the use of two common tests: the sum of coefficients test and the speed of adjustment test. The asymmetry tests were conducted using the standard likelihood ratio F test, which uses the sum of squared errors with and without imposing restrictions being tested.

Out of the four commodity futures markets studied over varying data frequencies, only daily wheat rejected both aggregate impact test and speed of adjustment test hypotheses. Daily wheat prices seem to respond faster to price decreases than to price increases. The implication of the results is that past wheat prices do affect current wheat prices and contain information. Hence, the weak-form efficient market hypothesis appears to be contradicted for wheat futures market in South Africa. Past studies tested the efficiency of South African futures market for white maize. Hence, research opportunities exist for testing the efficiency of yellow maize, wheat, sunflower seed and soybean traded on SAFEX. Another important implication of the results is that implementing policies accounting for asymmetric behaviour through price limit and margin policies will improve the functioning and stability of wheat futures market in South Africa.

REFERENCES

Alban J (1990). Jack Alban ends decade on high note. *Futures Magazine* 19(4):49.

Ardeni PG (1989). Does the law of one price really hold? *American Journal of Agricultural Economics* 71(3):661-669.

Aulton AJ, Ennew CT & Rayner AJ (1997). Efficiency tests of futures markets for UK agricultural commodities. *Journal of Agricultural Economics* 48:498-524.

Bailey DV & Brorsen BW (1989). Price asymmetry in spatial fed cattle markets. *Western Journal of Agricultural Economics* 14:246-252.

Baillie RT & Myers RJ (1991). Bivariate GARCH estimation of the optimal commodity future hedge. *Journal of Applied Econometrics* 6(2):109-124.

Dickey DA & Fuller WA (1981). Likelihood ratio statistics for autoregressive time series model specification. *Econometrica* 48:1057-1072.

Dejong DN, Nankervis JC & Whiteman CH (1992). The power problems of unit root tests in time series with autoregressive errors. *Journal of Econometrics* 53:323-343

Eviews (2002). *Eviews 4 Users' Guide.* Quantitative Micro Software, LLC.

Fortenbury TR & Zapata HO (1993). An examination of cointegration relation between futures and local grain markets. *Journal of Futures Markets* 13:921-932.

Goodwin BK (1992). Multivariate cointegration and the law of one price in international wheat markets. *Review of Agricultural Economics* 14(1):117-124.

Goodwin BK & Schroeder TC (1991). Cointegration tests and spatial price linkages in regional cattle markets. *American Journal of Agricultural Economics* 73(2):452-464.

Gravelines RS & Boyd M (1999). A note on asymmetry in commodity futures markets. *Canadian Journal of Agricultural Economics* 47:321-329.

Gujarati D (1995). *Basic econometrics.* Third Edition. New York: McGraw-Hill International Editions, USA.

Hossain MZ (2002). Modified Akaike Information Criterion (MAIC) for statistical model selection. *Pakistan Journal of Statistics* 18(3):383-393.

Hudson MA, Leuthold RM & Sarassoro GF (1987). Commodity futures price changes: Recent evidence for wheat, soybeans and live cattle. *The Journal of Futures Markets* 7(3):287-301.

Kahneman D, Knetsch J & Thaler R (1990). Experimental tests of the endowment effect and the coase theorem. *Journal of Political Economy* 98:1325-48.

Kindleberger C (1989). *Manias, panics and crashes: A history of financial crises*. New York: Basic Books Inc, USA.

Phillips PCB & Perron P (1988). Testing for a unit root in time series regression. *Biometrika* 75:335-346

Punyawadee V, Boyd MS & Faminow MD (1991). Testing for asymmetric pricing in the Alberta pork market. *Canadian Journal of Agricultural Economics* 39:493-501.

SAFEX (2004). *The Home Page of the South African Futures Exchange.* http:www.safex.co.za.

Sheldon IM (1987). Testing for weak-form efficiency in new agricultural futures markets: Some UK evidence. *Journal of Agricultural Economics* 38(1):51-64.

Smidt S (1968). A new look at the random walk hypothesis. *Journal of Financial and Quantitative Analysis* 3:235-261.

Townsend RF (1998). Econometric Methodology II: Strengthening time series analysis. *Agrekon* 37(1):153-166.

Wiseman JA, Darroch MAG & Ortmann GF (1999). Testing the efficiency of the South African futures market for white maize. *Agrekon* 38(3):321-335.