Acta Universitatis Danubius

ŒCONOMICA

Grain Price Discovery and Location Differentials in South Africa

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Abstract: This paper investigates the price discovery process between white and yellow maize spot prices and their respective futures prices in South Africa's SAFEX market, aiming to understand how futures prices inform spot markets. Building on previous South African studies, it employs the Toda and Yamamoto VAR Granger Causality method to analyze daily time series data for white and yellow maize from July 15, 2009, to March 23, 2023, revealing causal relationships between spot and futures prices. Results show white maize spot prices are Granger-caused by white maize futures prices, suggesting short-run causality and demonstrating price discovery in the spot market. A similar pattern is observed for yellow maize. However, mixed results emerge when futures prices are tested as the dependent variable, showing both bidirectional and unidirectional relationships between spot and futures prices. These findings emphasize the importance of futures prices in shaping spot prices for both maize types; while spot prices reflect fundamentals like supply and demand, futures prices capture market sentiment and external influences, valuable for traders and policymakers. This study adds insights into price discovery dynamics in the South African maize market, with implications for agricultural commodity traders and market analysts through its robust econometric approach.

Keywords: Price Discovery; Vector Autoregressive Models; Toda and Yamamoto VAR Granger Causality; Grain; JSE; South Africa.

JEL Classification: C58; D53; G1; G13

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1. Introduction

In a market where two or more similar products by nature and characteristics are traded, the arrival of new information distorts prices and opens an opportunity for price differentials. The same applies to agricultural commodity products traded on the Johannesburg Stock Exchange (JSE). Therefore, in order to standardize a common platform for pricing and trade, there are two globally accepted techniques. The first technique is referred to as trading at par, where products are traded on the exchange at the same price and traded equally at all delivery locations. The second technique is the use of a single reference point, utilising the concept of location differentials (LDs) applied to different product delivery points based on a single common central point determined by the system (Mare, 2015).

Commodities traded on the JSE have two options on the settlement date; some are cash-settled at expiration, while others are physically settled. The JSE uses a single reference point for all locally produced grains and oilseeds that are physically settled. LDs are applied to equalize the cost of grain delivered to different silos in terms of their location relative to a base location, historically identified as Randfontein (Coetzee, 2020) This approach, however, does not imply that all grains produced in South Africa must be delivered to Randfontein specifically. The delivery process remains linked to the existing silo network, allowing all silos meeting certain requirements to be registered as delivery points against the SAFEX commodity contract (Roberts, 2009). One of the risks participants are exposed to is known as basis risk. Basis risk exists due to the difference between the spot and futures price and is not a consequence of LD's. The widening of basis risk is removed for all short position holders by the introduction of LDs (Coetzee, 2020).

The location differential system in South Africa has been a point of discussion and indifference. Some participants agree with its use, while others advocate for its removal or trading at par. The current system forces market role-players to rely on the differential, instead of area demand and supply, leading to concerns about its impact on pre-seasonal and other contract prices, competitiveness, and transparency (JSE, 2021). The South African agricultural derivatives market plays a crucial role in price transparency and discovery. Price discovery and location differentials in South Africa are investigated in this study, with the results contributing to international and South African risk management, futures market, and economic practices and research. The remainder of the paper is organised as follows. Section two provides a review of related literature and the relevance of the study. Section three contains the description of data, and the methodology employed, along with the empirical tests carried out. Section four presents analysis and interpretation of the data, while section five provides a summary, conclusion of the main findings, policy implications, limitations of the study, and directions for future research.

2. Literature Review

In the literature, the concept of price discovery is explored, with a focus on its application in agriculture. However, no study has incorporated the effects of LDs in their analysis and findings. Price discovery is defined as the process of using futures market to reach equilibrium by determining expectations of future cash or transaction prices, incorporating all available information, quality, and quantity of a certain commodity at a specific time and place (Yang et al., 2001; Lapan et al., 1991; Schreiber & Schwartz, 1986; Thomsen & Foote, 1952). One of the functions of futures market is price discovery, reflecting all information at that specific point in time (Chiang & Fong, 2001; Garcia et al., 1997).

The idea that futures prices lead spot prices is supported by a significant body of empirical research. However, in a case of agricultural commodities where both spot and futures markets rely on the same underlying asset, the question of whether price changes in one market cause price changes in the other to follow arises when two markets are linked, as is the case with spot and futures markets on the same underlying commodity. This is because two prices exist that are driven by the same fundamental information (Strydom & McCullough, 2013).

Yang et al., (2001) using eleven most traded agricultural commodity futures in China investigates the performance of price discovery, suggesting an enhanced recursive cointegration approach. Despite having a relatively limited trading history and subject to different state interventions, the result indicates that China's agricultural futures markets usually play a more prominent role in the price discovery process as markets develop, even when temporal variations and geographical differences in the price discovery process are considered. Further investigation uncovers several variables of the role of futures vs local cash market prices in the price discovery process. Using nearby futures data in China may also lead to significantly incorrect conclusions.

Additionally, Bohl et al. (2019) focus on the debate regarding whether the spot or the futures market dominates the price discovery process in commodity markets. Using speculation and hedging as a new element and a new price discovery metric, the study analysed the relationship for various agricultural commodities and the results suggest that speculative activity reduces the level of noise in the futures markets under analysis, while increasing their relative contribution to the price discovery process. Their findings contribute to understanding the relative roles of these markets in price discovery.

Furthermore, Shrestha et al. (2020) empirically analysed the contribution of futures markets to the price discovery process for agricultural commodities, providing a comprehensive assessment of the information share and component share in the price discovery process using daily price data of seven agricultural commodities such as soybean, soybean oil, corn, wheat, cocoa and coffee from 1961 to 2017. their findings indicates that most of the price discovery takes place in the futures markets except for cocoa Shrestha et al. (2020). It is evident that most studies affirm to the hypothesis that futures prices lead to price discovery in the spot market.

However, this assumption is challenged by contradictory findings from several research. (Goss et al., 1976), for example, present insights into the economics of futures trading that may challenge the concept of total information reflection in futures prices. Kristoufek and Vovrda (2014) also examine inefficiencies in commodities futures markets. They discuss the inefficiencies in commodities futures markets, focusing on the contributions of long-term memory, fractal dimension, and approximation entropy to total inefficiency, which contradicts the efficient representation of all available information in futures pricing.

In their study Mustafa and Ahmed (2020) critically examines the concept of market efficiency and its implications for futures pricing. Their findings provide evidence that challenges the notion of total information reflection in futures pricing, indicating that market inefficiencies exist despite the efficient market hypothesis. Specifically, the findings suggest that long-term memory, fractal dimension, and approximation entropy contribute to total inefficiency in commodities futures markets, thereby questioning the complete incorporation of all available information in futures pricing. Similarly, Schwarz (2011) investigates the correlation between hedgers and speculators positions and returns in futures markets, indicating debates about the interpretation of such relationships, which call into question the complete reflection of available information in futures prices.

Kellard et al. (1999) give mixed empirical data on the relative efficiency of commodity futures markets, demonstrating that some research finds evidence of efficiency while others find evidence of inefficiency. This contradictory data calls into question the notion that current futures prices efficiently reflect all available information.

According to Yang et al., 2005, agricultural commodity prices and futures trading activities exhibit a lead-lag relationship. L and Mishra (2020) investigated the cointegration between future and spot prices for various agricultural commodities, concluding that futures and spot prices are typically cointegrated (Ali & Gupta, 2011; Kumar & Pandey, 2011) found that some agricultural commodities have a long-term relationship with futures prices. Kumar and Pandey (2011) found that there is a lead-lag relationship between spot and futures prices in four agricultural commodities (Kumar & Pandey, 2011). Additionally, Mansabdar et al., (2022) concluded that agricultural commodity futures in India fulfill their price discovery role well, dominating price discovery relative to the cash market (Mansabdar et al., 2022). Similarly, Peri et al., (2013) analysed the price discovery for storable commodities and concluded that futures markets generally dominate spot markets in registering and transmitting information (Peri et al., 2013).

However, competing evidence has been presented by Soni, 2014 and Mahalik et al., 2014; Malhotra, 2012 Mahalik et al., 2014; Malhotra, 2012. Soni's findings suggest that when cointegration is considered, neither spot nor future consistently leads or lags the other. (Mahalik et al., 2014) also found that while agriculture future price index, energy future price index, and aggregate commodity index effectively serve the price discovery function in the spot market, the reverse causality does not exist. Moreover, scholars like Ohemeng et al. (2016), Dolatabadi et al. (2014), Strydom and McCullough (2013), Kuiper et al. (2002), Mohan and Love (2004), and Shyy et al. (1996), however, dispute the notion that price discovery takes place in the futures market and offer evidence that it does so in spot markets.

In south Africa some studies by Mashamaite (2005) investigates price asymmetry in South African futures markets for agricultural commodities. The findings reveal the presence of price asymmetry, indicating that the adjustment of futures prices to spot price changes is not symmetric. Specifically, the study identifies that the response of futures prices to positive and negative spot price changes is asymmetric, suggesting that the adjustment process is not uniform across different market conditions. This asymmetry in price adjustments has implications for market participants, risk management strategies, and the efficiency of the futures markets for agricultural commodities in South Africa.

Likewise, the study by Motengwe (2013) investigates the effects of price volatility on trading returns in South African commodity futures markets. The findings of the study reveal that price volatility has a significant impact on trading returns within these markets. Specifically, the research highlights that increased price volatility is associated with fluctuations in trading returns, indicating a dynamic relationship between price volatility and trading performance. This suggests that market participants in South African commodity futures markets are influenced by price volatility, and the study provides valuable insights into the implications of volatility on trading returns within these markets.

3. Methodology

3.1. Data Description

This paper used a quantitative research approach to achieve the objective of this study; the data used in this study was collected directly from JSE (JSE, 2024). This study's dataset includes historical daily spot and futures prices for white and yellow maize traded on SAFEX from 15/07/2009 until 23/03/2023 marketing seasons the choice of the period is due to the availability of data for physically settled grain contracts on the JSE archives it is only available from 2019/2010 as well as different futures contract start dates and end dates. Most agricultural derivative futures contracts expire in March, May, July, September, and December, including those for white and yellow maize; Contract specifications and maturity months and for futures prices in this study are provided in Table 1. For the purpose of this study only March, May and July contracts were used since September and December contracts had few transections. To effectively analyse the price discovery, two sets of data points was collected for each contract the near-month contract price as well and the futures price as quoted on each contract excluding 25 days prior to the contract's expiry due to the convergence that happened between spot price and futures prices. The reasoning behind using eight- and four-weeks period to expiry date for futures prices is in line with the findings and recommendation of other authors as this helps to control the possibility of correlations in the samples due to the time period chosen and overlapping data analysis (Aulton et al., 1997; McKenzie et al., 2002; Muroyiwa & Mushunje, 2017; Strydom & McCullough, 2013; Tsay, 2005).

Table 8. Commodities used in the study

Commodity	Beginning	End	Observations	Maturity months
White maize	15/07/2009	23/03/2023	3369	3,5,7
Yellow maize	15/07/2009	23/03/2023	3369	3,5,7
Descriptive information on the contracts in this study is presented in the table. The months January to December are represented under the column "Maturity months", as respectively 1…,12.				

Source: Authors' own compilation

3.2. Model Specification

The literature takes at least two different approaches to measuring price discovery. In the first method, lead-lag return regressions are performed using vector autoregressive models (VAR). Using this technique, it is possible to determine which market drives price discovery and to analyse the dynamic relationship between various financial assets. Using vector error correction models (VECMs), the second method investigates the bivariate relationship or temporal precedence between paired returns, namely futures returns and spot market returns. When it comes to capturing the long-term equilibrium relationship between these paired returns and determining the short-term rate of adjustment towards the equilibrium, VECMs are especially helpful (Muroyiwa & Mushunje, 2017). This paper makes uses of the Toda and Yamamoto VAR Granger causality 1995 procedure to examine the relationship between spot and futures prices. The motivation for the section of the method is discussed below:

Let yt sequence be generated by the following linear function:

$$yt = \alpha 0 + \alpha 1t + \cdots + \alpha q\, tq + \eta t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Assume $\{\eta t\}$ sequence is a vector autoregression with k lag length and it can be presented as:

$$\eta t = \beta 1\eta t - 1 + \cdots + \beta k\eta t - k + \varepsilon t \ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots..(2)$$

It is assumed that k is the lag length that is optimal and εt is random vector. Transforming 1 into $\eta t = yt = \alpha 0 + \alpha 1t + \cdots + \alpha q\, tq$ …… and then substituting it into 2 to get equation 3:

$$yt = \alpha 0 + \alpha 1t + \cdots + aq\, tq + \beta 1yt - 1 + \cdots + \beta kyt - k + \varepsilon t \ldots (3)$$

As order of integration > 0, the order of trend a might be lower than order q. Assume $d > 1$ and $q = 1, a2 = a3 = \cdots = 0$ in equation 3. Then (3) becomes 4.

$$yt = a0 + a1t + \beta 1yt - 1 + \cdots + \beta kyt - k + \varepsilon t \ldots\ldots\ldots\ldots\ldots\ (4)$$

Toda and Yamamoto procedure is interested in the significance of coefficients of lagged y in 4, not the VAR's stationary position. Accordingly, the null hypothesis is to jointly test the vector $\boldsymbol{\beta}$:

$$H0: \beta 1 = \beta 2 = \cdots = \beta k = 0$$

Consider the following VAR:

$$yt = \alpha 0 + \alpha 1t + \cdots + aq\, tq + \beta 1yt - 1 + \cdots + \beta kyt - k + \cdots + \beta pyt - p + \varepsilon t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots(5)$$

The coefficients of the above equation represent estimated value and $p = k + d$. Equation 5. includes at least d more lags than k in equation 4. Because k is assumed to be the optimal lag length, the coefficients of additional lag are different from zero. Accordingly, the null hypothesis is still unchanged.

The primary achievement of Toda and Yamamoto (1995) was finding the statistical properties of null hypothesis via estimating equation 5. At first, they constructed a Wald statistic to test the null hypothesis. Then they proved that Wald statistic is asymptotically distributed as chi-square with usual degrees of freedom if $p = k + d$. The main factor of consideration is that the asymptotic property does not depend on whether equation 5 is integrated or cointegrated.

To test the variables for stationarity Augmented Dickey-Fuller (ADF) test for which the null hypothesis is non-stationarity as well as Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for which the null hypothesis is stationarity to determine the maximum order of integration between the viables. KPSS is used as cross check alternative to the standard stationarity test. This approach is supported by Kwiatkowski *et al.* (1992) who contend that their test is "intended to complement unit root tests, such as the Dickey-Fuller tests. By testing both the unit root hypothesis and the stationarity hypothesis, we can distinguish between series that appear to be stationary, series that appear to have unit root, and series for which the data (or the tests) are not sufficiently informative to be sure whether they are stationary or integrated." Joint testing provides more clarity on stationarity since it has two complementing null hypothesises. The second test is the lag selection order and criteria to perform this test measures such as the Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE) and Hannan-Quinn (HQ) Information Criterion can be used to determine the appropriate lag order of the VAR.

3.3. Results and Discussion

3.4. Descriptive Statistics

Table 2 and 3 depicts common descriptive statistics for yellow and white maize futures and spot price variables respectively. Looking at the measures of central tendency, mean and median we can observe that the mean and median averaged around 2500 and 2400 respectively. While for white maize it averaged around 2600 and 2488 respectively. Measures of normality- Kurtosis (measure the degree of sharpness and skewness (measure the degree of asymmetry) indicate that the data (George & Mallery, 2010). Hair *et al*. (2010) and Bryne (2010) are both positive and are around 3 and 2 respectively for yellow and white maize variables; this indicates normality in the variable, as the rule of thumb for asymmetry and kurtosis should be between -2 to +2 and kurtosis is between -7 to +7 (George & Mallery, 2010; Hair *et al*., 2010, Bryne, 2010).

Table 9. Descriptive Statistics on Yellow Maize Futures and Spot Prices

	YMSP	YMF_MARCH	YMF_MAY	YMF_JULY
Mean	2602.610	2647.534	2500.035	2481.521
Median	2490.000	2510.000	2364.000	2332.500
Maximum	5471.000	5312.000	4946.000	4937.000
Minimum	1075.000	1148.000	1156.000	1176.000
Std. Dev.	875.4026	858.3442	791.7524	764.2649
Skewness	0.625322	0.704600	0.880761	0.946751
Kurtosis	3.123333	3.336605	3.580231	3.865902
Jarque-Bera	225.3164	299.4786	490.7208	618.4791
Probability	0.000000	0.000000	0.000000	0.000000
Sum	8911336.	9065156.	8560121.	8496728.
Sum Sq. Dev.	2.62E+09	2.52E+09	2.15E+09	2.00E+09
Observations	3424	3424	3424	3424

Source: Author's own compilation

Table 10. Descriptive Statistics of White Maize Futures and Spot Prices

	WMSP	WMF_MARCH	WMF_MAY	WMF_JULY
Mean	2703.905	2756.885	2545.237	2484.149
Median	2562.080	2637.000	2419.000	2335.000
Maximum	6953.000	5434.000	5163.000	4964.000
Minimum	1019.000	1023.000	1056.000	1090.000
Std. Dev.	1012.134	970.8906	834.9685	752.4982
Skewness	0.605428	0.587941	0.924269	0.888435
Kurtosis	2.807375	2.787469	3.762998	3.799232
Jarque-Bera	211.0222	200.4368	561.3961	532.8690
Probability	0.000000	0.000000	0.000000	0.000000
Sum	9109455.	9287945.	8574905.	8369098.
Sum Sq. Dev.	3.45E+09	3.17E+09	2.35E+09	1.91E+09
Observations	3369	3369	3369	3369

Source: Author's own compilation

3.5. Correlation Analysis

Table 4 and 5 suggest a significant positive association between both yellow maize futures and white maize futures prices and their spot prices. All the futures contracts are highly correlated with the I spot prices; this is consistent with literature and the definitions agricultural derivatives and its characteristics. According to German (2014), Agricultural derivatives are financial derivatives such as options and futures that derives their values from the underlying agricultural commodity or assets these commodities include but not limited to maize, rice, coffee, wheat, sunflower, soyabeans and others. Based on this definition the high and positive correlation of both white maize and yellow maize with their spot prices is justified.

Table 11. Correlation Analysis - Yellow Maize Futures and Spot Prices

Correlation	LYMSP	LYMF_MARCH	LYMF_MAY	LYMF_JULY
LYMSP	1.000000			
LYMF_MARCH	0.992938	1.000000		
LYMF_MAY	0.971514	0.982658	1.000000	
LYMF_JULY	0.933690	0.954017	0.969327	1.000000

Source: Author's own compilation

Table 12 Correlation Analysis - White Maize Futures and Spot Prices

Correlation	LWM_SP	LWMF_MAY	LWMF_MARCH	LWMF_JULY
LWM_SP	1.000000			
LWMF_MAY	0.936850	1.000000		
LWMF_MARCH	0.981831	0.943013	1.000000	
LWMF_JULY	0.913695	0.965529	0.927305	1.000000

Source: Author's own compilation

3.6. Unit Root Results

In order to compute the model to analyse the price discovery in the futures and spot markets, pre-conditions exist for the data to fulfil, firstly a descriptive statistic is performed, correlation analysis and also need to establish non-stationarity of the data. To check for Phillips-Perron (PP) (Phillips & Perron, 1988) unit-root test is performed. Table 6 presents unit root test using the test statistics of ADF and KPSS for the variables used in the study, the white maize spot price and futures prices absolute test statistics are more than the critical value (absolute) then we can reject the null hypothesis and accept the alternative hypothesis; The same applies to the yellow maize variables the yellow maize spot price and futures prices absolute test statistics are more than the critical value (absolute) then we can reject the null hypothesis and accept the alternative hypothesis, meaning that both white and yellow maize variables are stationary at 5 percent significant level. The KPSS stationarity test is used to confirm the ADF findings on the unit root test for the variables to also be stationary.

Table 13. Unit Root Test

	ADF	KPSS		ADF	KPSS
LYMSP	-62.923**	0.0512***	**LWM_SP**	-10.4608**	0.0534***
LYMF_MARCH	-55.3387**	0.0456	**LWMF_MARCH**	-54.9852**	0.0547***
LYMF_MAY	-56.9987**	0.0452	**LWMF_ MAY**	-54.2612**	0.0465
LYMF_JULY	-57.0310**	0.02895	**LWMF_JULY**	-54.8756**	0.0391

Source: Author's own compilation

Notes: The *, **, *** indicate a 1%, 5% and 10% significance level, respectively. The LM critical values of the KPPS test are 1% = 0.739, 5% = 0.463, and 10% = 0.347. The ADF and KPSS estimates derived with Unit Root Test levels.

3.7. Optimal Leg Determination

Table 7 and 8 highlights lag order selection for the variable using AIC as the choice for leg selection, for white maize variables 4 legs are selected while for yellow maize selection 3 legs are selected.

Table 14. VAR Lag Order Selection Criteria - WMSP WMF_MARCH WMF_MAY WMF_JULY

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-73308.71	NA	1.86e+20	58.02351	58.03275	58.02686
1	-54996.57	36551.82	9.56e+13	43.54299	43.58917	43.55974
2	-54824.18	343.5507	8.45e+13	43.41921	43.50234	43.44938
3	-54755.99	135.6645	8.11e+13	43.37791	43.49798*	43.42148
4	-54717.13	77.20618*	7.96e+13*	43.35982*	43.51683	43.41679*
5	-54706.93	20.22023	8.00e+13	43.36441	43.55837	43.43479
6	-54698.30	17.09037	8.05e+13	43.37024	43.60114	43.45403
7	-54689.88	16.65490	8.09e+13	43.37624	43.64408	43.47343
8	-54676.82	25.78547	8.11e+13	43.37856	43.68335	43.48916

Source: Author's own compilation

Note: * indicates lag order selected by the criterion, while LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion.

Table 15. VAR Lag Order Selection Criteria - YMSP YMF_MARCH YMF_MAY YMF_JULY

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-70818.11	NA	5.72e+18	54.54148	54.55051	54.54475
1	-51927.97	37707.53	2.78e+12	40.00614	40.05129	40.02250
2	-51850.69	154.0370	2.65e+12	39.95894	40.04020*	39.98839
3	-51810.92	79.14794	2.61e+12*	39.94064*	40.05801	39.98317*
4	-51799.20	23.27537	2.62e+12	39.94394	40.09743	39.99955
5	-51793.17	11.97097	2.64e+12	39.95161	40.14122	40.02031
6	-51779.64	26.80091*	2.64e+12	39.95351	40.17924	40.03530
7	-51766.54	25.90711	2.65e+12	39.95575	40.21759	40.05062
8	-51759.16	14.56200	2.66e+12	39.96239	40.26035	40.07035

Source: Author's own compilation

Note: * indicates lag order selected by the criterion, while LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion.

3.8. Empirical Findings: VAR Granger Causality/Block Exogeneity Wald Tests Results

Table 9 presents estimate from the VAR Granger Causality/Block Exogeneity Wald Tests. The hypotheses guiding the analysis are H_o: Lagged coefficient(s) = 0 while H_1: Lagged coefficient(s) ≠ 0. The decision criterion is to reject the null hypothesis if the p-value of the Chi-squared statistics is less than 0.05. The results indicate that WMSP is Granger-caused by WMF_MARCH, which is significant, meaning we reject the null hypothesis and accept the alternative: WMSP is Granger-caused by future prices. A similar pattern emerges when YMSP is the dependent variable; the results show that YMF_MARCH and YMF_MAY are both significant, leading us to reject the null hypothesis and accept the alternative: yellow maize spot prices are Granger-caused by yellow maize futures prices. When future prices are the dependent variable, the spot price is significant in five runs, indicating that we reject the null hypothesis and accept the alternative hypothesis: both white and yellow maize futures prices are Granger-caused by white and yellow maize spot prices.

Table 16. VAR Granger Causality/Block Exogeneity Wald Tests Results

Dependent variable	Legs	VAR Granger Causality/Block Exogeneity Wald Tests	Prob
WMSP	4	WMF_MARCH : Significant	0.0000**
	4	WMF_MAY: Not significant	0.2733
	4	WMF_JULY: Not significant	0.2037
	12	All: Significant	0.0000**
YMSP	3	YMF_MARCH: Significant	0.0000**
	3	YMF_MAY: Significant	0.0000**
	3	YMF_JULY: Significant	0.0781
	9	All: Significant	0.0000**
Dependent variable	**Legs**	**VAR Granger Causality/Block Exogeneity Wald Tests**	**Prob**
WMF_MARCH	4	WMSP: Significant	0.0109**
	4	WMF_MAY: Not significant	0.8215
	4	WMF_JULY: Not significant	0.2314
WMF_MAY	4	WMSP: Significant	0.0000**
	4	WMF_MARCH: Not significant	0.5920
	4	WMF_JULY: Significant	0.0000**
WMF_JULY	4	WMSP: Significant	0.0242**
	4	WMF_MARCH: Not significant	0.5739
	4	WMF_MAY: Not significant	0.0767
YMF_MARCH	3	YMSP: Significant	0.0000**
	3	YMF_MAY: Significant	0.0000**
	3	YMF_JULY: Significant	0.0040**
YMF_MAY	3	YMSP: Not significant	0.4156
	3	YMF_MARCH: Significant	0.0124**
	3	YMF_JULY: Not significant	0.3033
YMF_JULY	3	YMSP: Significant	0.0039**
	3	YMF_MARCH: Not significant	0.5305
	3	YMF_MAY: Significant	0.0000**

Source: Author's own compilation

Notes: The *, **, *** indicate a 1%, 5% and 10% significance levels.

3.9. Discussion of Findings

In summary the stationarity test results suggest that white and yellow maize spot prices and futures prices are both stationary at 5 percent significant level. Therefore, the VAR model can be performed to analyse of price discovery between spot and futures prices. Optimal leg determination indicated 4 and 3 legs for white and yellow maize variables respectively. The results indicate that WMSP is Granger-caused by WMF_MARCH, which is significant, meaning we reject the null hypothesis and accept the alternative: WMSP is Granger-caused by future prices. This means that WMF-March futures contract has a causal effect of White maize spot price in the short run, these results confirm the real-world practice in trading of agricultural derivatives which are settled on daily basis reflecting the short tun causality. However, when considering WMF-MAY and WMF-JULY, they are both insignificant and do not granger cause WMSP in the short run. When analysing YMSP as a dependant the result indicate that YMF_MARCH and YMF_MAY are both significant, leading us to reject the null hypothesis and accept the alternative: yellow maize spot prices are Granger-caused by yellow maize futures prices.

This means that both YMF_MARCH and YMF_MAY have short-term causal effect on YMSP. When future prices are the dependent variable, the spot price is significant these results indicate a bidirectional relationship where both spot and future prices influence each other, the findings of this study are supported by other studies who supported the unidirectional Strydom and McCullough (2013) and Yan and Reed, (2014) in their studies found that futures market price influences the spot market for white maize price discovery agricultural commodities market, while Brenner and Kroner, (1995) and Yang *et al., (*2001) found that the causality is from the spot market to the futures market. The other group of scholars who found mix results include Sehgal et al., (2012) and Peri et al. (2013). In conclusion on can present that the South Africa white and yellow maize spot and futures market follow each other and influences each other in their trade, spot price support the fundamental of supply and demand while the futures market support the arrival of new information and traders' behaviour in the market.

4. Conclusion

Price discovery of both white and yellow maize in the south African agricultural commodities market was the focus of this study, Toda and Yamamoto VAR Granger Causality procedure was used in archiving the analysis of this price discovery process. Following previous findings this study has also established that there is price discovery in the spot-futures market in south Africa. These result mean that futures prices have a short run causality effect on the spot prices, indicating that the price discovery happens in the spot market, while others indicate spot prices has a short run causality effect on the futures prices. overall, the results show a mix of unidirectional and bi-directional Granger lead relationships between spot and futures in all the white and yellow maize variables. However interestingly this study discovers that in some instances spot prices are caused by futures prices behaviour. Both spot and futures prices play a very critical in the process of price discovery of both white and yellow maize markets. The findings of this study with mix findings are supported by both scholars who found the price discovery to be in the futures market such as Brenner and Kroner, (1995) and Yang et al., (2001 while others support the findings of price discovery in the spot market such as Kawaller et al., (1987), Pizzi et al. (1998), Alphonse (2000), Wats and Misra (2009), Strydom and McCullough, 2013; and Dolatabadi et al., (2014). This study recommends that the traders on the JSE SAFEX should formulate dynamic trading and hedging strategies that will use both information from the spot and futures market to take advantages presented by both markets. This study highlights a need to inform the market participants of the potential of price discovery in the futures market and the advantages it has for dynamic hedging strategies. On the policy side SAFEX must improve their observation systems to be able to provide the participants with full information and make informed trades, this is very important since early detection is crucial in price discovery mechanism process.

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