A vector error correction model (VECM) of FTSE/JSE SA Listed Property Index and FTSE/JSE SA Capped Property Index

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Abstract In this paper the Efficient Market Hypothesis (EMH) will be investigate from an empirical and theoretical basis. The closing $(Close_t)$, intraday high $(High_t)$, intraday low (Low_t) and opening $(Open_t)$, values of the FTSE/JSE SA Listed Property Index (FTJ253) and the FTSE/JSE Capped Property Index (FTJ254)will explore the impact on returns resulting from a one standard deviation shock. The examination of the interrelationship between the closing $(Close_t)$, intraday high $(High_t)$, intraday low (Low_t) and opening $(Open_t)$ values of the FTSE/JSE SA Listed Property Index (FTJ253) and the FTSE/JSE Capped Property Index (FTJ254) were conducted by making use of the Johansen cointegration test, a vector error correction model (VECM) and an impulse response function. The results of these tests provided an indication of the short- and long run dynamics of all the variables included, and the reaction of the variables to a one standard deviation shock. The results obtain indicate that there is an opportunity for arbitrage when the price deviate from the long run equilibrium until a new equilibrium is reached.

1 Introduction

Market efficiency is a fundamental concept to investments. Efficiency refers to the formation of an assets price that comprises of all the available price information.

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The defining of efficacy in markets or efficient markets is problematic in itself. Fama (1965a) define an efficient market as an market that at every price at every point in time reflect all the available information and were the asset price represents intrinsic value. Fama (1965b) describe an efficient market as a large numbers of competing rational profit maximising individuals trying to foretell future asset values on almost freely available information. Fama et al pronounce and efficient market as a market that reacts and adjust quickly to new information. Fama (1970) states that an market price that is fully reflective of all available information is called efficient.

Fama (1991) describes the market efficiency hypotheses as asset prices that fully reflect all available information. It is clear that an efficient market, as described by Fama, is one that is rational that provides accurate asset price that is based on the available information. In other words a market that is free from arbitrage or abnormal excess returns. The efficient market hypothesis is based on three elementary assumption, (1) all investors are rational and they value assets on their fundamental value reflecting all available information, (2) investors may be irrational, however, their investment activity is unrelated and uncorrelated without any negative effect on the underlying asset price, (3) if activities are irrational and correlated the action of arbitrageurs will result in profits. However, these action will restore the asset price to its fundamental value via the buy and sell activities of arbitrageurs and rational investors (Shiller, 1981).

However, Black (1986) states that investors value assets based on the noise rather than fundamental information implying that investors act irrational. De Long and Shiller (1988), is of the opinion that irrational investors effect the asset price to such an extent that arbitrageurs is unwilling to take a position in order to obtain a profit. According to De Long and Shiller (1988) this introduces an extra risk namely noise trader risk into the market. Implying that arbitrageurs will refrain from trading as they fear the continuous irrational investment conduct of investors. In other words arbitrageurs will not buy undervalued asset as the fear they will have to liquidated there position resulting in an unexpected loss. Therefore, in theory, a market is efficient when trading on or when price formation, from available information does not result in abnormal profit (Roberts, 1959, Fama, 1970).

In assessing the effectiveness of markets it is of critical importance to consider the types of available informational datasets and the corresponding level of efficiencies achieved with each of these informational datasets. (1) Historical or past prices as characterised by the weak form efficiency, (2) public available information represented by the semi-strong efficiency and (3) private information as considered by the strong-form efficiency.

When considering the efficiency of marks it is of importance to consider the implications of randomness of price movements. As deviations from an assets true value is random, it implies that there is an equal chance that an asset may be overvalued or undervalued at any specific time in point. It also implies that these deviations of prices are uncorrelated with no observable variability. In considering the randomness of an asset price deviation from intrinsic value it would imply that no investor or group of investors will be able to, on a constant basis, to outperform the market using any investment strategy (Damodaran, 2012).

There are currently four property indices listed on the Johannesburg Stock Exchange. In this paper the closing ($Close_t$), intraday high ($High_t$), intraday low (Low_t) and opening ($Open_t$), values of the FTSE/JSE SA Listed Property Index (FTJ253) and the FTSE/JSE Capped Property Index (FTJ254) comprises the top 20 most liquid companies, by full market cap, in the real estate investment and services sector and the real estate investment trusts sector, with a primary listing on the JSE. However, the FTSE/JSE Capped Property Index (FTJ254) capped at 15% at each quarterly review.

These two indices will be analysed for the presence of information that will allow the investor to make an abnormal return. A vector error correction (VEC) proses will be applied to investigate the return generation process and represent the short and long run dynamics of the variables included. The study will try and explain the relationship both static and dynamic in the two selected time series datasets for the FTJ253 and FTJ254. The investigation will be done by making use of Johansen cointegration test, a vector error correction model (VECM) (Engle and Granger, 1987) and finally impulse response was used.

The remainder of the paper is structured as follows; part 2 discusses the data. In part 3 will be a brief explanation of the methodology used and in part 4 will cover the results and interpretation of the findings. Part 5, discusses the conclusion of the study. When appropriate the EViews nations and table headings was retained.

2 Data specification and methodology

In this study the open the daily opening, closing, intraday high and intraday lowest prices of the FTSE/JSE SA Listed Property Index (FTJ253) and the FTSE/JSE Capped Property Index (FTJ254) will be used. The study period is from 4 January 2010 until 31 December 2014. All the datasets were obtainted from Thomson Reuters Eikon. In order to detrmine the short and long run dynamics of the variables included in this study, a Johansen cointegration test was performed in order to determine wheter a long run relationship exists among these variables, thereafter a vector error correction model was employed and finally impulse response was used to show how the variables respond after a shock has occured to a given variable. With regards to model specification, according to Koop (2006), the VAR and VECM models should be specified as follows:

$$\begin{aligned}
Close_t &= \alpha_1 + \sum_{i=1}^{p} \beta_{1i} Close_{t-i} + \sum_{i=1}^{p} \delta_{1i} High_{t-i} + \sum_{i=1}^{p} \kappa_{1i} Low_{t-i} + \sum_{i=1}^{p} \gamma_{1i} Open_{t-i} + u_{1t} \\
High_t &= \alpha_2 + \sum_{i=1}^{p} \beta_{2i} Close_{t-i} + \sum_{i=1}^{p} \delta_{2i} High_{t-i} + \sum_{i=1}^{p} \kappa_{2i} Low_{t-i} + \sum_{i=1}^{p} \gamma_{2i} Open_{t-i} + u_{2t} \\
Low_t &= \alpha_3 + \sum_{i=1}^{p} \beta_{3i} Close_{t-i} + \sum_{i=1}^{p} \delta_{3i} High_{t-i} + \sum_{i=1}^{p} \kappa_{3i} Low_{t-i} + \sum_{i=1}^{p} \gamma_{3i} Open_{t-i} + u_{3t} \\
Open_t &= \alpha_4 + \sum_{i=1}^{p} \beta_{4i} Close_{t-i} + \sum_{i=1}^{p} \delta_{4i} High_{t-i} + \sum_{i=1}^{p} \kappa_{4i} Low_{t-i} + \sum_{i=1}^{p} \gamma_{4i} Open_{t-i} + u_{4t}
\end{aligned}$$

$$\Delta Close_t = \omega_1 u_{1(t-1)} + \alpha_1 + \sum_{i=1}^{p} \beta_{1i} \Delta Close_{t-i} + \sum_{i=1}^{p} \delta_{1i} \Delta High_{t-i} + \sum_{i=1}^{p} \kappa_{1i} \Delta Low_{t-i} + \sum_{i=1}^{p} \gamma_{1i} \Delta Open_{t-i} + \xi_{1t}$$
$$\Delta High_t = \omega_2 u_{2(t-1)} + \alpha_2 + \sum_{i=1}^{p} \beta_{2i} \Delta Close_{t-i} + \sum_{i=1}^{p} \delta_{2i} \Delta High_{t-i} + \sum_{i=1}^{p} \kappa_{2i} \Delta Low_{t-i} + \sum_{i=1}^{p} \gamma_{2i} \Delta Open_{t-i} + \xi_{2t}$$
$$\Delta Low_t = \omega_3 u_{3(t-1)} + \alpha_3 + \sum_{i=1}^{p} \beta_{3i} \Delta Close_{t-i} + \sum_{i=1}^{p} \delta_{3i} \Delta High_{t-i} + \sum_{i=1}^{p} \kappa_{3i} \Delta Low_{t-i} + \sum_{i=1}^{p} \gamma_{3i} \Delta Open_{t-i} + \xi_{3t}$$
$$\Delta Open_t = \omega_4 u_{4(t-1)} + \alpha_4 + \sum_{i=1}^{p} \beta_{4i} \Delta Close_{t-i} + \sum_{i=1}^{p} \delta_{4i} \Delta High_{t-i} + \sum_{i=1}^{p} \kappa_{4i} \Delta Low_{t-i} + \sum_{i=1}^{p} \gamma_{4i} \Delta Open_{t-i} + \xi_{4t}$$

3 Results

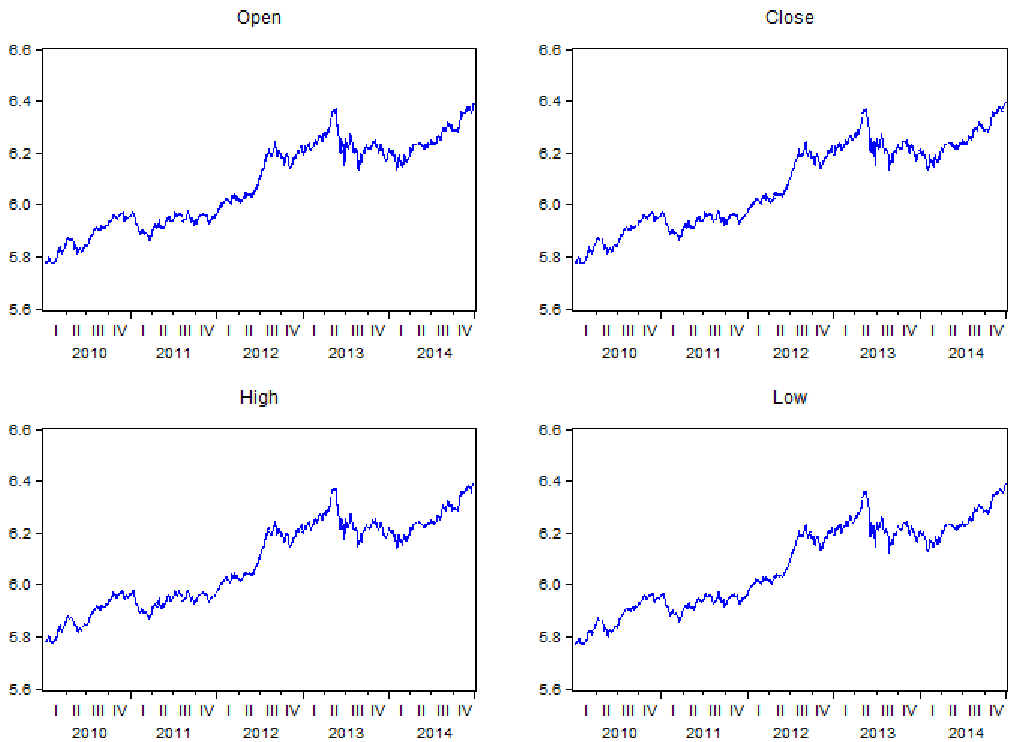
The results will be explained in two section. Firstly all the results for the FTJ53 will be discuss followed by the result of the FTJ254. The comparison of the two sets of results will be conducted in the conclusion section of the paper.

3.1 FTSE/JSE SA Listed Property Index (FTJ253)

In Figure 1 the index level of the open, intraday high, intraday low and close of the FTJ253 can be seen. It is clear that from the start of the study period theindices have been upward trending with a large decrease in prices in the second quarter of 2013. This was due to an increase in yields resulting from an increase in rental inflation.

Figure 2 below shows that the log returns of the FTJ253 seem to be mean reverting. The mean of each return series is close to zero. There also seems to be an increase in volatility during the second quarter of 2013.

Fig. 1 Line graphs of the FTSE/JSE SA Listed Property Index (FTJ253)



We observe that the returns series are not normally distributed, the histograms exhibit signs of leptokurtosis. The mean of each variable seems to be close to zero as indicated in Figure 3 below. The observations are in line with the stylized facts of financial time series, as explained by McNeil et al., (2006).

The descriptive statistics in Table 1 below confirm our expectation of leptokurtic distributions, in addition the Jarque Bera probability in each case is less than five percent, and therefore we can reject the null hypothesis of normality. Furthermore, Table 1 indicates that the returns series are negatively skewed.

Fig. 2 Log returns of the FTSE/JSE SA Listed Property Index (FTJ253)

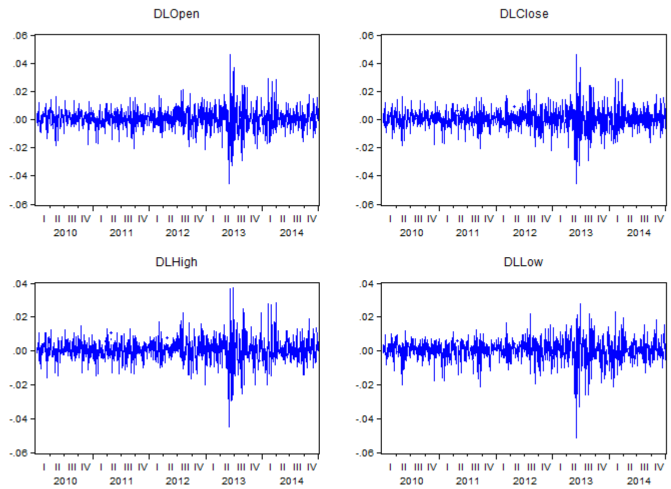
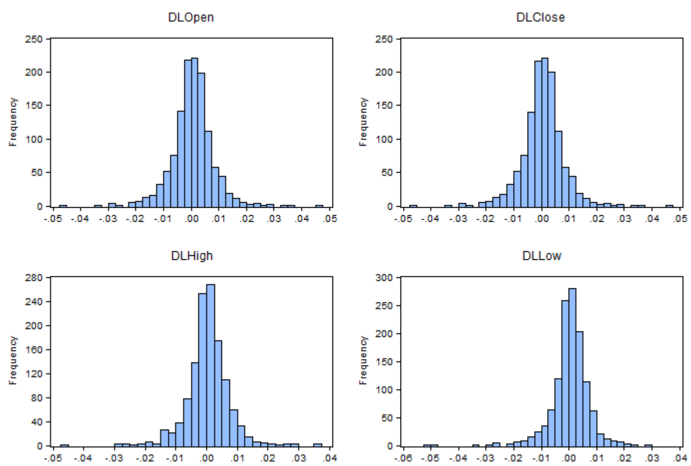


Fig. 3 Histogram of the log returns of the FTSE/JSE SA Listed Property Index (FTJ253)



The augmented Dickey Fuller unit root test and the Phillips Perron test in Table 2 show that the variables are not stationary at level, however the log returns are stationary. This implies that the logged series are integrated of order one.

In Table 3, the sequential modified LR test statistic, final prediction error, and Akaike information criterion suggest that the optimal lag length is nine lags.

Table 1 Descriptive Statistics SA Listed Property Index (FTJ253)

	OPEN	CLOSE	HIGH	LOW
Mean	0.0005	0.0005	0.0005	0.0005
Median	0.0007	0.0007	0.0005	0.0007
Maximum	0.0465	0.0465	0.0372	0.0281
Minimum	-0.0452	-0.0452	-0.0452	-0.0516
Std. Dev.	0.0073	0.0074	0.0066	0.0064
Skewness	-0.0911	-0.0949	-0.1008	-1.2224
Kurtosis	7.65	7.6202	8.9924	11.382
Jarque-Bera	1124.305	1110.094	1866.392	3957.893
Probability	0	0	0	0
Sum	0.6153	0.6108	0.6158	0.6127
Sum Sq. Dev.	0.0672	0.0674	0.0543	0.0516
Observations	1246	1246	1246	1246

Source: Researchers' analysis

Table 2 Unit root test FTJ253

Variable	ADF	PP
Open	-0.8723	-0.8085
Close	-0.8937	-0.8702
High	-0.8956	-0.8055
Low	-0.9957	-0.8311
D(Open)	-30.2213***	-30.2689***
D(Close)	-19.5353***	-30.2698***
D(High)	-27.0048***	-27.0337***
D(Low)	-24.3469***	-23.7835***

*(**) [***]: Statistically significant at a 10(5)[1] % level

Source: Researchers' analysis

The AR roots graph (figure 4) shows that all the roots lie within the unit circle. Hence we can conclude that the VAR model is stable when estimated using nine lags

The cointegration test suggests that when 3 cointegrating equations is the hypothesised number of cointegrating equations, we do not reject the null hypothesis. Therefore we conclude that three (of a possible three) long run relationships exist among the variables included. The results can be observed in Table 4 and 5.

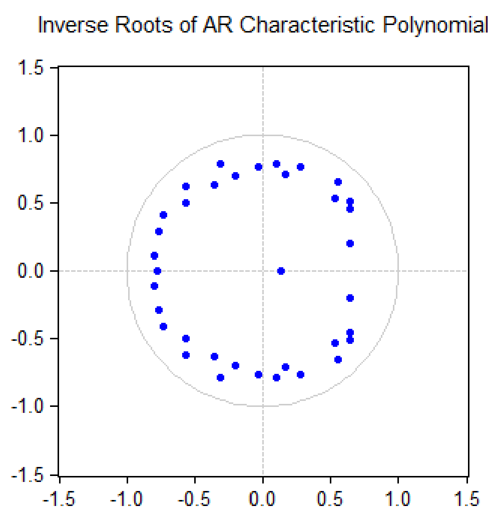
Table 3 Lag length criteria FTJ253

Lag	LogL	LR	FPE	AIC	SC	HQ
0	15691.66	NA	1.13E-16	-25.364	-25.3475	-25.3578
1	24021.38	16592.11	1.65E-22	-38.8058	-38.72300*	-38.7747
2	24057.24	71.20199	1.60E-22	-38.8379	-38.6889	-38.78186*
3	24077.59	40.26732	1.58E-22	-38.8449	-38.6297	-38.764
4	24093.03	30.45303	1.59E-22	-38.844	-38.5626	-38.7382
5	24106.24	25.961	1.59E-22	-38.8395	-38.4918	-38.7087
6	24130.77	48.06931	1.57E-22	-38.8533	-38.4394	-38.6976
7	24155.62	48.53774	1.55E-22	-38.8676	-38.3874	-38.687
8	24180.61	48.6429	1.53E-22	-38.8821	-38.3357	-38.6766
9	24197.06	31.92286*	1.53e-22*	-38.88288*	-38.2702	-38.6525
10	24210.05	25.12696	1.53E-22	-38.878	-38.1992	-38.6227

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

Source: Researchers' analysis

Fig. 4 AR roots graph FTJ253



When one considers the error correction coefficients of the three long run relationships, it is evident that the error correction coefficient of the opening price is statistically significant, however the coefficient is positive, this implies that the variable is nonresponsive and will take very long time to return to equilibrium after a

Table 4 Unrestricted Cointegration Rank Test (Trace) FTJ253

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.
None *	0.104761	287.0159	47.85613	0.0001
At most 1 *	0.069652	150.124	29.79707	0.0001
At most 2 *	0.047571	60.81625	15.49471	0
At most 3	0.000425	0.52546	3.841466	0.4685
Source: Researchers' analysis				

Table 5 Unrestricted Cointegration Rank Test (Maximum Eigenvalue) FTJ253

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value	Prob.
None *	0.104761	136.8919	27.58434	0
At most 1 *	0.069652	89.30772	21.13162	0
At most 2 *	0.047571	60.29079	14.2646	0
At most 3	0.000425	0.52546	3.841466	0.4685
Source: Researchers' analysis				

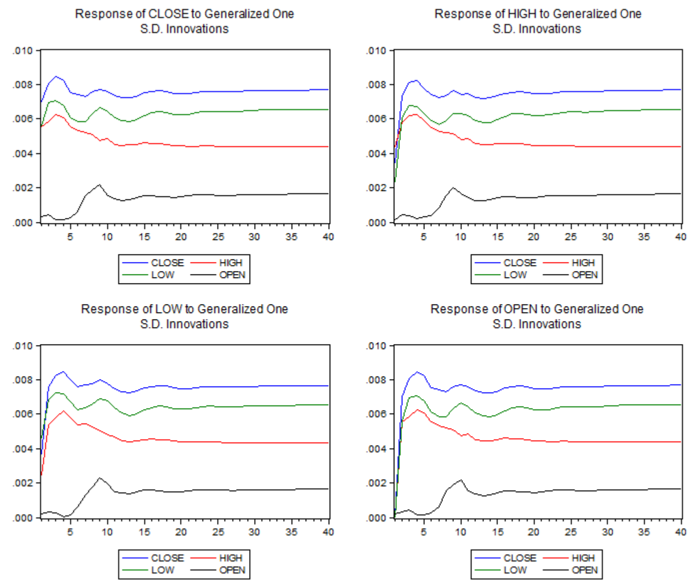
deviation. The error correction coefficients of the closing, high and lowest prices are significant and of the correct sign, this means that a deviation from the long run relationship will be corrected. The error correction process is rapid when closing and highest prices are considered, but slow when highest prices are considered. The error correction coefficients of the highest and lowest prices are significant and of the correct sign, the variables will adjust back to the long run relationship by a magnitude equal to the error correction coefficient daily.

Table 6 Vector Error Correction Model FTJ253

Standard errors in ( ) & t-statistics in [ ]				
Cointegrating Eq:	CointEq1	CointEq2	CointEq3	
CLOSE(-1)	1	0	0	
HIGH(-1)	0	1	0	
LOW(-1)	0	0	1	
OPEN(-1)	-1.00005	-1.0018	-0.99403	
	-3.90E-05	-0.00114	-0.00136	
	[-25423.5]	[-876.326]	[-730.578]	
C	-0.0002	0.005838	-0.03164	
Error Correction:	D(CLOSE)	D(HIGH)	D(LOW)	D(OPEN)
CointEq1	-3.86014	-0.34781	-2.81503	0.991302
	-2.65804	-1.66617	-1.74035	-0.08628
	[-1.45225]	[-0.20875]	[-1.61750]	[11.4891]
CointEq2	-0.48235	-0.7303	-0.42994	0.0032
	-0.17534	-0.10991	-0.1148	-0.00569
	[-2.75093]	[-6.64458]	[-3.74501]	[0.56217]
CointEq3	-0.14242	-0.20922	-0.52639	0.002996
	-0.14388	-0.09019	-0.09421	-0.00467
	[-0.98982]	[-2.31971]	[-5.58758]	[0.64149]
C	-0.00158	-0.00013	-0.00144	0.000489
	-0.00133	-0.00083	-0.00087	-4.30E-05
	[-1.18870]	[-0.16162]	[-1.65694]	[11.3599]
R-squared	0.121764	0.572368	0.509245	0.999074
Adj. R-squared	0.09315	0.558435	0.493255	0.999044
Sum sq. resids	0.058986	0.023177	0.025287	6.22E-05
S.E. equation	0.00702	0.0044	0.004596	0.000228
F-statistic	4.255371	41.08041	31.84869	33105.98
Log likelihood	4399.409	4977.168	4923.282	8639.505
Akaike AIC	-7.04836	-7.98249	-7.89536	-13.9038
Schwarz SC	-6.88278	-7.81691	-7.72979	-13.7382
Mean dependent	0.000478	0.000485	0.000487	0.000493
S.D. dependent	0.007372	0.006622	0.006457	0.007368
Determinant resid covariance (dof adj.)	1.34E-22			
Determinant resid covariance	1.18E-22			
Log likelihood	24209.79			
Akaike information criterion	-38.8647			
Schwarz criterion	-38.1527			
Source: Researchers' analysis				

Figure 5 below indicates the impulse responses of the FTJ253 to the introduction of a one standard deviations shock to the close, intraday high, intraday low and closing values. If a shock is introduced to all variables individually the closing price response by increase at first before reaching a new equilibrium after 15 days or lag periods. The reaction of each individual variable to each variables individual shock is very similar except for the opening price. The initial response of the opening price to the introduction of a shock to each individual variable is very little. For the first 5 lag periods (days). In each instance the opening price reacts with an upward moved around lag period 5 reaching a high around lag period 8 to 10 before levelling off to a new equilibrium around lag period 15.

Fig. 5 Impulse Response of FTJ253



3.2 *FTSE/JSE SA Capped Property Index (FTJ254)*

The line graphs below in Figure 6, of the opening, closing, intraday high and intraday lowest prices of the FTJ254 exhibit an upward trend. There also seems to be a slight decrease in the level of the index during the second quarter of 2013.
The log returns of the opening, closing, highest and lowest prices of the FTJ254 index seem to exhibit signs of volatility clustering, as indicated in Figure 6 below. As to be expected, the log returns of the intraday high and intraday low prices seem to be the most volatile. Furthermore, the histograms show that the returns do not look normally distributed, and show signs of leptokurtosis.

The ADF and PP unit root tests show that the variables are nonstationary at level, however the variables are stationsary at first difference. Therefore we conclude that the logged price indices are integrated of order one.
The FTJ254 is slightly positively skewed, as apposed to the slightly negatively skewed FTJ253. The descriptive statistics results for the FTJ254 can be seen in Table 7 below.

The lag length criteria of the estimated VAR model can be seen in table 9. The Final Prediction Error and Akaike Information criterion suggest that 8 lags should be used, this is one less than the optimal lag length of the VAR model estimated for FTJ253. The stability test and the cointegration test is performed using 8 lags.

Fig. 6 Line graphs of the FTSE/JSE SA Capped Property Index (FTJ254)

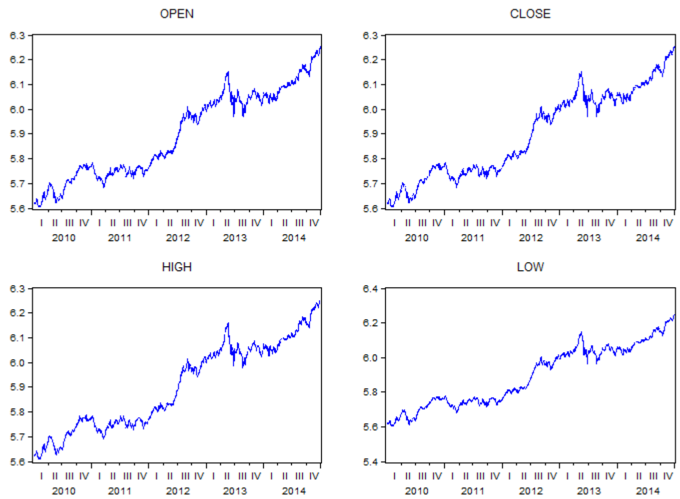
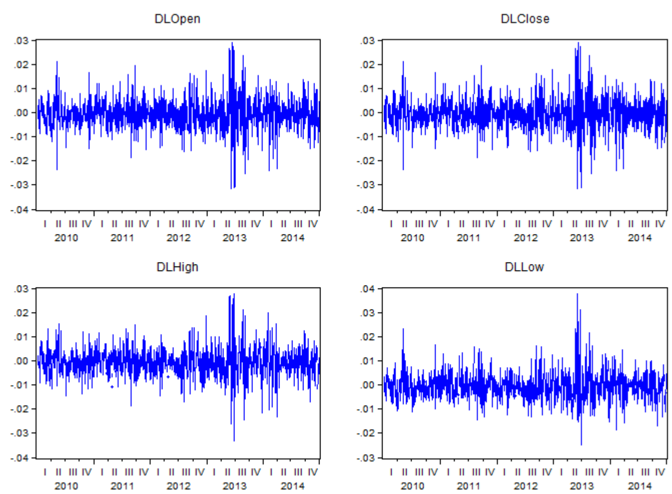


Fig. 7 Log returns of the FTSE/JSE SA Capped Property Index (FTJ254)



Tables 10 and 11 show that if we assume a linear deterministic trend in the data, the trace statistic and the maximum eigenvalue, there are three cointegrating relationships among the variables included.

Fig. 8 Log returns of the FTSE/JSE SA Capped Property Index (FTJ254)

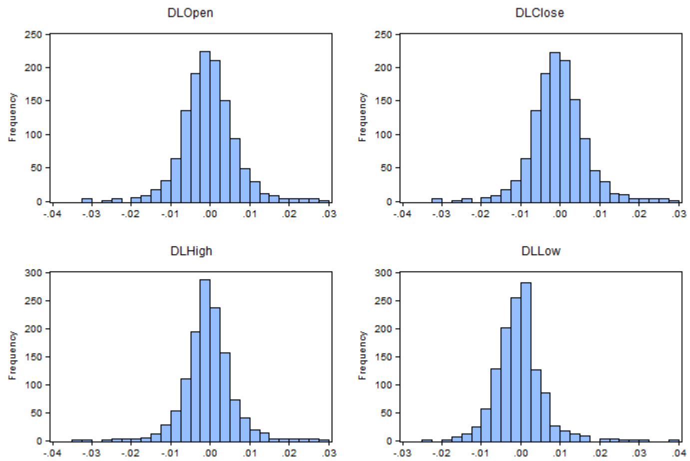


Table 7 Unit root test FTJ254

Variable	ADF	PP
Open	-0.063	-0.1492
Close	-0.0684	-0.1838
High	-0.281	-0.1331
Low	-0.2702	-0.1576
D(Open)	-20.0804***	-30.5064***
D(Close)	-20.1441***	-30.5502***
D(High)	-27.2292***	-27.2292***
D(Low)	-21.7472***	-24.6395***

*(**) [***]: Statistically significant at a 10(5)[1] % level

Source: Researchers' analysis

Table 8 Descriptive Statistics FTJ254

	DLOPEN	DLCLOSE	DLHIGH	DLLOW
Mean	-0.00051	-0.0005	-0.0005	-0.0005
Median	-0.00074	-0.00071	-0.00063	-0.00055
Maximum	0.028928	0.028928	0.027553	0.037855
Minimum	-0.03158	-0.03158	-0.03335	-0.02498
Std. Dev.	0.006517	0.006527	0.005845	0.005658
Skewness	0.11894	0.127422	0.064193	0.869502
Kurtosis	5.773846	5.774902	6.799788	7.585408
Jarque-Bera	402.3961	403.1343	750.4488	1248.601
Probability	0	0	0	0
Sum	-0.62938	-0.6238	-0.62823	-0.62547
Sum Sq. Dev.	0.052884	0.053038	0.042531	0.03985
Observations	1246	1246	1246	1246

Source: Researchers' analysis

Table 9 Lag length criteria FTJ254

Lag	LogL	LR	FPE	AIC	SC	HQ
0	15961.37	NA	5.94E-17	-26.0104	-25.9937	-26.0041
1	24205.63	16421.32	8.90E-23	-39.4224	-39.3391*	-39.3910*
2	24235.76	59.81042	8.69E-23	-39.4454	-39.2954	-39.3890
3	24251.76	31.67215	8.69E-23	-39.4454	-39.2288	-39.3639
4	24271.35	38.63187	8.64E-23	-39.4513	-39.1679	-39.3447
5	24280.96	18.88971	8.73E-23	-39.4408	-39.0909	-39.3092
6	24298.98	35.3082	8.70E-23	-39.4441	-39.0275	-39.2874
7	24326.91	54.54307	8.54E-23	-39.4636	-38.9803	-39.2817
8	24345.48	36.13411	8.50e-23*	-39.4678*	-38.9178	-39.2608
9	24354.65	17.79696	8.60E-23	-39.4567	-38.8400	-39.2246
10	24365.65	21.26716	8.67E-23	-39.4485	-38.7652	-39.1914
11	24374.82	17.66519	8.76E-23	-39.4374	-38.6874	-39.1552
12	24385.06	19.65633	8.85E-23	-39.4280	-38.6113	-39.1207
13	24398.31	25.34798	8.89E-23	-39.4235	-38.5402	-39.0911
14	24413.42	28.82524	8.90E-23	-39.4220	-38.4721	-39.0646
15	24420.74	13.92084	9.03E-23	-39.4079	-38.3913	-39.0254
16	24448.59	52.73121*	8.86E-23	-39.4272	-38.3439	-39.0196

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

Source: Researchers' analysis

Table 10 Unrestricted Cointegration Rank Test (Trace) FTJ254

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.**
None *	0.12095	344.9973	47.85613	0.0001
At most 1 *	0.093934	185.4025	29.79707	0.0001
At most 2 *	0.049794	63.28194	15.49471	0
At most 3	4.02E-05	0.0498	3.841466	0.8234

Source: Researchers' analysis

Table 11 Unrestricted Cointegration Rank Test (Maximum Eigenvalue) FTJ254

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.**
None *	0.12095	159.5948	27.58434	0.0001
At most 1 *	0.093934	122.1206	21.13162	0.0001
At most 2 *	0.049794	63.23214	14.2646	0
At most 3	4.02E-05	0.0498	3.841466	0.8234

Source: Researchers' analysis

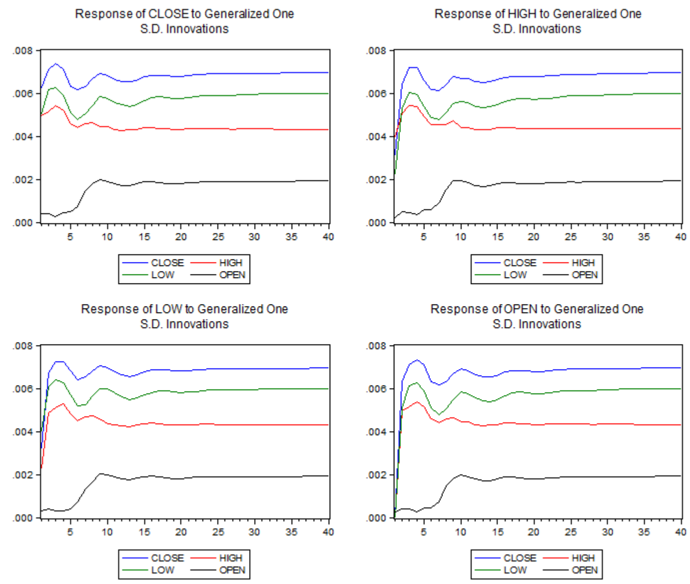
When one considers the long run relationship of the variables included, it is evident that the loading coefficients are negative and close to one, this is evidence of future spot parity. In addition, the error correction coefficients of the closing price and intraday low are statistically significant and of the correct sing in the first cointegration equation. Both variables will adjust rapidly after a deviation from the long run relationship. In the second cointegrating equation, the closing price, intraday high, and intrady low are statistically significant and of the correct sign, the variables will adjust by a magnitude equal to the error correction coefficient daily after a deviation from the long run relationship. Finally, the intraday high and low are statistically significant in the third cointegrating equation.

Table 12 Vector Error Correction Model FTJ254

Standard errors in ( ) & t-statistics in [ ]				
Cointegrating Eq:	CointEq1	CointEq2	CointEq3	
CLOSE(-1)	1	0	0	
HIGH(-1)	0	1	0	
LOW(-1)	0	0	1	
OPEN(-1)	-1.00004	-1.0007	-0.99656	
	-3.90E-05	-0.0009	-0.00105	
	[-25950.8]	[-1107.91]	[-945.766]	
C	-0.00028	-0.00069	-0.01601	
Error Correction:	D(CLOSE)	D(HIGH)	D(LOW)	D(OPEN)
CointEq1	-5.2508	-2.14882	-2.85458	0.997668
	-2.12903	-1.35323	-1.36859	-0.08156
	[-2.46629]	[-1.58793]	[-2.08579]	[12.2317]
CointEq2	-0.40982	-0.79014	-0.47831	0.003972
	-0.17427	-0.11076	-0.11202	-0.00668
	[-2.35170]	[-7.13349]	[-4.26983]	[0.59498]
CointEq3	-0.10275	-0.24832	-0.57626	0.003426
	-0.14598	-0.09279	-0.09384	-0.00559
	[-0.70389]	[-2.67629]	[-6.14094]	[0.61262]
C	-0.00229	-0.00107	-0.00152	0.000506
	-0.00109	-0.00069	-0.0007	-4.20E-05
	[-2.09533]	[-1.53217]	[-2.16626]	[12.0896]
R-squared	0.104717	0.549725	0.508178	0.998682
Adj. R-squared	0.078648	0.536614	0.493857	0.998644
Sum sq. resids	0.047383	0.019143	0.01958	6.95E-05
S.E. equation	0.006279	0.003991	0.004036	0.000241
F-statistic	4.016902	41.92801	35.48498	26027.44
Log likelihood	4539.038	5100.067	5086.095	8577.43
Akaike AIC	-7.2747	-8.18105	-8.15847	-13.7988
Schwarz SC	-7.12578	-8.03212	-8.00955	-13.6498
Mean dependent	0.000501	0.000505	0.000502	0.000507
S.D. dependent	0.006541	0.005862	0.005673	0.006532
Determinant resid covariance (dof adj.)	7.45E-23			
Determinant resid covariance	6.62E-23			
Log likelihood	24585.25			
Akaike information criterion	-39.4657			
Schwarz criterion	-38.8203			
Source: Researchers' analysis				

Figure 9 indicates the individual response of a one period standard deviation shock to each individual variable for the FTJ254. The response to the introduction of shock to the index values is similar to those of the FTJ253. It seems that in all for cases the market reaches new equilibrium after 15 lag periods (days).

Fig. 9 Impulse Response of FTJ254



4 Conclusion

The purpose of this paper was to explore the market efficacy of the FTSE/JSE SA Listed Property Index (FTJ253) and the FTSE/JSE Capped Property Index (FTJ254) to the introduction of a one standard deviations shock. The one standard deviations shock was introduced the closing ($Close_t$), intraday high ($High_t$), intraday low (Lowt) and opening ($Open_t$), values for the daily values for the period 4 January 2010 until 31 December 2014. The results obtained for both the indices are very similar except for the distribution of the FTJ254 that is slightly positively skewed vs. the FTJ253 that is negatively skewed.

It is clear from the results obtained that arbitrage opportunity is present when the one standard deviation shock is introduced to each individual variable. The results indicate that after 15 lag periods (15 days) the market values of the two indices reach a new equilibrium. One aspect of the variables included in this study that was not explored any further is the volatility of the property indices on the JSE. Therefore further research might include a volatility model that accounts for volatility clustering shown by figures 2 and 7.

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