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Abstract

Purpose - This research aims to ascertain the extent to which the Covid-19 epidemic affected the relationship between inflation and Real Estate Investment Trust (REITs) returns in South Africa.

Design/methodology/approach - This research used the Johansen cointegration test, and effective test in establishing if there is a long-run cointegrating equation between the variables. ~~In order to~~To ascertain if COVID-19 resulted in a different relationship regime between inflation and REITs returns, the sequential Bai-Perron method was used.

Findings - Between December 2013 and July 2022, there was no evidence of a long-run relationship between inflation and REITs returns, and a restricted Vector Autoregressive (VAR) model with a period lag for each variable best describing the relationship. Using the sequential Bai-Perron method, for one break, the results show February 2020 as a structural break in the relationship. A cointegrating equation is also found for the period before the structural break and another after the break. Interestingly, the relationship is negative before the break and a new positive relationship (regime) is confirmed after the noted break.

Originality/value - This is one of the first studies to test inflation relationship with REITs returns in South Africa and the effects of COVID-19 thereof. This research helps REITs stakeholders to position themselves in light of any changes to macroeconomic activity within South Africa.

Keywords - Covid-19, Real Estate Investment Trusts (REITs), Inflation, Johansen cointegration, structural breaks, South Africa

1. Introduction

The paper investigates the extent to which the Covid-19 epidemic affected the relationship between inflation and Real Estate Investment Trusts (REITs) returns in South Africa. From their inception in the US more than 50 years ago, REITs have seen steady growth across the world as a distinct investment option in real estate markets. Between 1990 and 2021, for example, REITs have grown in both number and market capitalisation from 120 listed REITs in two countries to over 800 in more than 40 countries (Nareit, 2022). Their continued growth has been a function of the many benefits associated with this investment option., including increased access to the real estate investment markets, improved stock liquidity, steady access to capital, greater opportunities for portfolio diversification and stability, strong record of performance, to name a few. Coën, et al, 2022 emphasise the importance of public real estate markets in terms of portfolio diversification. However, like many other investment undertakings, REITs have not been immune from to the shocks arising from the events surrounding the Covid-19 pandemic. COVID-19 arguably changed the world and the behaviour of many financial assets and their relationships with macroeconomic variables. In South Africa, the pandemic seems to have come with it, or left, considerable inflationary pressures in the economy. It is therefore imperative that the relationship between increasing inflation and the performance of REITs is unpacked as this should not only push knowledge boundaries but equally benefit investment decision-making. The paper does not dwell on the dynamics of the Covid-19 pandemic, but rather simply traces REITs returns and inflation prior and during/after the Covid-19 pandemic. The starting point is a literature review on the subject.

2. Literature review

A Real Estate Investment Trusts (REIT) can be defined as a type of liquid asset class that allows investors to have access to and participate in a relatively illiquid real estate market without having to trade in the physical assets (Kola and Kadongo, 2017; Zhu, 2018; Sukor, et al, 2020). They allow investors to profit from the highly illiquid real estate assets while concurrently experiencing the marketability and liquidity benefits of traditional stock market assets. There are many areas of differentiations of REITs across countries. In South Africa, for example, REITs can be internally or externally managed, are required to invest a minimum of 75% of all funds in real estate and are permitted to invest offshore. In comparison with the US REITs, which are the oldest, South African REITs, established only in 2013, are subject to a gearing limit of 60% whilst US REITs have no gearing limit; and South African REITs must distribute 75% of their income to investors while US REITs must comply with a heavier 90% income distribution. REITs are exempt from taxation under on the condition that they distribute at least 90%the stipulated proportion of their income to their shareholders each year as dividends (Kola and Kadongo, 2017). In Kenya, REITs are allowed to deduct the dividends paid to their shareholders from their taxable incomes and this unique tax can translate into superior yields for investors seeking higher returns with relative stability in general prices (Irandu, 2017).

2.1 Rationale for and benefits of REITs

The rationale for and benefits of REITs are now a subject of commonplace statement knowledge as they have been cited by many authors. Chief among the positive attributes is that REITs are relatively a more liquid asset class than direct real estate investment due to their tradability in the stock markets and smaller capital outlay requirements (Chen et al., 2005). Other benefits revolve around steady access to capital, greater opportunities for portfolio diversification and stability, strong record of performance, among others (Marzuki and Newell, 2020; Dabara, 2022). REITs are also said to be good at providing the enabling environment for international competitiveness and increasing attractiveness to foreign investors (Ooi, et al, 2006; Carstens and Freybote, 2018). REITs benefit communities, economies, and investors. They contribute to economic growth, job creation, environmental stewardship, capital markets development and financial security. Globally, the growth of REITs returns has outperformed bonds, private real estate and stocks (Nareit, 2022).

2.2 Studies on REITs and inflation

Generally, REITs are influenced by the changing economic conditions and the relationship between REITs investment returns and inflation is of much interest to both domestic and international investors. Inflation and inflation cycles have been a major underlying reason for the financial successes and failures of real estate investments in recent history (Munk, et al, 2004). These cycles have complex impacts on cash flow variables and those of real estate returns and investment values are no exception. At the time of writing, global markets seemed to signal a high probability of inflation rates of over 3 percent persisting in coming years, including those in the United States, Euro zone, and the United Kingdom (Adrian, et al, 2022). The war in Ukraine could have been one contributing factor to rising inflation globally, which brings brought substantial uncertainty into the economies. South Africa is not spared from such inflationary pressures. Statistics South Africa recently reported headline consumer inflation of 7.4% year on year in June 2022, versus analysts' predictions of 7.2% (StatsSA, 2022). This headline inflation in June 2022 was the highest since May 2009, during the global financial crisis. The difficulties brought about by inflationary pressure revolve around the fact that investor decision--making heavily relies on forecasting the future returns using expected economic activity and as such any uncertainties in forecasting inflation makes it difficult to determine the real future performance of the assets.

Some parallels can be made with other investment assets and their relationship with inflation. From a theoretical perspective, two important reasons have historically been said to make stocks good hedges against inflation (Lintner, 1975). First, equities represent claims against real assets whose values are expected to keep pace with changes in purchasing power. Second, firms leverage their capital and are net debtors on average, enabling shareholders to benefit from unexpected inflation as the firm's. However, some studies in industrialisszed economies suggest that the relationship between stock returns and inflation is negative (Spyrou, 2004). One explanation given is the negative correlation between inflation and real output growth. Government debt instruments fail as hedges against unexpected inflation, although these assets do provide protection from anticipated inflation. Common stock returns, however, are negatively related to inflation, suggesting that common stocks are rather perverse as hedges against inflation. In recent years, the empirical analysis of stocks' ability to protect investors from inflation-related losses in purchasing power has received considerable attention in the academic literature (Spyrou, 2004; Alagidede & Panagiotidis, 2010). Most studies agree on the proposition that the return of common stocks co-moves with inflation in a one-to-one relation as predicted by the Fisher model of 1930 (Fisher, 1930 Chen, 2015), which suggests that nominal stock returns are a hedge against inflation, and that an increase in inflation should increase expected nominal dividend payments. The argument is that the discount rate should be determined by the rate of return that investors expect to gain as dividend yield or capital yield on the stock (Gordon, 1959). Therefore, an increase in inflation expectations and actual inflation rates should also increase the expected flow of future nominal dividend payments for stock and this leads to an upward revision of stock prices.

In contrast with the classical economic theories, the recent empirical literature has not supported the hypothesis that nominal stock returns may serve as a hedge against inflation resulting in "inflation-stock returns puzzle" (Li, & Zhao, 2019). Most of the empirical literature in history reports a negative relationship between inflation rates and stock returns in the post-1953 era. Lintner (1975) and Donald (1975) reported a negative relationship between inflation and real output and equity prices. The authors claimed that as the inflation rate increases, companies ~~try~~ attempt to raise external financing. Regardless of whether debt or equity financing is used as external funds, the company's real cost of capital rises. This increase will reduce the optimal rate of real growth even if its profit margin is maintained and product demand continues to expand at the same rate. The ability for the ~~landlords~~ investors to adjust rents to compensate for inflation makes direct commercial real estate relatively a good inflation hedge. Thus, as gross domestic product rises, inflation rises as demand for goods and services rise pushing the value of Direct Commercial Real Estate (DCRE) higher (Park et al. 2012). A diversified portfolio of commercial real estate provided a complete hedge against inflation over the 1973-1983 period (Hartzell et al. 1986).

A study by Akinsomi *et al.* (2018) found interest rates and inflation to be the most significant drivers of DCRE rental growth in SA for all property types as a whole. Alexakis et al. (1996) argue that high inflation rates are affecting stock prices due to the volatility in inflation rates and these mainly exist in the emerging capital markets, while economies experiencing low inflation rates have stability in stock prices and these mainly exist in developed capital markets. Several studies agree with the argument that emerging capital markets are mostly affected negatively by the inflation rate. This conclusion is reported by Reddy (2012) in India, Adusei (2014) in Ghana, Uwubanmwen and Eghosa (2015) in Nigeria, Silva (2016) in Sri Lanka and Jepkemei (2017) in Kenya. Using regression models, cointegration, the Vector Error Correction Model (VECM), the Granger Causality Test and, the Impulse Response and Variance Decomposition respectively, these studies showed that, REITs do not always follow direct property in reacting to economic activity and sometimes its equities properties are more evident. This is worrying because the whole REITs innovation is meant to benefit property investors than promote wider equity investments.

Findings from a study by Dabara et al. 2019 revealed that the return profile of REITs and non-REITs equities in Nigeria from 2007 to 2016 had experienced some level of volatility with the non-REITs outperforming the REITs investment asset (the highest returns obtained from REITs investment was 5.43%, while the highest returns for the ~~non REITs~~non-REITs was 41.79%). Inflation was seen to be mostly in double digits and had kept increasing throughout the study period, ranging between 4.37 and 18.45. Analysis of the relationship between indirect real estate investment returns and inflation in the study area revealed negative Beta coefficients for both REITs and ~~non REITs~~non-REITs investments in the study area. This was indicated by a ~~beta~~ Beta coefficient of - 0.127 and -0.225 for REITs and non-~~-~~REITs asset classes respectively. These~~is~~ results suggested ~~a~~ perverse hedging characteristics for all the securitis~~z~~ed real estate investments in the study area (Dabara et al. 2019).

Real estate is considered one approach to hedge against inflation, given the asset class usually has little correlation with stocks and bonds, and therefore. So naturally, investor interest is soaring. The USA's REITs profitability over during 2013–2017 was 9.9 %, which is several times higher than inflation (1.32 %) and deposit profitability (0.6 %), which explains the popularity of this collective investment instrument among the population in the United States (Sedipkova, 2019). Using the Granger non-causality test, the authors demonstrate that a unidirectional relationship, in which inflation-rate shifts cause REIT index changes, exists in Japan and Singapore and that a wealth effect, in which stock index movements cause REIT index changes, exists in Singapore (Fang et al. 2016). It is suggested that returns on nominal stocks are a hedge against inflation, therefore concluding, that an increase in current and expected inflation should increase expected nominal dividend payments. This is theoretically correct, however most empirical studies illustrate a different narrative. Using standard statistical tools that include Johansen cointegration test, linearity, normality tests, cointegration regression, Granger causality and vector error correction model, results show that cointegration exists between the stock prices, the changes in stock prices due to inflation rates. The paper finds that inflation rates are negatively associated with stock prices. Changes in real inflation rates Granger cause significant changes in stock prices. There is significant speed of real interest rates and significant speed of adjustment to long run equilibrium between changes in stock prices due to changes in inflation rates (Eldomiaty et al. 2020). In addition, it was examined that increased inflation rates affected prices in the stock market because of the volatility in inflation rates, which exist predominantly in emerging/developing capital markets. This suggests that while economies that experience decreased inflation have a stable stock market and this is predominantly present in developed capital markets. The study found that the African REITs (N-REITs) and M-REITs provided a hedge (albeit partial), against all inflation components. In contrast, UK-REITs could not provide a hedge against expected inflation while US-REITs provided a hedge only against one inflation component (expected inflation). Thus, it can be argued that investors interested in hedging against all inflation components should invest in the African (Nigerian) and Malaysian REITs (Edionwe & Ogunba, 2017).

To conclude the literature review, it would appear that studies on this relationship illustrate two different narratives. One being that inflation has an insignificant impact on REIT returns, while the second narrative suggests that inflation is positively related to the REIT returns. A conclusion can be drawn that REITs cannot hedge against inflation and the impact of this macroeconomic variable on REITs is negative (Fang et al. 2016). However, the relationship between REITs returns and the macroeconomic variables is not consistent with that of direct property investment and stocks.

3. Methodology

The research was informed by, and relied on, secondary data sources to establish the extent to which the epidemic affected the relationship between inflation and Real Estate Investment Trust (REITs) returns in South Africa. South African REITs were launched in May 2013 and before their introduction, property unit trusts (PUTs) and property loan stocks (PLSs) were the main types of listed property investment products in the South African investment market. It was therefore expected that sufficient secondary data would be available to enable robust statistical analysis (using Eviews 12) of the relationship between the REITs returns and the inflationary pressures triggered by the Covid-19 pandemic.

3.1 Statistical analyses

The paper employs Johansen cointegration methodology to ascertain if there is a long-run relationship between REITs returns and inflation as well as the direction of the impact. According to Hendry (1995), cointegration, which focuses on stationary time series, has grown over the years to be a primary empirical technique used to ascertain long-run relations between variables. While cointegration is used to determine if there is a long-run relationship between 2 or more variables, failure to establish a cointegrating equation does not imply that no other relationship exists between variables (Rao & Kumar, 2009~~7~~). Johansen (1988) states that, for cointegration to work, variables should be integrated to the same first order i.e. *I(1)*, thus they have to be stationary at the first difference. Unlike the Engle-Granger Test which produces only one equation, the Johansen cointegration test can produce multiple cointegrating equations and is ~~that~~ more suited when various variables are being considered.

According to Johansen (2009), the Trace and the Eigen values, can be obtained from a Johansen test to infer ~~of~~ the presence of cointegrating equations between variables. Let ~~'~~us consider a general vector autoregressive $VAR_{(p)}$ model:

$$Y_t = \alpha + \rho_1 Y_{t-1} + \ldots + \rho_p Y_{t-p} + \varepsilon_t \qquad (1)$$

Where: α is the vector-valued mean of the series,

ρ_i, are the coefficient matrices for each lag and,

ε_t is a multivariate Gaussian noise with mean zero

The Vector Error Correction Model (VECM) which is found by differencing equation (1) is a result found when the existence of cointegrating equations is made, thus:

$$\Delta Y_t = \sigma + \rho Y_{t-1} + \delta_1 \Delta Y_{t-1} + \ldots + \delta_p \Delta Y_{t-p} + \varepsilon_t \qquad (2)$$

Where: $\boldsymbol{\Delta Y_t = Y_t - Y_{t-1}}$ is the differencing operator,

ρ is the coefficient matrix for the first lag and,

$\boldsymbol{\delta_i}$ are the matrices for each differenced lag.

There is no cointegration when the matrix is $\rho = 0$, so for the eigenvalue to be achieved, there is need to decompose ρ. Thus, the rank of matrix ρ is given by $r = 0$, $r = 1$ up to $r = n - 1$ where n is the number of time series. The null hypothesis of $r = 0$ ~~representing~~ represents a scenario of no cointegrating equation among the tested time series. Thus, where a rank is $r > 0$, then a cointegrating equation between variables is present. The null hypothesis for both the Trace and Eigenvalue test is therefore:

Null Hypothesis: no cointegrating equation thus $H_0: r = 0$, The alternate hypothesis for the Trace test is that the number of cointegrating equations is at least 1, so $r = q$ thus testing for r will continue increasing until the null is no longer rejected (Brooks, 2002). According to Brooks (2002), the maximum eigenvalue test alternate hypothesis on the other hand is that $q_0 + 1$ (instead of $q > q_0$) so testing for r* will increase from 1 to 2…….to $n - 1$ thus, until the null hypothesis is no longer rejected.

3.2 Data issues

Despite the early 2013 introduction of REITs in South Africa, most counters only launched towards the second half of the year. As such, this research uses monthly data from December 2013 up to July 2022. The Total Return Index REITs data was collected from the Johannesburg Stock Exchange (JSE) for the said period. The initial index data code was J867, but this discontinued in February 2021 in line with the FTSE/JSE Market Note of March 2018 which ~~sort~~ sought to ensure index changes conformed to FTSE Russell Industry Classification Benchmark (ICB). The index code change to JS3512 did not affect the data and as such, these were joined together for purposes of this research. The proxy for inflation, Consumer Price Index, data was collected from Stats SA for the period December 2013 to July 2022.

4. Results and analysis

Eviews 12 was used in the analysis of data in this research and the process started with the standardisation of the data through converting it into logs. The next step was unit root testing which is required for cointegration to ensure that results from the procedure are not spurious. Augmented Dickey Fuller Test was used with the following Null Hypothesis:

$$H_0 = There\ is\ a\ unit\ root\ present$$

The results for the unit root test are presented in Table 1, for both inflation and REITs returns at levels as well as first difference of the same series.

Table 1: Unit Root Test results

For both REITs returns and inflation series, we fail to reject the Null at the level at neither 1% nor 5% level of significance. As such the series were differenced once to ascertain if Null would be rejected and the results show that the differenced series in each case is stationary since the Null for the existence of a unit root is rejected.

4.1 Johansen Cointegration Test

After it was established that the REITs returns and Inflation series were stationary at the first difference, the Johansen Cointegration Test was then performed. ~~Before that, t~~The choice of lag length is an important part of the process for VAR models and cointegration because using too many or too few lags may result in loss of degrees of freedom, multicollinearity, statistically insignificant coefficients and/or specification errors. As such, optimum lag length had to be determined for the model used for cointegration test and this was chosen using a statistical information criterion, and for this research, Akaike information criterion (AIC) was used, and its choice is of limited value to the scope of this research.

Table 2: Lag length selection results

Table 2 shows the results for the AIC lag length selection at 5% level of significance and in this case the VAR is optimised at 3lags. Apart from optimum lags helping to determine the existence of a cointegrating equation between variables, it is important to note that the dependence of REITs returns on inflation might not be instantaneous but happen over time (lagged), hence the need to determine optimum lags.

Having defined the optimum lags (3 lags), an unrestricted cointegration rank test for Trace and Maximum Eigenvalue was then determined.

Table 3: Cointegration results

Table 3 above shows the summary of the test results for Johansen cointegration test. Using the Trace and max-Eigen statistics, the results fail to reject the Null hypothesis of no cointegrating equation at 5% level of significance for REITs and Inflation between December 2013 and July 2022. Thus, in the short-run, if there are inflation shocks that affect the movement of REITs returns, these might not converge in the long-run as there is no defined long-run relationship between the two variables. As a result of these ~~results~~findings, no Vector Error Correction Model (VECM) can be performed and instead, a restricted VAR would best define the relationship and the impact of inflation on REITs.

Table 4: Unrestricted VAR for the whole sample period

Table 4 is a summary of the unrestricted VAR for the REITs returns component of the system. The Durbin-Watson statistic, which tests for autocorrelation in a model has a statistic~~s~~ close to 2 which shows that there is no autocorrelation in this model. Unfortunately, most of the coefficients are statistically insignificant and this may be due to an over parameterised model with too many lags leading to multicollinearity. To determine the significance of the generalised model coefficients, a Wald test was performed. Initially, a joint test for all the coefficients was ~~done~~ conducted before testing the significance of each coefficient. The Joint Wald test with the following Null Hypothesis was performed:

Null Hypothesis: LR(-1)=LR(-2)=LR(-3)=LF(-1)=LF(-2)=LF(-3)=0

Where: LR is the coefficient of REIT lags and LF is that of Inflation

Table 5: Wald Test results for the joint test of the VAR coefficients in Table 4

The results in Table 5 show that the Null should be rejected, and the coefficients are jointly not equal to zero nor jointly insignificant. However, the unrestricted VAR has five out of seven coefficients that are statistically insignificant at 5% level of significance which is worrying. Thus, using the Wald test, each coefficient was tested for significance and Table 6 below has the results of the test.

Table 6: Wald Test results for each VAR coefficients in Table 4

The results in Table 6 show that the coefficient of the first lag of REIT returns series is the only one that is statistically significant and that is not such a good result. To move from the over-parametised model to a parsimonious option, we removed each of the statistically insignificant coefficients starting with the worst results i.e. REIT(-2) and recalculateding the VAR.

***Table 7**: Unrestricted VAR for the parsimonious model*

Table 7 presents the results of removing insignificant coefficients and this is the final parsimonious model defining the relationship between REITs returns and inflation between December 2013 and July 2022. The final parsimonious model is presented below as equation (1):

$$REIT_t = 1.044 + \underset{(0.028)}{0.945REIT_{t-1}} - \underset{(0.071)}{0.132Inf_{t-1}} \quad (3)$$

Where: *REIT* represents total REIT returns, *Inf* is inflation the change in inflation and t is the current period. With tThe standard errors are in parentheses.

In equation (3), a unit increase in total REIT returns a month ago earlier results in a 0.945% increase in total REIT returns in the current period. A unit increase in inflation a period (month) ago results in a 0.132% decrease in total REIT returns. The model confirms a negative relationship between lagged inflation and REITs returns during the period December 2013 and July 2022. The Durbin-Watson statistics, which is between critical values of 1.5 to 2.5 indicates that we reject the Null Hypothesis: residuals are uncorrelated, . This is good newswhich is a positive development.

4.2 Further Analysis

In early 2020, most countries including South Africa announced a national lockdown induced by the spread in the COVID-19 virus and this resulted in temporary business closures among other restrictive measures. This event has the propensity to redefine a series and its relationship with other variables. Fig 1 below shows the diagrammatical representation of the REIT returns and inflation series over this research period.

Figure 1: REITs and Inflation series throughout the period

While the REITs returns (RT) series in Figure 1 is typically volatile, the beginning of 2020 represents a sharp drop, and this is ~~right~~ just about the time COVID 19 restrictions were instituted in most countries including South Africa. To ascertain statistically if this breakpoint exists and if it is the main one for the relationship, we used the sequential Bai-Perron method as outlined by Bai (~~1997~~2014) and Bai and Perron (~~1998~~2003) to determine a single breakpoint using the following hypothesis:

$H_0 = there\ is\ no\ breakpoint$

Table 6 below displays the results of the sequential breakpoint test ~~and~~ where critical values ~~are~~ were obtained from Bai & ~~-~~Perron (2003).

Table 8: Structural Breakpoint Results

The results of the test show that if one breakpoint is sought from the relationship, February 2020 is confirmed as such a breakpoint which is not surprising given the earlier submission regarding the impact of ~~COVID~~ Covid-19 on financial markets. With this structural breakpoint already established, we ascertain if there is a cointegrating relationship between REITs returns and Inflation, before and after this breakpoint. The period before is from December 2013 to January 2020 ~~and~~ while the period after the breakpoint ~~being~~ is March 2020 to July 2022.

The VAR model was established ~~in order to~~to determine optimum Lag length and the following results were obtained.

Table 9: Lag length selection results before and after the breakpoint

Using the Akaike Information Criteria (AIC), the optimum lag length for the period before the breakpoint was 3 and that of the period after was found to be 7 as outlined in Table 9. This information was then used to estimate the existence of cointegrating relations between REIT returns and inflation.

Table 10: Cointegration results before the breakpoint

Table 10 shows the unrestricted cointegration test results for Trace and Maximum Eigenvalue statistics and both results reject the Null hypothesis of no cointegrating equation at the 5% level of significance. Instead, there is evidence of at most 1 cointegrating equation. The long run relationship confirmed in Table 10 is negative, so we can conclude that before the breakpoint in February 2020, inflation had a negative impact on REITS returns.

Table 11: Cointegration results after the breakpoint

For the period after the breakpoint, a positive long run relationship is confirmed in Table 11 where the Trace and Max-eigenvalue test results indicate the existence of at most one cointegrating equation between REITs returns and inflation. At first, these results seem to be confusing since there was no long run relationship over the whole research period as outlined in Table 3. However, the results of the tests show that for the period before the breakpoint, inflation ~~innovations~~ had a negative impact on REITs returns while for the period after the breakpoint, the impact was positive.

4.3 Vector Error Correction Model

Having determined at least one cointegrating equation before and after the breakpoint as well as establishing that the impact of inflation was different in both before and after breakpoint periods, we now define the Vector Error Correction Model (VECM) in order to examine long and short-run dynamics of the cointegrating series.

$$ECT_{t-1} = 1.000RE_{t-1} + 4.699Inf_{t-1} - 29.208 \quad (4)$$

$$ECT_{t-1} = 1.000RE_{t-1} - 5.840Inf_{t-1} - 18.697 \quad (5)$$

Equations (4) and (5) represent the Error Correction Term (ECT), which is a lagged value of the residuals obtained from cointegrating equation of the impact of inflation on REITs returns. Generally, the ECT contains information about the long-run impact of inflation on REITs returns, which information is derived from the cointegration relationship. Equation (4) which represents the ECT for the period before the breakpoint indicates that inflation has a negative impact on REITs returns, while a positive impact is confirmed in equation (5). As will be seen in equation (6), the ECT is expected to be negative if a long-run relationship exists and this is to ensure that previous deviations from the long-run equilibrium are corrected in the current period, thus inverting the coefficient signs in equations (4) and (5).

$$\Delta RE_t = -0.04ECT_{t-1} - 0.028\Delta RE_{t-1} - 0.337\Delta RE_{t-2} - 0.598\Delta Inf_{t-1} + 0.156\Delta Inf_{t-2} + 0.004 \quad (6)$$

$$\Delta RE_t = -0.743ECT_{t-1} - 0.018\Delta RE_{t-1} + 0.186\Delta RE_{t-2} + 0.074\Delta RE_{t-3} + 0.267\Delta RE_{t-4} + 0.367\Delta RE_{t-5} + 0.147\Delta RE_{t-6} - 14.625\Delta Inf_{t-1} - 7.414Inf_{t-2} - 15.913Inf_{t-3} - 5.448\Delta Inf_{t-4} + 3.136\Delta Inf_{t-5} - 1.877\Delta Inf_{t-6} + 0.18 \quad (7)$$

Equations (6) and (7) represent the VECM for the relationship between REITs returns and Inflation before the breakpoint and after the breakpoint, respectively. It is ~~good to see~~noteworthy that the coefficient of ECT in both cases is negative which confirms long-run equilibrium since previous deviations always get corrected and for the period before the breakpoint the speed of adjustment is 4% while for the period after, it is quite high at 74.3%. In equation (6), a percentage change in REITs returns in the previous month is associated with a 0.028% decrease in REITs returns in the short-run. Equally, a percentage change in inflation in the previous period and two periods before is associated with a decrease of 0.598% and an increase of 0.156% respectively. Similar inferences can be made regarding the decrease and increase of REITs returns after the breakpoint as ~~presented by~~shown in equation (7).~~,~~ ~~as~~ As an example, a percentage increase in inflation 6 months ~~ago~~ earlier is associated with a 1.877% decrease in REITs returns in the short-run.

To validate the VECM for before and after the breakpoint, we carried out diagnostic tests, including: Residual Serial Correlation LM Test;~~,~~ Residual Normality Test; and the Residual Heteroskedasticity Tests. The LM Test (Breusch-Godfrey test) tested whether or not the residuals are serially correlated with the hope that they are not auto correlated. The Null hypothesis for the test is:

H_0: *Residuals are not auto − correlated*

Table 12: Residual Serial Correlation LM Test results before the breakpoint

The results for the serial correlation LM Test for the VECM before the breakpoint ~~is~~ are shown in Table 12. We cannot reject the Null for no serial correlation for any of the lags on this model since the Probability values for the Chi-square statistics are above 0.05, which represents 5% level of significance. This means that the residuals of the VECM are not auto-correlated and this is a good result that confirms the appropriateness of the model.

Table 13 below shows the results ~~for~~ of the auto-correlation LM test for the model represented by equation (7) and the period after the breakpoint. The Null hypothesis for the test is still the same and the results, are generally good apart from lag 1.

Table 13: Residual Serial Correlation LM Test results after the breakpoint

The results in Table 13, fail to reject the Null hypothesis for lags 2-5 but the Null is rejected for one lag (lag-1). If more lags had resulted in the rejection of the Null, this would have been worrying as it would have indicated that the errors of the model are correlated.

Another important diagnostic test for the models is the normality test, which seeks to ascertain if the residuals are normally distributed. The Null hypothesis for the test is as follows:

H_0: *Residuals are multivariate normal*

Table 14: Residual Normality Test results

The Jarque-Bera statistics in Table 14, for the period before the break, has probability values above 0.05, the cut-off 5% Level of significance indicating that the Null hypothesis cannot be rejected and the residuals for the model are normal. So, the model as represented by equation (6) has normally distributed errors which is a good thing and an indication that the model for data before the breakpoint is properly specified. Table 15, also shows the results of the residual normality test for the period after the breakpoint as represented by equation (7) above. The Joint test Jarque-Bera statistics is also above 0.05 (5% level of significance) so we fail to reject the Null hypothesis and thus conclude that the residual of the VECM represented by equation (7) are normally distributed.

The next diagnostic test is the heteroskedasticity test (White's general test) which helps to check if the residuals have a constant variance or not. The expectation is that the variance of the residuals are is constant thus homoskedastic. The Null hypothesis for the test are is as follows:

H_0: *There is no heteroscedasticity*

Table 15: Residual Heteroskedasticity Test results

Table 15 shows the results of heteroscedasticity diagnostic test, performed on the VECM using the White's test that checks if the residuals of the model represented by equation (6) and equation (7) respectively have constant variance or not. If the residuals possess a constant variance, they are said to be homoskedastic and that is was our expectation. The results in Table 15, show that the errors of the VECM before the breakpoint are heteroscedastic and this is not a good thing. At least this is the only test this model actually fails. For the period after the breakpoint, the results for the VECM indicate that the Null hypothesis cannot be rejected since the Chi-sq statistics probability value is above 0.05 (5% level of significance) and as such the errors are homoscedastic which is a good result for this model.

5. Conclusions

This research sought to ascertain the relationship between inflation and REITs returns in South Africa. The results indicate that the impact of inflation on REITs has been negative between December 2013 and July 2022. However, using the Johansen cointegration methodology, no long-run relationship could be established between REITs returns and inflation over the said period. The period in question includes the volatile COVID-19 era which arguably has had an impact on financial markets world over. Using the Bai and Perron (1998) sequential breakpoint test, it was established that February 2020 was a breakpoint for the relationship when one breakpoint was sought. This is just about the time most countries instituted restrictive COVIDCovid-19 measures including lockdown and South Africa was not spared. Given the defined breakpoint, Johansen cointegration tests were undertaken before and after the noted breakpoint. Apart from producing relatively good results when diagnostic tests were performed on the VECM, representing the cointegration relationship for these results, the existence of a negative coefficient for error correction term was a welcome result. This confirms the long-run dynamics and ensures that previous deviations from the long-run equilibrium are corrected in the current period. Overall, the results were surprising in that, at most one cointegrating equation was established for both cases, i.e., before the breakpoint and after the breakpoint. At a glance, these results were confusing since no long-run relationship was found for the combined dataset. However, the impact of inflation on REITs was negative before the breakpoint and then became positive after the breakpoint. This represents a shift in the relationship regime between the two variables which is driven by the emergence of ~~COVID~~Covid-19 and with time, it would be interesting to ~~know~~ establish how long this shift would lasts~~s~~ and/or if it resets~~s~~ to pre-breakpoint settings over time. For academics, professionals and other REITs stakeholders, these results challenge their pre-conceived pre-~~COVID~~Covid-19 knowledge of the impact of inflation on this asset class. If these results ~~are~~ were sustained overtime, new knowledge and theories would be required to understand why the new regime exists. Given that South African REITs are dominated by commercial property investment, office and retail, though at the time of writing it might have been too early to say, these results could be speaking to new tenant and consumer behaviours, where working from home and online shopping is now a major shift in behaviour.

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Effects of COVID-19 on the relationship between inflation and REITs returns in South Africa

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Tables and Figures

Table 1: Unit Root Test results

		Real Estate Investment Trusts		Inflation	
		Levels	**1st Difference**	**Levels**	**1st Difference**
Test statistic		-1.097048	-8.924818*	0.263287	-7.555735*
Test critical values	1%	-3.495021	-3.495677	-3.496346	-3.496346
	5%	-2.889753	-2.890037	-2.890327	-2.890327
	10%	-2.581890	-2.582041	-2.582196	-2.582196
The unit root test results with asterisk (*) represents cases where the Null is rejected at the 5% level of significance.					

Table 2: Lag length selection results

Lag	LogL	AIC
0	88.48869	-1.801848
1	515.1281	-10.60684
2	521.1585	-10.64914
3	526.6268	-10.67972*
4	527.9910	-10.62481
5	531.0489	-10.60519
6	533.2206	-10.56710
7	537.3545	-10.56989
8	540.3722	-10.54942
Results with asterisk (*) represents the optimum lag length.		

Table 3: Cointegration results

Unrestricted Cointegration Rank Test for Trace and Maximum Eigenvalue				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.061501	6.763834	15.49471	0.6052
At most 1	0.004156	0.416460	3.841465	0.5187
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.061501	6.347374	14.26460	0.5691
At most 1	0.004156	0.416460	3.841465	0.5187
Trace and Max-eigenvalue test indicates no cointegration at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 4: Unrestricted VAR for the whole sample period

Vector Autoregression Estimates		
Sample (adjusted): 2014M03 2022M07		
Included observations: 101 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
	REIT	Prob
REIT-1)	1.040791 (0.10488) [9.92343]	0.0000
REIT(-2)	-0.007467 (0.15328) [-0.04872]	0.9612
REIT(-3)	-0.098236 (0.10317) [-0.95222]	0.3422
Inflation(-1)	-2.180087 (1.80001) [-1.21115]	0.2274
Inflation(-2)	2.553606 (2.91588) [0.87576]	0.3823
Inflation(-3)	-0.523716 (1.82329) [-0.28724]	0.7742
C	1.219455 (0.52427) [2.32601]	0.0211
Durbin-Watson stat	1.946047	

Table 5: Wald Test results for the joint test of the VAR coefficients in Table 4

Test Statistic	Value	df	Probability
Chi-square	1807.541	6	0.0000
LR is REIT coefficient and LF is Inflation coefficient			

Table 6: Wald Test results for each VAR coefficients in Table 4

Coefficient	Chi-Square Value	Probability
REIT (-1)	98.47439	0.0000
REIT (-2)	0.002373	0.9611
REIT (-3)	0.906716	0.3410
Inflation (-1)	1.466886	0.2258
Inflation (-2)	0.766953	0.3812
Inflation (-3)	0.082505	0.7739

***Table 7**: Unrestricted VAR for the parsimonious model*

Estimation Method: Least Squares				
Sample: 2014M01 2022M07				
	Coefficient	Std. Error	t-Statistic	Prob.
REIT(-1)	0.945467	0.027681	34.15620	0.0000
Inflation(-1)	-0.132128	0.070862	-1.864569	0.0637
C	1.044407	0.485933	2.149284	0.0328
Durbin-Watson stat	1.749836			

Figure 1: REITs and Inflation series throughout the period

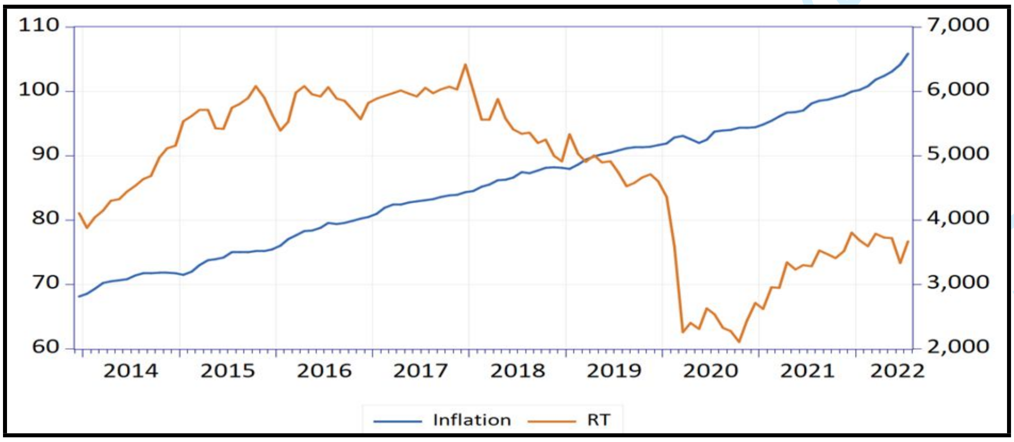

Table 8: Structural Breakpoint Results

Sample: 2013M12 2022M07 Included observations: 104 Breakpoint test options: Trimming 0.15, Max. breakpoints 1, Significant level 0.05			
Sequential F-statistic determined breakpoints: 1			
		Scaled	Critical
Breakpoint Test	F-statistic	F-statistic	Value
0 vs. 1 *	157.5616	315.1232	11.47
* Significant at the 0.05 level. Breakpoint dates:			
	Sequential	Repartition	
1	2020M02	2020M02	

Table 9: Lag length selection results before and after the breakpoint

Lag	Before the structural breakpoint		After the structural Breakpoint	
	LogL	AIC	LogL	AIC
0	141.1885	-4.217833	81.09734	-5.454989
1	410.2628	-12.25039	149.3257	-9.884533
2	413.3511	-12.22276	152.8736	-9.853349
3	419.6479	-12.29236*	162.7859	-10.26109
4	420.3806	-12.19335	167.6228	-10.31881
5	423.5529	-12.16827	171.5770	-10.31565
6	426.0186	-12.12178	175.5865	-10.31631
7	433.5214	-12.22792	180.7212	-10.39457*
8	435.4360	-12.16473	183.8072	-10.33153
Results with asterisk (*) represents the optimum lag length.				

Table 10: Cointegration results before the breakpoint

Unrestricted Cointegration Rank Test for Trace and Maximum Eigenvalue				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.219172	20.04738	15.49471	0.0096
At most 1	0.038240	2.729335	3.841465	0.0985
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.219172	17.31805	14.26460	0.0160
At most 1	0.038240	2.729335	3.841465	0.0985
Trace and Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Normalized cointegrating coefficients (standard error in parentheses)				
LR	LF			
1.000000	4.061754			
	(1.05799)			

Table 11: Cointegration results after the breakpoint

Unrestricted Cointegration Rank Test for Trace and Maximum Eigenvalue				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.638382	32.74624	15.49471	0.0001
At most 1	0.105969	3.248426	3.841465	0.0715
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.638382	29.49781	14.26460	0.0001
At most 1	0.105969	3.248426	3.841465	0.0715
Trace and Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Normalized cointegrating coefficients (standard error in parentheses)				
LR	LF			
1.000000	-5.029221			
	(1.17792)			

Table 12: Residual Serial Correlation LM Test results before the breakpoint

VEC Residual Serial Correlation LM Tests Sample: 2013M12 2020M01						
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	2.081507	4	0.7208	0.520536	(4, 124.0)	0.7208
2	7.142278	4	0.1286	1.822867	(4, 124.0)	0.1286

Table 13: Residual Serial Correlation LM Test results after the breakpoint

VEC Residual Serial Correlation LM Tests Sample: 2020M03 2022M07						
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.35623	4	0.0040	5.089612	(4, 24.0)	0.0041
2	5.170115	4	0.2703	1.378454	(4, 24.0)	0.2710
3	2.506511	4	0.6435	0.632753	(4, 24.0)	0.6440
4	2.810520	4	0.5900	0.713902	(4, 24.0)	0.5906
5	3.285655	4	0.5112	0.842723	(4, 24.0)	0.5119
6	2.764560	4	0.5980	0.701570	(4, 24.0)	0.5985

Table 14: Residual Normality Test results

VEC Residual Normality Tests Orthogonalization: Cholesky (Lutkepohl)		
Joint test:	Jarque-Bera	Prob.
Results before the breakpoint	1.603435	0.8082
Results after the breakpoint	0.694794	0.9520

Table 15: Residual Heteroskedasticity Test results

VEC Residual Heteroskedasticity Tests (Levels and Squares)		
Joint test:	Chi-sq	Prob.
Results before the breakpoint	57.53359	0.0018
Results after the breakpoint	78.71559	0.4560

Effects of COVID-19 on the relationship between inflation and REITs returns in South Africa

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Tables and Figures

Table 1: Unit Root Test results

		Real Estate Investment Trusts		Inflation	
		Levels	**1st Difference**	**Levels**	**1st Difference**
Test statistic		-1.097048	-8.924818*	0.263287	-7.555735*
Test critical values	1%	-3.495021	-3.495677	-3.496346	-3.496346
	5%	-2.889753	-2.890037	-2.890327	-2.890327
	10%	-2.581890	-2.582041	-2.582196	-2.582196
The unit root test results with asterisk (*) represents cases where the Null is rejected at the 5% level of significance.					

Table 2: Lag length selection results

Lag	LogL	AIC
0	88.48869	-1.801848
1	515.1281	-10.60684
2	521.1585	-10.64914
3	526.6268	-10.67972*
4	527.9910	-10.62481
5	531.0489	-10.60519
6	533.2206	-10.56710
7	537.3545	-10.56989
8	540.3722	-10.54942
Results with asterisk (*) represents the optimum lag length.		

Table 3: Cointegration results

Unrestricted Cointegration Rank Test for Trace and Maximum Eigenvalue				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.061501	6.763834	15.49471	0.6052
At most 1	0.004156	0.416460	3.841465	0.5187
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.061501	6.347374	14.26460	0.5691
At most 1	0.004156	0.416460	3.841465	0.5187
Trace and Max-eigenvalue test indicates no cointegration at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Table 4: Unrestricted VAR for the whole sample period

Vector Autoregression Estimates		
Sample (adjusted): 2014M03 2022M07		
Included observations: 101 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
	REIT	Prob
REIT-1)	1.040791 (0.10488) [9.92343]	0.0000
REIT(-2)	-0.007467 (0.15328) [-0.04872]	0.9612
REIT(-3)	-0.098236 (0.10317) [-0.95222]	0.3422
Inflation(-1)	-2.180087 (1.80001) [-1.21115]	0.2274
Inflation(-2)	2.553606 (2.91588) [0.87576]	0.3823
Inflation(-3)	-0.523716 (1.82329) [-0.28724]	0.7742
C	1.219455 (0.52427) [2.32601]	0.0211
Durbin-Watson stat	1.946047	

Table 5: Wald Test results for the joint test of the VAR coefficients in Table 4

Test Statistic	Value	df	Probability
Chi-square	1807.541	6	0.0000
LR is REIT coefficient and LF is Inflation coefficient			

Table 6: Wald Test results for each VAR coefficients in Table 4

Coefficient	Chi-Square Value	Probability
REIT (-1)	98.47439	0.0000
REIT (-2)	0.002373	0.9611
REIT (-3)	0.906716	0.3410
Inflation (-1)	1.466886	0.2258
Inflation (-2)	0.766953	0.3812
Inflation (-3)	0.082505	0.7739

***Table 7**: Unrestricted VAR for the parsimonious model*

Estimation Method: Least Squares				
Sample: 2014M01 2022M07				
	Coefficient	Std. Error	t-Statistic	Prob.
REIT(-1)	0.945467	0.027681	34.15620	0.0000
Inflation(-1)	-0.132128	0.070862	-1.864569	0.0637
C	1.044407	0.485933	2.149284	0.0328
Durbin-Watson stat	1.749836			

Table 8: Structural Breakpoint Results

Sample: 2013M12 2022M07 Included observations: 104 Breakpoint test options: Trimming 0.15, Max. breakpoints 1, Significant level 0.05			
Sequential breakpoints:	F-statistic	determined	1
		Scaled	Critical
Breakpoint Test	F-statistic	F-statistic	Value
0 vs. 1 *	157.5616	315.1232	11.47
* Significant at the 0.05 level. Breakpoint dates:			
	Sequential	Repartition	
1	2020M02	2020M02	

Table 9: Lag length selection results before and after the breakpoint

Lag	Before the structural breakpoint		After the structural Breakpoint	
	LogL	AIC	LogL	AIC
0	141.1885	-4.217833	81.09734	-5.454989
1	410.2628	-12.25039	149.3257	-9.884533
2	413.3511	-12.22276	152.8736	-9.853349
3	419.6479	-12.29236*	162.7859	-10.26109
4	420.3806	-12.19335	167.6228	-10.31881
5	423.5529	-12.16827	171.5770	-10.31565
6	426.0186	-12.12178	175.5865	-10.31631
7	433.5214	-12.22792	180.7212	-10.39457*
8	435.4360	-12.16473	183.8072	-10.33153
Results with asterisk (*) represents the optimum lag length.				

Table 10: Cointegration results before the breakpoint

Unrestricted Cointegration Rank Test for Trace and Maximum Eigenvalue

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.219172	20.04738	15.49471	0.0096
At most 1	0.038240	2.729335	3.841465	0.0985

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.219172	17.31805	14.26460	0.0160
At most 1	0.038240	2.729335	3.841465	0.0985

Trace and Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Normalized cointegrating coefficients (standard error in parentheses)	
LR	LF
1.000000	4.061754
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