Inflation Hedging With South African Stocks: A JSE Sectoral Analysis.

Dennis Kawawa and Jamela Hoveni

Abstract
Inflation risk erodes purchasing power, redistributes wealth from lenders to borrowers and threatens investor's long term objectives which are often specified in real terms; financial market volatility presents an additional risk for investors and portfolio managers concerned with not only real returns but also absolute returns. Understanding key investment risks, of which inflation is one, is crucial for investment managers in order to design effective hedging strategies to preserve wealth over the long run. Empirical tests of the Fisher hypothesis in South Africa have shown that stocks are a good hedge against inflation. However, empirical evidence from developed countries have also shown that the relationship between stocks and inflation is heterogeneous across the sectors and industries. This paper analyses the sectoral differences in the hedging ability South African stocks to test for this heterogeneity. Johannsen Cointegration techniques will be employed to update empirical tests of the Fisher hypothesis for the South Africa market. The paper presents disaggregated sector models to test heterogeneity across the nine sectors of the JSE securities exchange. Understanding which of these sectors offers the best hedge against inflation is important to investors, allowing them to place money where the value will be best preserved during times of higher inflation.
Key words: Inflation and stock prices; fisher hypothesis; hedging; portfolio management.

1. INTRODUCTION

Inflation is defined as the persistent rise in the average of all prices (Arnold and Auer, 2015). "Inflation risk erodes purchasing power, redistributes wealth from lenders to borrowers and threatens investors long term objectives which are often specified in real terms", for these reasons it has been argued that there are few issues in finance as important as the impact of inflation on financial markets and the associated implications for investment policies (Ang *et al.,* 2012; Arnold and Auer, 2015). Due to this perceived importance to financial markets, the effects of inflation on various financial assets have been widely studied. One of the key areas of focus has been the relationship between inflation and stocks, specifically the ability of stocks to hedge against inflation (Luintel and Paudyal, 2006; Chinzara, 2011; Arnold and Auer, 2015; Tiwari *et al*., 2015).

While there are several ways in which stocks can hedge inflation, the most basic approach focuses on the correlation between stock returns and inflation. Thus "an asset is an inflation hedge if its real return is independent of the rate of inflation, implying a positive correlation between the nominal return of the asset and inflation" (Arnold and Auer, 2015). This approach aims to test the *fisher hypothesis* through tests of significance of the slope coefficient which captures the relationship between stock returns and inflation. The *fisher hypothesis* as a theoretical framework is used in studies such as for example (Fama, 1981; Gultekin, 1983; Lothian and Simaan, 1998; Anari and Kolari, 2001; Tiwari *et al*., 2015).

Similar to studies that test the fisher hypothesis globally the results of South African studies have also been mixed with some studies documenting a positive relationship (Arjoon *et. al*., 2011; Eita, 2012, Marx and Struweg, 2015) while others document a negative relationship (Khumalos, 2013, Tripathi and Kumar, 2014).

The fisher model provides a macro model of testing whether the stock market as an index broadly provides a good hedge against inflation. The assumption underlying such an approach is that the effects of inflation across the different stock market sectors and industries are homogeneous. These macro level studies account for the majority of the research in this area. Recent stock market studies have highlighted heterogeneous effects. Ang *et al*., (2012) suggest

that the effect of inflation on stock prices is likely to be heterogeneous across various industries and that although the overall stock market may be a poor hedge for inflation, certain sectors have characteristics that make them a better hedge than others. Boudoukh *et al.* (1994) analyse the cross-sectional relation between industry-sorted stock returns and expected inflation and found that non-cyclical industries tend to have a positive relationship with inflation whereas the opposite was true for cyclical industries.

Thus this paper hopes to fill in the empirical gap in the South African literature by analysing the sectoral differences in the hedging ability of stocks in South Africa. The study proceeds with an updated empirical test of the fisher hypothesis in South Africa for a sample of data up to 2016. This analysis will be replicated 9 times to cover each of the sectors of the JSE. The paper is arranged as follows: Section 2 reviews the literature, sections 3 presents the methodology employed in this study, section 4 provides information on the data used in the study, Section 5 presents the results, and Section 6 concludes.

Of key interest is the identification of which sectors of the Johannesburg Stock exchange are the best hedges against inflation in South Africa. This has implications for portfolio management strategies in a world of macro-economic volatility and uncertainty.

2. LITERATURE REVIEW

According to Ibrahim and Agbaje (2013), original studies analysing the relationship between inflation and stock returns focused on the Fisher hypothesis. Given that the empirical evidence at the time was suggestive of a positive relationship, the conclusion was therefore that stocks are a hedge against inflation .These simple tests of the Fisher hypothesis supported the one to one positive relationship between stock returns and inflation (Nelson, 1976). Using the Fisher hypothesis, these studies suggested that investors in the stock market are fully compensated for upward movements in the general price level through corresponding increases in the nominal stock market returns and thus the real returns remain independent and unaffected (Tiwari *et al.*, 2015).

The Fisher hypothesis was first used to explain the relationship between interest rates and inflation[1]. This hypothesis was then generalized to all assets in efficient markets, including stocks. (Arnold and Auer, 2015)

The Fisher hypothesis relating to stocks can be specified as:

$$\delta_t^R = \alpha_0 + \alpha_2 \pi_t + e_t$$

Where δ_t^R is the nominal stock returns, π is the actual inflation which is the combination of the unexpected and expected inflation, while e, is the error term. The sign of α_2 determines if the specification is in line with the Fisher hypothesis. Thus, a significant and positive sign for α_2 suggests that stock returns hedge inflation, while a negative sign suggests the contrary (Ibrahim and Agbaje, 2013).

There have been a number of empirical studies testing the Fisher hypothesis in US and European markets as well as some developing nations. The results of these studies have been mixed, with some studies reporting a positive relationship (Luintel and Paudyal, 2006; Solnik and Solnik, 1997; Lothian and Simaan,1998), while other studies report a negative relationship, thus rejecting the Fisher hypothesis (Fama, 1981; Gultekin, 1983; Marx and Struweg, 2015; Tiwari *et al.*, 2015).

[1] The hypothesis asserts that the nominal interest rate consists of a real rate plus the expected inflation rate (Tiwari et al., 2015). Fisher believed that the real and monetary sectors of the economy are for the most part unrelated, he hypothesized that the expected real rate of interest is determined by real factors such as the productivity of capital and is independent of the expected inflation rate (Tiwari et al., 2015)

To explain the negative relationship between stock prices and inflation, the proxy hypothesis, tax-effect hypothesis and inflation hypothesis were developed. The proxy hypothesis developed by Fama (1981) enjoys the most prominence. Fama (1981) hypothesised that the relationship between stocks and inflation was induced by the negative relationship between inflation and other real economic activity, which are in turn explained by a combination of money demand theory and the quantity theory of money. The inflation hypothesis was proposed by Geske and Roll (1983), who incorporated the fiscal and monetary linkages in explaining the relationship between stock return and inflation. The hypothesis explained that in economic conditions that reduce stock prices (such as a recession) government expenditure will increase to boost the economy and result in higher inflation. Thus in times when stocks are low inflation will be high and a negative relationship will be observed (Ibrahim and Agbaje, 2013). The tax-effect hypothesis was introduced by Feldstein (1980) who observed for the US economy that due to the valuation of depreciation and inventories, inflation generates artificial capital gains that are taxed. This additional tax burden reduces the return on the stocks. Empirical research testing these hypotheses have yielded mixed results, with some hypotheses being more acceptable than others (Aperigis and Eleftheriou, 2002; Engsted and Tanggaard, 2002; Ibrahim and Agbaje, 2013).

Although the aforementioned hypothesises provided plausible theoretical explanations of the observed negative relationship, more recent papers argue that the negative relationship found in early studies can be ascribed to spurious results as a result of the use of inappropriate econometric approaches (Arnold and Auer, 2015). They point to the use of small sample to test the fisher hypothesis, which by its nature describes a long-run relationship between assets and inflation. Thus an obvious way to overcome these empirical short comings would be to use a longer time series to test the long run relationship between inflation and stock returns.

Boudoukh and Richardson (1993) used a much longer time series, collecting almost 200 years of data[2] for the US and the UK, and found that long-term nominal stock returns are positively related to forecasted and actual long-term inflation. Solnik and Solnik (1997) and Lothian and Simaan (1998) using a longer data set for a panel of eight and 23 advanced economies, find that the Fisher hypothesis holds at a 1-year holding period horizon. However, even for horizons of less than 12 months the Fisher model could not be rejected. Lothian and Simaan (1998) find that average stock returns co-move with inflation in the long run in almost all 23 OECD countries examined. The two variables were also found to be positively correlated across countries. Lothian and McCarthy (2001) tested both the short run and long run relationship between stocks and inflation and found that for the US and UK. They found that stock returns and inflation had a positive relationship in the long run, and a negative relationship in the short run.

Engsted and Tanggaard (2002) assessed the hedging properties of US and Danish stocks, using expected returns and inflation in a VAR model, found that Danish stock returns co-move with expected inflation in the long run but not at short horizons. For US stocks, however, the relationship between expected returns and inflation is quite weak at all horizons. Thus the impact of the investment horizon on stock returns varies. Schotman and Schweitzer (2000) are the first to formally test the sensitivity of the hedging property of stocks to time. They showed that stocks provide a hedge against inflation if the investor's investment horizon is 15 years or longer. Anari and Kolari (2001) tested the long-run Fisher effect for six major economies[3] and found evidence supporting the Fisher hypothesis. Furthermore, the impulse response analysis showed that although initially the response of stock prices to a shock in inflation is negative, the response turns positive over long horizons. The results of this study helped to reconcile previous short-run and long-run evidence concluding that stocks were a

[2] from 1802 to 1990

[3] the US, Canada, the UK, France, Germany and Japan

good inflation hedge over a long holding period. In addition to testing the long run dynamics, studies have also incorporated the use of more advanced techniques such as cointegration as a way to deal with spurious regressions.

Among the first authors to apply cointegration and ECM in an inflation hedging context are Cochran and Defina (1993). Cochran and Defina (1993)[4] found that for both expected and unexpected components, real stock returns are not independent of inflation. Hence, US stocks do not provide a long-term hedge. Using a vector error correction model (VECM) with quarterly data[5] Ely and Robinson (1997), found that stocks maintain their real value relative to goods prices and this conclusion generally does not depend on the source of the inflation shock (real or monetary sector).

Luintel and Paudyal (2006) were the first to test the heterogeneity across industries using a cointegration framework. The results of this study found, using both aggregated and disaggregated industry level UK stocks data, that in the long run UK stock are a hedge for inflation. They highlighted that the consumer goods industry provided the best hedge while the mineral extraction sector compensated investors the least for inflation. The finding that the resources sector provides the least protection against inflation was also supported by the findings of Sadorsky (2001), whose research concluded that natural resources stocks are not good inflation hedgers contrary to intuition.

Further to this, research by Ahmed and Cardinale (2005) analysing stocks in different inflation regimes[6] in the US, the UK, Germany and Japan found mixed results but concluded that stocks tend to be a partial inflation hedge. Their results also supported the hypothesis that stocks appear to react asymmetrically to the level of inflation. With the exception of Japan they found that in the short run (one year), stock returns have been significantly higher in times of 'normal' inflation (up to 3% percent) but lower in case of deflation or very high inflation. Their conclusion was that stocks do not offer protection when it is most needed.

Kim and Ryoo (2011) also found similar results to Ahmed and Cardinale (2005) finding that stock returns and inflation show asymmetric adjustments to the long-run equilibrium depending on the period (high vs. low inflation regime). Within a sample period of more than 200 years, US common stocks have been a hedge against inflation since the early 1980s.

The pioneer study on inflation hedging by stocks in South African is Bethlehem (1972). Bethlehem (1972) examined the returns by randomly selecting a sample of 20 industrial shares quoted on the JSE during the period January 1951 to January 1971. The results showed that South African equities were a very good hedge against inflation during the two decades, although inflation was low during that time. Roome (1986) also supported the findings of Bethlehem (1972) that equities in South Africa were hedges against inflation. Similarly, a long run study by Firer and Mcleod (1999) examining the performance of equities, cash and inflation from 1925 to 1998 showed that equities are a hedge against inflation in South Africa. Contrary to the previous studies, Jorion and Goetzmann's (1999)[7] study found evidence of a negative relationship between inflation and stock market returns (Eita, 2012). One should point out that these earlier studies used simple hypothesis tests and that more recently; studies have adopted more sophisticated empirical techniques.

Geyser and lowies (2001) study examined the relationship of individual stocks on the South African and Namibian stock exchange, and inflation indexes of the respective countries. The study picked the top 10[8] stocks from the respective stock exchanges and using regression analysis examined if there was a negative correlation between inflation and share prices. While the results of Geyser and Lowies (2001) were mixed, the conclusion is that neither of the two

[4] used US data from 1947 to 1989

[5] from 1957 to 1992 for 16 industrialised countries

[6] from 1919 to 2002

[7] (for the period January 1947 to December 1996)

[8] (in 2000)

selected countries offered a perfect hedge against inflation. The results of their study also highlighted that that companies in the mining sector exhibited a negative correlation with inflation while companies in other sectors such as financial services, information technology and food and beverage sectors exhibited a slight positive correlation.

Arjoon *et al. (2012)* studied the long run relationship between inflation and real stock prices in South Africa using a structural bivariate vector autoregressive (VAR) methodology with quarterly data from 1980 to 2010. Their study found considerable evidence that in the long run real stock prices do not react to permanent changes in inflation which led them to conclude that, at least in the long run, investment in stocks could provide a hedge against inflation.

In order to test the causal relationship between stocks and inflation, Eita (2012) studied the relationship between stock market returns and inflation in South Africa using quarterly data from 1980 to 2008 using the all-share index (ALSI) and gold index (GOLD) as proxies for stock market returns on the JSE. The study found the relationship was positive and the causality is unidirectional from inflation to stock market returns when the gold was used as the proxy. In this case, where the gold index was used, the past and present values of inflation could help predict stock market returns. However, when the all-share index was used as a proxy for stock market returns, it was found that the causality was bi-directional which suggests that the two variables jointly cause each other. This implied that past and present value of inflation could be used to predict stock market returns. Similarly, past and present values of stock market returns can be used to predict inflation and that for the period 1980 to 2008 stocks in south were a hedge against inflation.

Khumalo's (2013) study used an Auto-Regressive Distributed lag model (ARDL) to examine the interactions between inflation and stock prices over the long run using data covering the period 1980 to 2010. They found that there is a strong negative relationship between stocks and inflation. The results of this study imply that stock prices generally decline during the inflationary phase (Khumalo, 2013). Tripathi and Kumar (2014) studied the relationship of inflation and stocks for the BRICS markets using quarterly data from 2000Q1 to 2013Q4, there results found that only Brazilian stocks had a positive relationship with domestic inflation. For South Africa, a significant negative relationship was found while their study also found unidirectional causality from stock returns to changes in inflation.

Marx and Struweg (2015) examined if the relationship between inflation, growth, interest rates and stock market returns are affected by periods of stagflation. Marx and Struweg (2015) found that overall stock markets were a hedge against inflation but during stagflation the strength of the relationship declined. Their results also found that "The market becomes cheaper as inflation rises and more expensive as inflation falls, suggesting that investors do not believe that the market is, in fact, a good inflation hedge".

3. METHODOLOGY

To achieve the objectives of the study cointegration testing will be used. One issue that has been noted in the past was that "stock returns and inflation rates exhibit special time-series properties. Inflation is a slow-moving and persistent process, with much lower variance than stock returns. This negatively influences correlation tests between the two variables because non-stationary variables introduce the problem of spurious regression, which is the detection of significant relationships even though none exist" (Arnold and Auer, 2015).

To avoid this problem, studies search for cointegration between inflation and stock returns. If the two variables are found to be non-stationary but cointegrated, the equation $\delta_t^R = \alpha_0 + \alpha_2\pi_t + e_t$ can be interpreted as a cointegrating regression, reflecting an equilibrium relationship between stock returns and inflation. Therefore, finding cointegration combined

with a slope parameter not significantly different from one is supportive of a long-run Fisher relationship. (Arnold and Auer, 2015).

Johansen (1988) cointegration procedure will be used to test for cointegration. The test for cointegration will initially be conducted on the JSE all-share index return and inflation to determine if stocks in general are a good hedge for inflation in South Africa. The test will then be conducted on the returns of each of the nine sectors of the JSE and inflation.

Below are the specific methodological steps that will be used to test for cointegration:

1. Test if variables are stationary and integrated at the same level

The inflation variable and all share index return will be tested for stationarity, using the augmented Dickey-Fuller Test and KPSS. If both variables are found to be non-stationary in level terms but integrated at the same level, the next step will be to conduct the test for cointegration. To insure the robustness of the test we also employ the KPSS test. (Luintel and Paudyal, 2006)

2. Test for Cointegration

Using the inflation and the stock price indexes a 2 variable VAR models will be run. As the Johansen cointegration test is sensitive to the lags, the VAR will be used to find the appropriate optimal lag lengths using the Akaike (AIC) and Schwarz-Bayesian (SIC) information criterion.

The general VAR model with *k* lags is specified as:

$$\Delta X_t = \prod X_{t-1} + \sum_{t=1}^{k} BiX_{t-i} + pz_t + E_{kt}$$

Where:

$X_t = [S_t, \pi_t]$ is a 2×1 vector

$\Pi = ab$

After establishing the appropriate lags, the number of cointegrated vectors is determined by rank of the $\prod$ matrix. To determine the rank, the Johansen trace statistics and the maximum Eigen values are used. (Luintel and Paudyal, 2006)

Johansen trace statistics is given as,

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \lambda_i)$$

where r is the number of cointegrating vectors under the null hypothesis. The trace stats tests the null hypothesis that the number of cointegrating vectors is less than or equal to r, against the alternative hypotheses that they are more than r cointegrating vectors.

The maximum Eigen values is given as:

$$\lambda_{max}(r, r+1) = -Tln(1 - \lambda_{r+1})$$

The maximum Eigen value test, tests the null hypothesis that the number of cointegrating vectors is equal to r against the alternative hypothesis that the number of cointegrating vectors is r + 1.

If Cointegration can't be found then no long run relationship exists between stocks and inflation thus the Fisher hypothesis will be rejected. If cointegration is found, this implies an equilibrium relationship between stock returns and inflation and a cointegration regression can be estimated to determine if the relationship is positive or negative (Luintel and Paudyal, 2006).

3. Long-run estimation (cointegration regression)

We then estimate the following long-run equation by normalizing by the stock returns with variables in log form:

$$\delta_t = \alpha_0 + (d)\pi_t + e_t$$

δ_t^R represents JSE all-share index return

π_t represents inflation rate

If the variables are in log terms, the coefficient d in this equation is the elasticity of stock prices with respect to inflation, otherwise known as the Fisher coefficient. As stated above finding a positive value for d not significantly different to one can be considered confirmation of the fisher hypothesis and thus it can be concluded that stocks are a hedge for inflation. (Luintel and Paudyal, 2006)

The above steps will be repeated 9 times substituting the JSE all-share index return for each of the 8 sectoral indexes[9]. To compare the hedging ability of the sectors, the coefficient d of each model run in step 3 will be compared. The greater the value for d the greater the elasticity of the stock returns is to changes to inflation and thus theoretically the better hedge of inflation.

4. DATA

The data used in this analysis is from Thomson Reuters DataStream, The Data consists of monthly stock prices from Feb 2001 to Dec 2016, this period is chosen as this period begins a year after inflation targeting had been adopted in South Africa (Woglom, 2003), as to minimise the effects of structural breaks that have been noted to effect cointegration test (Luintel and Paudyal, 2006). To capture the stock returns of stocks at an aggregated level the JSE all-share index return is used. For the various disaggregated industries, we use the respective JSE index. The Indies include JSE/FTSE Basic Materials price index, JSE/FTSE Industrials price index, JSE/FTSE Consumer Goods price index, JSE/FTSE Health Care price index, JSE/FTSE Consumer Services price index, JSE/FTSE Telecommunications price index, JSE/FTSE Financials price index, and JSE/FTSE Technology price index .We use the monthly South African Consumer price index (December 2016=100) as the proxy for Inflation.

Bellow we provide the descriptive data of the monthly (unannualised) inflation rate and index returns of the indices to be used in the analysis. The data shows that the average monthly inflation was 0.4% whereas the average monthly return for the JSE all-share index was 1.2% during the period. The average monthly rates range from 0.737% (Industrial Index) to 1.798% (consumer services). Although the table displays return data our analysis will use the logs of the Index values in level terms as significant information could be lost from using

[9] The 8 sectors that make up the JSE are Basic Materials, Industrials, Consumer Goods, Health Care, Consumer Services, Telecommunications, Financials, and Technology

data in their first differences and using log values allow us to interpret results as the elasticity (Alagidede and Panagiotidids, 2012)

Table 1 Descriptive Data

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis
Inflation Rate	0.466	0.406	1.878	-0.826	0.460	0.557	3.440
All Share Index	1.034	1.115	14.033	-13.956	4.816	-0.142	3.509
Basic Materials Index	0.930	0.602	18.215	-22.573	6.891	-0.224	3.539
Consumer Goods Index	1.401	1.640	19.665	-21.752	6.128	-0.412	4.532
Consumer Services Index	1.798	2.180	13.930	-16.392	5.492	-0.189	2.807
Financial Index	0.875	1.026	13.038	-14.467	4.737	-0.203	3.445
Health Care Index	1.047	1.573	15.671	-89.139	8.449	-6.452	69.542
Industrials Index	1.116	0.808	13.158	-15.711	5.001	-0.352	3.564
Technology Index	0.737	1.173	35.000	-41.761	9.179	-0.602	6.600
Telecommunications Index	1.226	0.774	20.749	-18.912	7.326	0.119	3.214

5. FINDINGS

Test for stationary. Table 2 summarises the results for the ADF and KPSS stationarity tests

Table 2 Stationarity Results

	ADF		KPSS	
	T-Stat		LM-Stat	
Variable	**level**	**First Difference**	**Level**	**First Difference**
CPI	-0.146842 (-0.9414)	-9.675191*** (0.000)	1.697216	0.069046***
All share Index	-1.000618 (-0.7529)	-14.36833*** (0.000)	1.573636	0.09501***
Basic Materials Index	-2.815345* (-0.058)	-8.404492*** (0.000)	1.084751	0.338916***
Consumer Services Index	-0.354144 (-0.913)	-13.47457*** (0.000)	1.631287	0.069053***
Consumer Goods index	0.008645 (0.9574)	-6.364647*** (0.000)	1.622772	0.141623***
Health care Index	-1.696919 (-0.4312)	-13.80127*** (0.000)	0.803147	0.269495***
Financials Index	-0.462845 (-0.8943)	-13.38632*** (0.000)	1.482679	0.089653***
Industrials Index	-1.098252 (-0.7164)	-12.98946*** (0.000)	1.517967	0.131814***
Technology Index	-0.326889 (-0.9172)	-12.14319*** (0.000)	1.385813	0.53119**

Telecommunications Index	-1.318785 (-0.6207)	-13.65592*** (0.000)	1.437597	0.293239***

***, **, * Unit root 1%, 5% respectively for ADF

***, **, * stationary at 1%, 5% respectively for KPSS

We find that both the ADF and KPSS results are consistent, all variables are non-stationary at level terms but stationary at first difference at the 5% significance level. From these results we conclude that the Consumer price index and the 9 stock indices are integrated at the same level, I(1), Thus the test for cointegration can be conducted .

Cointegration test

Having confirmed the integration level of the variables the time series, 2 variable VAR models were constructed each consisting of the CPI index and each of the sectorial indexes to test for the optimal lag order to be used in the cointegration test. The lag lengths chosen by the AIC and SIC are displayed in the table below. The AIC and SIC provided differing results in some cases, where the results differed we opted to use the SIC as it fit closer with the assumption that any interaction of inflation and stocks would occur quickly. (Luintel and Paudyal, 2006)

Table 3. Lag selection

	Selection criteria	
Index	**AIC**	**SC**
All share Index	2	1
Basic Materials Index	3	1
Consumer Services Index	2	2
Consumer Goods index	7	2
Health care Index	2	2
Financials Index	3	2
Industrials Index	2	2
Oil and Gas Index	2	1
Technology Index	9	2
Telecommunications Index	2	2

Table 4 shows results of the Johansen trace test. We test the Null hypothesis that there is no cointegrating relationship and if the hypothesis is rejected we test if there is at most one cointegrating vector. Each model consists of two variables so we test if there is zero one or two cointegrating vectors. The results suggest that there is at least one cointegrating vector between each pair of variables, and two cointegrating vectors between the Technology index and CPI suggesting a strong relationship between these two variables.

Table 4 Cointegration Test Johansen races Eigen value Test

	H0:Rank<	
Index	0	1
All share Index	63.5372 (0.0000)	3.246055 (0.5357)
Basic Materials Index	38.71376 (0.0001)	7.204487 (0.116)
Consumer goods Index	49.31872 (0.000)	5.527363 (0.2305)

	H0:Rank<	
Index	0	1
Consumer services Index	52.1547 (0.000)	4.744538 (0.3126)
Financial Index	49.98488 (0.0000)	3.586762 (0.4771)
Health care Index	34.69853 (0.0003)	3.357358 (0.5161)
Industrials Index	46.53048 (0.0000)	2.920059 (0.5957)
Technology Index	58.57209 (0.0000)	23.66856 (0.0001)
Telecommunications Index	41.30631 (0.0000)	2.242317 (0.7291)

Table 5 Shows maximum Eigen value test the results for the maximum stat shows consistent results the trace stat test with all pairs of models indicating at least one cointegrating vector with the exception of Technology that shows at most two cointegrating vectors.

Table 5 Cointegration Test Johansen Maximum Eigen value Test

	H0:rank =	
	0	1
All share index	60.29115 (0.0000)	3.246055 (0.5357)
Basic materials Index	31.50927 (0.0001)	7.204487 (0.116)
Consumer Goods Index	43.79135 (0.0000)	5.527363 (0.2305)
Consumer Services Index	47.41016 (0.0000)	47.41016 (0.3126)
Financial Index	46.39812 (-0.0295)	3.586762 (-0.4395)
Health Care Index	31.34117 (0.0001)	3.357358 (0.5161)
Industrials Index	43.61042 (0.0000)	2.920059 (0.5957)
Technology Index	34.90353 (0.0000)	23.66856 (0.0001)
Telecommunications Index	39.06399 (0.0000)	2.242317 (0.7291)

Having found evidence of cointegration between CPI and each stock index we estimate the cointegrating relationship. The results are shown in table 6.

The results of the cointegration estimation show that in the period of February 2001 to December 2016 all variables are found to have a positive and significant relationship with CPI. The all share index (ASI) is found to have a positive relationship with a 1% change in inflation resulting in 2.20% change in the all share index. These results are similar to results found by Alagidede and Panagiotdis (2010) who found that a 1% change in inflation results in a 2.264% change in the All share index and are also consistent with the tax augmented fisher

hypothesis, which postulates that the percentage change is expected to be greater than 1 to compensate returns lost to tax.

The Consumer service index and the Consumer goods have the greatest overall reaction to a change in inflation, with a 1% change in inflation resulting in a 3.78% and 3.24% change in the index returns respectively. The Basic Materials service index has the smallest overall reaction to changes in inflation, with a 1% change in inflation resulting in a 1.13 % in returns. These results are consistent with Luintel and Paudyal (2006) study that found that for the UK the consumer goods sector stocks was the best hedge for inflation while basic material was the only index to actually have no long run relationship with inflation.

This evidence suggest that in times of high inflation investors are most compensated for changes in inflation in stocks relating to the consumer services and consumer Goods sectors, but that in general all sector provide some hedge for inflation.

Table 6. Cointegration Estimation Results

	Variable	Coefficient	Std. Error	t-Statistic	Prob.
All Share Index	CPI	2.204448	0.122239	18.03395	0.0000
	C	0.855929	0.510217	1.677576	0.0951
Basic Materials Index	CPI	1.130834	0.184636	6.124679	0.0000
	C	5.145571	0.770658	6.676854	0.0000
Consumer Goods Index	CPI	3.247485	0.139217	23.32682	0.0000
	C	-3.70217	0.581083	-6.37115	0.0000
Consumer services Index	CPI	3.778687	0.152325	24.8067	0.0000
	C	-7.55153	0.635797	-11.8773	0.0000
Financials Index	CPI	1.856759	0.132454	14.01818	0.0000
	C	2.121799	0.552853	3.837905	0.0002
Health Care Index	CPI	1.651645	0.393209	4.200431	0.0000
	C	2.834879	1.641229	1.72729	0.0858
Industrials Index	CPI	2.269747	0.15456	14.68524	0.0000
	C	0.504995	0.645123	0.782788	0.4347
Technology Index	CPI	2.612534	0.228495	11.43364	0.0000
	C	-1.14216	0.953726	-1.19757	0.2326
Telecommunications	CPI	2.889326	0.240118	12.03296	0.0000
	C	-3.75652	1.002237	-3.74813	0.0002

6. Conclusion

The relationship of stocks and inflation in south Africa has been widely studied with no consensus being made on whether the relationship is positive or negative thus no conclusion has been made on if stocks provide a hedge for inflation in south Africa or not. Evidence has shown that although the overall stock market may not be a good hedge for inflation the relationship might be heterogeneous across industry stocks. (Ang *et al*., 2012)

In this this study We examine the fisher hypothesis asserting whether overall stocks provide a hedge against inflation in South Africa, and add to the literature by examining whether the hedging ability is heterogeneous across industries of the JSE. Using Sector indexes and the CPI data for the period 2001 to 2016 we find that all the pairs of stock indexes and CPI are cointegrated thus implying a long run relationship between them. From estimation of a cointegration regression we find that all stock indexes have a positive relationship with inflation implying the would be able to hedge inflation. We find that indexes relating to consumer indexes provide the best hedge against inflation with the consumer service index having the greatest CPI Coefficient of 3.778687 followed by the consumer good index with 3.247485. Overall we conclude that all sectors of the JSE provide a hedge for inflation.

References

AHMED, S., & CARDINALE, M. (2005). Does inflation matter for equity returns?. *Journal of Asset Management*, *6*(4), 259-273.

ALAGIDEDE, P. (2009). Relationship between stock returns and inflation. Applied Economics Letters, 16(14): 1403-1408.

ALAGIDEDE, P., & PANAGIOTIDIS, T. (2010). Can common stocks provide a hedge against inflation? Evidence from African countries. Review of financial economics, 19(3): 91-100.

ANG, A., BRIÈRE, M., & SIGNORI, O. (2012). Inflation and individual equities (No. w17798). National Bureau of Economic Research.

ANARI, A., & KOLARI, J. (2001). Stock prices and inflation. Journal of Financial Research, 24(4): 587-602

AMENC, N., MARTELLINI, L., & ZIEMANN, V. (2009). Inflation-hedging properties of real assets and implications for asset–liability management decisions. The Journal of Portfolio Management, 35(4): 94-110.

APERGIS, N., & ELEFTHERIOU, S. (2002). Interest rates, inflation, and stock prices: the case of the Athens Stock Exchange. Journal of Policy Modeling, 24(3): 231-236.

ARJOON, R., BOTES, M., CHESANG, L. K., & GUPTA, R. (2012). The long-run relationship between inflation and real stock prices: empirical evidence from South Africa. *Journal of Business Economics and Management*, *13*(4), 600-613.

ARNOLD, S., & AUER, B. R. (2015). What do scientists know about inflation hedging?. The North American Journal of Economics and Finance, 34: 187-214.

BETHLEHEM, G. (1972). An Investigation of the Return on Ordinary Share Quoted on the Johannesburg Stock Exchange with Reference to Hedging against Inflation. *South African Journal of Economics*, *40*(3), 176-185.

BODIE, Z. (1976). Common stocks as a hedge against inflation. The Journal of Finance, 31(2): 459-470.

BOUDOUKH, J., & RICHARDSON, M. (1993). Stock returns and inflation: A long-horizon perspective. The American economic review, 83(5): 1346-1355.

BOUDOUKH, J., RICHARDSON, M., & WHITELAW, R. F. (1994). Industry returns and the Fisher effect. the Journal of Finance, 49(5): 1595-1615.

CHINZARA, Z. (2011). Macroeconomic uncertainty and conditional stock market volatility in South Africa. South African Journal of Economics, 79(1): 27-49.

COCHRAN, S. J., & DEFINA, R. H. (1993). Inflation's negative effects on real stock prices: new evidence and a test of the proxy effect hypothesis. *Applied Economics*, *25*(2), 263-274.

EITA, J. H. (2012). Inflation and stock market returns in South Africa. The International Business & Economics Research Journal (Online), 11(6): 677.

ELY, D. P., & ROBINSON, K. J. (1997). Are stocks a hedge against inflation? International evidence using a long-run approach. *Journal of International Money and Finance*, *16*(1), 141-167.

ENGSTED, T., & TANGGAARD, C. (2002). The relation between asset returns and inflation at short and long horizons. Journal of International Financial Markets, Institutions and Money, 12(2): 101-118.

FAMA, EF. (1981). Stock Returns, Real Activity, Inflation, and Money. The American Economic Review, 71(4): 545-565.

FAMA, E. F., & SCHWERT, G. W. (1977). Asset returns and inflation. Journal of financial economics, 5(2): 115-146.

FELDSTEIN, M. (1980). Inflation, tax rules, and investment: some econometric evidence. The American Economic Review, 70: 839–847.

FIRER, C., & MCLEOD, H. (1999). Equities, bonds, cash and inflation: Historical performance in South Africa 1925 to 1998. *Investment Analysts Journal*, *28*(50), 7-28.

GAVRIILIDIS, K., & KGARI, L. M. (2016). Stock Returns and Inflation: The Case of Botswana. Handbook of Frontier Markets: The African, European and Asian Evidence, 27.

GESKE, R., & ROLL, R. (1983). The fiscal and monetary linkage between stock returns and inflation. The Journal of Finance, 38(1): 1-33.

GEYSER, J. M., & LOWIES, G. A. (2001). The impact of inflation and stock prices in two SADC countries. *Meditari: Research Journal of the School of Accounting Sciences*, *9*(1), 109-122.

GULTEKIN, N. B. (1983). Stock market returns and inflation: evidence from other countries. The Journal of Finance, 38(1): 49-65.

IBRAHIM, TM., & AGBAJE, OM. (2013). The relationship between stock return and inflation in Nigeria. European scientific journal, 9(4): 146-157

JOHANSEN, S., (1988). Statistical analysis of Co-integration vectors. Journal ofEconomic Dynamics and Control 12(1): 231-254.

JORION, P., & GOETZMANN, W. N. (1999). Global stock markets in the twentieth century. *The journal of finance*, *54*(3), 953-980.

JSE SECURITIES EXCHANGE, (2017).About the JSE Available at www.jse.co.za

[Accessed 11 May 2017]

KHUMALO, J. (2013). Inflation and stock prices interactions in South Africa: VAR analysis. *International Journal of Economics and Finance Studies*, *5*(2), 23-34.

KIM, J. H., & RYOO, H. H. (2011). Common stocks as a hedge against inflation: Evidence from century-long US data. *Economics Letters*, *113*(2), 168-171.

LUINTEL, K. B., & PAUDYAL, K. (2006). Are common stocks a hedge against inflation?. Journal of Financial Research, 29(1): 1-19.

LOTHIAN, J. R., & MCCARTHY, C. H. (2001). Equity returns and inflation: The puzzlingly long lags.

LOTHIAN, J. R., & SIMAAN, Y. (1998). International financial relations under the current float: evidence from panel data. *Open economies review*, *9*(4), 293-313.

MARX, C., & STRUWEG, J. (2015). Stagflation and the South African equity market. *Procedia Economics and Finance*, *30*, 531-542.

NELSON, C. R. (1976). Inflation and rates of return on common stocks. The journal of Finance, 31(2): 471-483.

SADORSKY, P. (2001). Risk factors in stock returns of Canadian oil and gas companies. Energy economics, 23(1): 17-28.

SCHOTMAN, P. C., & SCHWEITZER, M. (2000). Horizon sensitivity of the inflation hedge of stocks. *Journal of Empirical Finance*, *7*(3), 301-315.

SOLNIK, B., & SOLNIK, V. (1997). A multi-country test of the Fisher model for stock returns. Journal of International Financial Markets, Institutions and Money, 7(4): 289-301.

ROOME, W. B. (1986). Equities–a Hedge Against Inflation. *Businessman's Law*, *16*(3), 67-69.

TIWARI, AK., DAR, AB., BHANJA, N., AROURI, M., & TEULON, F. (2015). Stock returns and inflation in Pakistan. Economic Modelling, 47: 23-31

TRIPATHI, V., & KUMAR, A. (2014). Relationship between Inflation and stock returns–evidence from BRICS markets using Panel Co integration Test.

WOGLOM, G. (2003). How has inflation targeting affected monetary policy in South Africa?. *South African Journal of Economics*, *71*(2), 198-210.