Equity Prices And Inflation In South Africa: An Empirical Analysis

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ABSTRACT

This paper attempts to assess the indirect relationship between equity prices and inflation in South Africa in order to infer the possible reaction of the monetary authority in the face of excessive changes in equity price or bubble. To this end, use is made of a system equation, rather than a single equation, in the context of cointegrating VAR with over-identifying restrictions. The paper decomposes actual inflation into expected and unexpected components and shows that the two components react differently to the changes in equity prices. Nonetheless, given a weak reaction of expected inflation to the change in equity prices and the fact that monetary authority behaviour is forward-looking in South Africa, the paper concludes that equity prices should not form part of the monetary authority reaction function in South Africa.

Keywords: equity prices; inflation; monetary policy; cointegrating VAR

1.   INTRODUCTION

*T*he relationship between equity prices and inflation has been extensively investigated in a number of studies in finance literature (see Fama, 1981; Blanchard, 1981; Bernanke and Gertler, 2001; Cecchetti, Genberg and Wadhmani, 2003). This relationship has an implication for the conduct of monetary policy, as it informs whether monetary authority, in an explicit or implicit inflation-targeting regime, should intervene in the face of an equity market bubble. It is important to note that the debate on the role of monetary policy in the dynamics of the equity market has been raging. There are two competing schools of thought in the literature regarding the response of monetary policy to asset price changes or bubbles. The first school of thought, associated mainly with Bernanke and Gertler (2001), suggests that monetary policy should respond only to observed changes in equity prices to the extent that they signal changes to inflation or any other indicator that monetary policy targets. This conclusion is challenged by Cecchetti, Genberg and Wadhmani (2003). These authors argue that raising interest rates modestly as equity prices rise above what are estimated to be warranted levels can reduce the effects of asset price bubbles on output and inflation, thus enhancing financial and macroeconomic stability.

A number of studies have been conducted on assessing the relationship between equity prices and inflation in the context of developed economies. For example, Tatom (2002) finds that there is a negative long-run equilibrium relationship between inflation and equity prices. The author finds that the causality evidence indicates that the relationship between asset prices and inflation is uni-directional in that increases in the equity price lead to lower inflation. Fama (1981) contends that the negative relationship between stock returns and inflation observed during the post-1953 period in the US is puzzling given the accepted wisdom that common stock should be a hedge against inflation. Moreover, the author shows that this negative relationship is the consequence of proxy effect in that stock returns are determined by forecasts of more relevant real variables, and the negative relationship between stock returns and inflation is induced by negative relations between inflation and real activity. Chami, Cosimano and Fullerkamp (1999) assert that inflation has an impact on asset prices. The authors maintain that contractionary monetary policy curbs inflation, decreases the real value firm's assets and causes a decrease in equity prices. Cochran and Defina (1993) examined the effects of inflation on stock prices in the context of the proxy effect hypothesis. The authors find that inflation, actual or unanticipated, depresses real stock prices. Nonetheless, inflation does not proxy for future changes in real output, as suggested by Fama (1981) and Kaul and Seyhun (1990).

Few studies have been conducted on the relationship between stock prices and inflation in the context of developing and emerging market economies. This is due to the limited size of stock market activities and the negligible effects these market activities have on the real economy, especially in the case of developing countries. Nonetheless, Adrangi et al. (2002) find some evidence of a long-run equilibrium relationship between price levels, stock prices and real activity in Brazil. The authors indicate that this finding is consistent with the proxy effect hypothesis. Moreover, Chatrah et al (1997) investigate the relationship between stock prices and inflation in the light of Fama (1981) proxy hypothesis in the case of India. The authors find that the proxy hypothesis holds in the case of India.

A number of studies modelling the relationship between stock prices and inflation in the context of proxy hypothesis make use of single equation representations. For example, Adrangi et al. (2002) tested the two propositions separately, namely the negative association between inflation and the real economy and the positive association between real activity and stock returns, by making use of ordinary least square (OLS) method. However, because the proxy effect explanation is based on an indirect relationship between inflation and stock prices, the use of single equations may yield inconsistent estimates mainly due to the issue of the endogeneity of the regressors. To remedy to this shortfall, this paper models the relationship between stock prices and inflation in the context of the proxy hypothesis by making use of the cointegrating vector autoregressive (VAR) model. The VAR model has the advantage of dealing with the issue of endogeneity as well as modelling an indirect effect between variables. A number of studies assessing the relationship between equity price and inflation attempt in fact to investigate the impact of inflation on stock price in order to gauge whether equity market can be used as a hedge against inflation. Nonetheless, the approach of this paper is different in that it intends to assess whether stock prices affect inflation in South Africa in order to determine whether the South African monetary authority should include stock price in its reaction function.

The remaining sections are structured as follows: section 2 presents the literature review. The methodology of cointegrated VAR and the data used in the analysis are discussed in section 3. Section 4 presents the empirical results, and section 5 concludes the paper.

2. LITERATURE REVIEW

In an attempt to explain the negative relationship between stock returns and inflation during the post-1953 period in the US, Fama (1981) indicates that this negative relationship is puzzling given the rationale that common stock, representing ownership of the income generated by real assets, should be a hedge against inflation. The author shows that the relationship between stock returns and inflation is due to the combination of the inflation-real activity and real activity-stock returns relationship. For Fama (1981) an increase in inflation may proxy a decrease in the demand for money caused by a lower growth in real activity. A drop in real activity should signal a decrease in expected profit and thus a drop in stock returns. Given this channel of transmission, Fama dubbed the negative relationship between stock returns and inflation the 'proxy effect'. Several explanations have been proposed to explain the observed negative relationship between real stock returns and inflation. Feldstein and Summers (1979) attribute this relationship to the redistributive effect of unexpected inflation due to the contraction of nominal income caused by the effect of taxation. The authors indicate that because taxes are levied in nominal income, higher inflation leads to bracket creep and thus higher tax liability return on equity. Feldstein and Summers (1979) make a distinction between the expected and unexpected inflation's effect on return on equity. The authors indicate that the effect of expected inflation on current stock returns may be neutral, as investors have anticipated its effect on stock returns. Nonetheless, unexpected inflation should lower stock prices. Moreover, Geske and Roll (1983) show that the negative relationship between real stock returns and inflation can be attributed to a countercyclical monetary policy in that an expansionary monetary policy, to accommodate negative shock in real activity, will produce a simultaneous decline in stock price and an increase in inflation.

Few studies have been conducted in testing the proxy hypothesis in the context of emerging market economies. In one of these, Chatrath et al (1997) investigated the relationship between stock prices, inflation and output in order to assess the possibility of the proxy effect in India. The authors find that the relationship between real activity and inflation does not account for the negative relationship between real stock returns and the unexpected component of inflation. Moreover, Adrangi et al. (2002) investigated the relationship between stock

prices and inflation in the case of Brazil. The authors show that their findings support Fama's proxy hypothesis in the long run.

It is important to note that a number of studies assess the proxy hypothesis by making use of a single equation method. For example, in their empirical analysis to test the proxy hypothesis in Brazil, Adrangi et al. (2002) first purge the possible impact of output on inflation from the first equation and then employ the purged inflation variable in the second equation. The second equation constitutes the basis for assessing the proxy hypothesis whereby stock returns are regressed against output and the purged inflation variable. The authors show that a strong negative relationship between real stock returns and inflation in the second equation contradicts the proxy hypothesis and indicates that there is a direct effect of inflation on stock returns. A number of studies testing the proxy hypothesis in the context of linear models have relied to this type of methodology (see Cochran and Defina, 1993; Chatreth, Ramchander and Song, 1997; Adrangi et al. (2002)).

This paper relies on the Johansen's cointegration method to model the indirect relationship between stock prices and inflation in South Africa. Johansen and Juselius (1994) show that different cointegration relations can be identified within the VAR system and restrictions on each of the cointegration relations are essential in order to identify the long-run structure. With this methodology, the paper will be able to estimate the indirect pass-through from stock price and output to inflation in South Africa.

3. METHODOLOGY AND DATA

The method used to test for cointegration and to estimate the cointegrating vector is the vector autoregressive (VAR) maximum likelihood technique, outlined by Johansen and Juselius (1994). Letting Z_t , a vector that includes different variables, the VAR is represented as:

$$Z_t = \mu + \sum_{i=1}^{n-1} \Pi_i Z_{t-i} + \varepsilon_t \tag{3}$$

where Π_i is a $n \times n$ matrix of parameters, μ is a constant term and $\varepsilon_t \approx iid\,(0, \Omega)$. The VAR system of expression (3) can be rewritten as a vector error correction model (VECM)

$$\Delta Z_t = \mu + \Pi Z_{t-1} + \sum_{i=1}^{n-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_t \tag{4}$$

where Γ_i is the parameter of short-term coefficients and Δ is an expression for first difference series. The rank of Π, r, determines how many linear combinations of Z_t are stationary. If $r > 1$, one is able to show the indirect relationship that exists between variables given a proper economic identification.

The paper makes use of monthly seasonally adjusted data for South Africa from January 1994 to November 2008. The end period corresponds to the time before the full effect of the 2007-2008 global financial crisis. This indicates that the paper assesses the indirect relationship between stock price and inflation before the effect of the global financial crisis. The specification of the VAR model includes the following variables: the treasury bill rate (TB) to represent the short-term interest rate. The natural logarithm of manufacturing production (LNMANU) is used as an important indicator of economic activities in South Africa. The first difference of the logarithm of the consumer price index (CPIX), (DLNCPI), is used to represent the rate of inflation and the natural logarithm of the Johannesburg all-share equity indices (LNJSE) is used to represent equity prices. Contrary to a number of studies assessing the relationship between stock price and inflation in emerging markets, the VAR model in this paper includes the logarithm of the South African Rand-US Dollar exchange rate (LNEXCH) to account for the importance of the exchange rate in determining stock prices in emerging market economies (Abdalla and Murinde,

1997). With the inclusion of these important variables that explain stock price in emerging market in general and South Africa in particular, we assume that the VAR model in this paper is well-specified.

It is important to note that Cochran and Defina (1993) show that in order to investigate the effects of inflation on stock prices, a distinction needs to be made between the anticipated and unanticipated components of inflation. The authors show that the two components affect stock prices differently. Thus, this paper decomposed inflation into anticipated and unanticipated components using the autoregressive integrated moving average (ARIMA) model. The predicted values of this model proxy the expected values, while the errors proxy the unanticipated values of inflation.

4.   EMPIRICAL RESULTS

The VAR model in this paper is expressed as follows:

$$Z_t = (TB,, LNEXCH, LNMANU, LNJSE\ DLNCPI)$$

It is essential to note that DLNCPI represents the actual inflation. To determine the existence of cointegration and the number of cointegration vectors, each variable is tested for unit root using the Augmented Dickey-Fuller test. The results reported in Table 1 show that all series are integrated at order one I (1).

Table 1: ADF Unit Root Tests

Variables	τ -statistics at level	τ -statistics at first difference
DLNCPI	-0.318967	-2.930189**
LNJSE	-0.733615	-13.09697*
LNMANU	-0.685698	-2.022339**
TB	-1.972461	-8.384202*
LEXCH	-1.185211	-9.155362*

* and ** denote rejection of the null hypothesis at 1% and 5% level of significance, respectively.

To test the number of cointegrating relations, we set up an initial VAR and included a constant and two dummy variables. The first dummy variable takes the value of zero before March 1995 and unit afterward to account for the liberalisation of the Johannesburg Securities Exchange and the South African Bond Exchange in March 1995 (Tswamuno, 2007). The second dummy variable accounts for the change in monetary policy regime with the adoption of inflation targeting framework in South Africa from February 2000.

We tested the number of cointegration relations in a system of variables that includes the dummy variables to account for the structural breaks. This test was carried out according to the procedure suggested by Johansen, Mosconi and Nielsen (2000). Johansen, Mosconi and Nielsen show that if there is a structural break in the data-generating process, and if the break can be described by adding dummy variables to the deterministic part of the system, the inclusion of such variables in the model will lead to a change in the asymptotic distributions for the cointegrating rank. Thus, to determine the cointegrating rank the lag length of the VAR process, $p = 2$, was selected using the Hannan-Quinn (HQ) information criteria. The two dummy variables were included as exogenous variables. The LM-statistic of 31.89, with a probability of 0.16 obtained from chi-square with 25 degree of freedom, indicates that the null hypothesis of no serial correlation is not rejected with the VAR lag length of 2. The results of the trace and Max-eigenvalue tests of cointegration, reported in Table 2 and Table 3, respectively, indicate the presence of two cointegrating relations or ranks $(r = 2)$.

Table 2: Trace Test For Cointegration

Null Hypothesis	Trace Statistic	Critical Value (5%)	Prob.
$r = 0$	97.54330*	47.85613	0.0000
$r = 1$	45.13802*	29.79707	0.0004
$r = 2$	14.24016	15.49471	0.0766
$r = 3$	0.159051	3.841466	0.6900

Trace test indicates 2 cointegration equations at 5% level
* denotes rejection of the null hypothesis at 5% level

Table 3: Maximum Eigenvalue Test For Cointegration

Null Hypothesis	Maximum-Eigen Stat	Critical Value (5%)	Prob.
$r = 0$	52.40528*	47.85613	0.0000
$r = 1$	30.89787*	21.13162	0.0016
$r = 2$	14.08111	14.26460	0.0534
$r = 3$	0.159051	3.841466	0.6900

Maximum-Eigenvalue test indicates 2 cointegrating equations at 5% level
* denotes rejection at 5% level

Table 4 presents the results of the estimation of the cointegrating vectors under the over-identification restrictions specified in the cointegrating relations for a vector comprising actual inflation. The first cointegrating equation is normalised according to inflation and the second equation is normalised according to economic activities.

Table 4: Estimation Of The Cointegration Vectors Of Z_t Under Over-Identifying Restrictions

	Cointegrating Equation 1	Cointegrating Equation 2
DLNCPI	1	0
TB	-0.000259*	0
LNJSE	0	-0.173*
LEXCH	-0.00000539*	0
LNMANU	-0.009313*	1

* and ** indicate level of significance at 1% and 5% levels, respectively. Likelihood ratio for binding restriction, $\chi^2(2)$=0.3736

The results of the likelihood ratio for binding restriction indicates that the chi-square statistic with degree of freedom 2, $\chi^2(2)$, is less than the critical value at more than the 5% level. This indicates that the null hypothesis of the cointegrating vector restrictions is not rejected at more than the 5% level. The following long-run relationship is implied from the estimation represented in Table 4:

$$DLNCPI_t = 0.000259\,TB_t + 0.00000539\,LEXCH_t + 0.009313\,LNMANU_t \tag{5}$$

$$LNMANU = 0.173\,LNJSE \tag{6}$$

It is important to note from equations 5 and 6 that the impact of stock price on manufacturing production introduces a feedback mechanism between inflation and manufacturing production. Thus, stock prices influence inflation through manufacturing production or economic activities. While this finding supports the indirect effect between stock prices and inflation in South Africa, it also shows that the effect of stock prices on inflation is positive in that a 1% increase in stock price leads to a 0.0016% increase in inflation. Nonetheless, these results indicate a

weaker response of inflation to the change in stock prices. Contrary to studies which have found a negative relationship between economic activities and inflation, the results of this paper show that the increase in equity price, although inflationary, has a negligible effect on inflation.

Next, we decompose inflation into anticipated and unanticipated components in order to assess the indirect relationship between stock prices and the anticipated (expected) component of inflation. We follow the methodology suggested by Schwert (1989), where inflation is modelled using the autoregressive integrated moving average (ARIMA) model. The predicted values of this model proxy the expected values of inflation. It is important to note that Pretorius and Janse Van Rensburg (1996) emphasise the best performance of the ARIMA(0,1,1) model in forecasting inflation in South Africa.

Using monthly data from January 1994 to November 2008, equation 7 presents the estimation of the ARIMA (0,1,1) model of inflation in South Africa, where the expression d( ) denotes the first difference of inflation, and AR(1) and MA(1) are the first-order lag of the autoregressive and moving average variables respectively. Values in brackets denote the standard error statistics.

$$d(DLNCPI) = \underset{(0.08)}{0.114}\, AR(1) - \underset{(0.02)}{0.952}\, MA(1) \tag{7}$$

The predicted value obtained from this model represents the values of anticipated inflation, $(DLNCPIA_t)$. Thus, the new vector used to assess the indirect relationship between anticipated inflation and stock prices is expressed as:

$$Y_t = (TB_t, LNEXCH_t, LNMANU_t, LNJSE_t\ DLNCPIA_t)$$

As with the previous vector, the Trace and Maximum Eigenvalue cointegration tests indicate that there a two cointegrating relationships among the variables in Y_t. The estimation of the matrix of the cointegrating vector implies the following long-run relationship under over-identifying restrictions:

$$DLNCPIt = \underset{(0.000094)}{-\,0.00006}\, TBt + \underset{(0.0000013)}{0.0000024}\, LNEXCHt - \underset{(0.0016)}{0.0039}\, LNMANUt \tag{8}$$

$$LNMANU = \underset{(0.013)}{0.185}\, LNJSE \tag{9}$$

where values in brackets represents the standard errors of the estimated coefficients. The results reported in equations 8 and 9 indicate that there is an indirect negative relationship between equity prices and expected inflation. This implies that the increase in equity prices reduces expected inflation in South Africa.

The rationale behind the indirect negative relationship between stock prices and expected inflation is that shocks to equity prices are perceived as supply shocks in South Africa, and, thus, they raise the expectation that prices should decrease in the future. Nonetheless, the indirect positive relationship between stock prices and actual inflation is in line with the stock market wealth effect on consumption. In fact, the increase in stock prices in South Africa should lead to the increase in household wealth and total income and thus trigger consumption spending and actual price levels in South Africa (Muellbauer and Prinsloo, 2007). In addition, these findings suggest that realised inflation is not properly discounted or anticipated by economic agents in South Africa. This is reflected by the coefficients of correlation between actual $(DLNCPI_t)$, expected $(DLNCPIA_t)$ and unexpected $(DLNCPIU_t)$ inflation reported in Table 5.

Table 5: Coefficients Of Correlation Between Expected, Unexpected And Actual Inflation

	$DLNCPI_t$	$DLNCPIA_t$	$DLNCPIU_t$
$DLNCPI_t$	1		
$DLNCPIA_t$	0.14	1	
$DLNCPIU_t$	0.96	-0.13	1

The results reported in Table 5 show that there is a high correlation between the unexpected inflation and realised inflation (96%), while the correlation between expected and actual inflation is very low at 14%. To confirm the robustness of these results, we estimated the coefficient of correlation between actual inflation and inflation expectations of all surveyed participants in South Africa, published by the South African Reserve Bank,[1] and found the coefficient of correlation of 23%. This figure still indicates a low correlation between actual and expected inflation in South Africa.

The different results obtained on the effect of equity prices on expected inflation and actual inflation provide mixed signals on the possible reaction of the South African monetary authority to an equity price bubble. Nonetheless, because the South African's monetary authority actions are appropriately described by forward-looking behaviour, it is appropriate, given the small negative effect of stock prices on expected inflation, that the monetary authority does not include equity prices in its reaction function. Moreover, the slightly positive effect between equity prices and actual inflation, where a 1% increase in equity prices leads to a 0.0016% increase in actual inflation, suggests that the effect of the change in equity price is small and negligible. These results suggest that the South African Reserve Bank should not include equity prices in its reaction function.

5.   CONCLUSION

This paper attempted to assess the indirect relationship between equity prices and inflation in South Africa in order to infer the possible reaction of the South African's monetary authority in the face of equity price bubble in its inflation targeting regime. Use is made of the cointegrating VAR with over-identifying restrictions. The paper decomposes inflation into expected and unexpected components in order to assess the possible effects of equity prices on expected and actual inflations. The results of the paper show that there is an indirect positive relationship between equity prices and actual inflation in that equity prices directly affect economic activities and the latter directly affect actual inflation. Moreover, the paper finds that equity prices indirectly affect negatively expected inflation in South Africa. The paper indicates that the negative relationship between equity prices and expected inflation can be attributed to the perception by market participants that equity price shocks are part of supply shocks. Nonetheless, the positive relationship between equity prices and actual inflation is ascribed to stock market wealth effects. In the light of these findings, the paper argues that the different reactions of actual and expected inflations to changes in equity prices should send a mixed signal on how the monetary authority should respond to equity price shocks in South Africa. Nonetheless, given its forward-looking behaviour and the weak response of all the components of inflation to the change in equity prices, the paper concludes that the South African monetary authority should not include equity prices in its reaction function.

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