

# Relationship between Inflation and Stock Returns – Evidence from BRICS markets using Panel Co integration Test

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## Abstract

Stocks are generally considered to be a good hedge against inflation because of their tendency to move together. This paper examines long term relationship between inflation and stock returns in BRICS markets using panel data for the period from March 2000 to September 2013. Correlation results reveal a significant negative relationship between stock index and inflation rate for Russia and a significantly positive relationship for India & China. ADF, PP and KPSS unit root tests indicate non-stationary characteristic of the data. Further we find no long term co-integrating relationship between stock index values and inflation rates using Pedroni panel co integration test. These findings have important implications for policy makers, regulators and investment community at large. There may seem to be short term contemporaneous relationship between inflation and equity returns but in the long run they do not seem to be significantly integrated. Changes in inflation may bring some short run movement in stock return but certainly equity does not seem to be a good hedge against inflation in long run at least in emerging BRICS markets.

**Keywords:** BRICS, Stock Index, Inflation, Unit root test, Pedroni Panel Co integration Test, Johansen Co integration Test

**JEL Classification:** G12, G14.

## 1. Introduction

Stock markets are today regarded as a very important part of the overall financial system as they boost growth of all sectors of the economy by channelizing savings from funds-surplus units of the society to funds deficit units and enables optimum allocation and utilization of scarce capital resources thus providing the base for long term sustainable economic growth.

As sound and efficient stock market is now considered crucial for economic progress, focus has therefore shifted to establish factors which determine stock returns. While financial theory provides for company and industry specific factors, there is a growing conviction among financial researchers that macroeconomic variables do play a crucial role in determining stock market performance.

Among the macroeconomic variables, inflation is considered to be one of the most crucial factors impacting stock returns. Inflation is an increase in general level of price of goods and services in an economy resulting in a fall in purchasing power or value of money.

Earliest inferences on relation between inflation and stock returns were based on hypothesis presented by Irving Fisher in 1930. From Fisher's hypothesis, it can be inferred that real assets returns should move positively with expected inflation rates. Thus, there should be a positive relationship between Inflation and stock returns whereby nominal stock returns should rise along with inflation providing investors a hedge against inflation.

On the other hand, a contrarian view of a negative relation between inflation and stock returns is also very much prevalent. Fama (1981) explained that negative stock returns-inflation relations are induced by the positive correlation between stock returns and real activity and the negative correlation between inflation and real activity – the Proxy Hypothesis. This is based on the following reasons:

- Increase in inflation increases the consumption expenditure (as more money is required to buy same quantity of goods and services), resulting in fall in savings and investment by channelizing scarce resources meant for investment to consumption. This decreases the demand for stocks and other financial assets causing a fall in share prices.
- Also, an increase in inflation adversely affects corporate profits through increased input costs, increased interest pay-outs and demand pressures. This again causes a fall in stock prices due to adverse corporate performance.
- From another perspective, a rise in inflation rate increases the discount rate in the stock valuation model, leading to lower share prices.
- Increase in inflation would also attract monetary and fiscal policies which would reduce money supply, increase interest rates and curb aggregate demand. This would again adversely affect growth rate, corporate performance and stock returns.

This relationship between stock returns and inflation is still not clearly established for emerging economies like BRICS nations due to both paucity of research work and emergence

of conflicting results. This forms the basic premise for our present research.

BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa. The BRICS members are all developing countries, but they are distinguished by their large, fast-growing economies and significant influence on regional and global affairs. As of 2014, the five BRICS countries represent almost 3 billion people which are 40% of the world population and a combined nominal GDP of US\$16.039 trillion, i.e., 20% of world GDP.

This paper aims at establishing long term relationship between stock returns and inflation for emerging BRICS economies using Panel Co integration Test.

This research would be of particular relevance to various stakeholders such as regulators and policy makers, investors, academicians and researchers. This study can help regulators and policy makers to have a better comprehension of relationship between inflation and stock returns which would give them a better understanding of BRICS stock market, to gauge the impact of their macroeconomic policies relating to inflation on stock market and frame inflation policies in a manner which improves stock returns while minimizing volatility.

Investors can use this study to plan their investment strategies after considering the impact of future expected inflation on stock returns in BRICS. For example, if the study establishes a negative relationship, they would be better off in reducing their exposure to these markets in times of high inflation by making appropriate diversification in their global portfolios.

This study would also be a rich addition to the existing theoretical and empirical frameworks on relationship between inflation and stock returns, particularly for emerging markets.

The rest of the paper is organized as follows: Section 2 presents brief review of related literature. Section 3 provides the data and methodology. Section 4 discusses the empirical results and their economic interpretation. The conclusions and implication are presented in Section 5.

## 2. Review of Literature

The relationship between stock returns and inflation has been extensively probed for advanced and developed economies over the past three decades and majority of them have found a negative relationship. The prominent ones are mentioned below.

**Fama (1981)** found a strong negative relationship between stock returns and inflation.

**Geske and Roll (1983)** studied the US stock market and found that stock price is negatively related to inflation.

**Asprem (1989)** investigated a number of European countries and established that stock prices were negatively related to inflation.

**Chatrath et al. (1997)** examined the relationship between stock prices and inflation for India market. He found that stock return and inflation were negative related.

**Maysami and Koh (2000)** established that inflation had a co-integrating relationship with

Singapore stock market prices.

**Gallagher and Taylor (2002)** documented the linkage between stock prices and macroeconomic variables for US markets and found that expected and unexpected inflation negatively affect the stock returns.

**Mukhopadhyay and Sarkar (2003)** analysed the Indian stock market returns prior to and after market liberalization for the influence of macroeconomic factors on returns. They found that inflation exerted influence on Indian stock returns in the post-liberalization period.

**Tursoy et al. (2008)** reported a strong link between the stock returns and inflation, risk premium, term structure of interest rate, and money supply.

**Victor and Kuwornu (2011)** found a significant relationship between stock market returns and consumer price index (inflation).

**Khan et al. (2013)** scrutinized the influence of selected macroeconomic variables on stock market prices in Bangladesh. Use of Co integration analysis along with Vector Error Correction Model (VECM) found that inflation does not impact stock prices in the long-run.

**Tripathi and Seth (2013 & 2014)** identified Inflation as one of the principal factors through Factor analysis. They also found a co-integrating relationship between stock return and inflation.

Thus, a majority of studies covering different markets conducted using different methodologies and for varying time periods confirm a negative relationship between inflation and stock returns. However, a comprehensive investigation of this relationship for major emerging economies like BRICS is conspicuous by its absence. It provides a research gap which the authors have sought to fill with the present work.

### **3. Data and Methodology**

#### **3.1. Data**

The time period of study was January 2000 to September 2013. Frequency of data was quarterly. Thus, we had a total of 55 observations for the study period. Data used in the study was Inflation rate and Stock Index values of BRICS nations. For inflation rate, change in Consumer Price Index year on year was taken for Brazil, Russia, China and South Africa. While for India, change in Wholesale Price Index year on year was taken as proxy for inflation rate. All the data on inflation was collected from Bloomberg database.

For stock index data, the daily closing adjusted index values of prominent benchmark market indices in different countries was taken from Bloomberg database and Yahoo finance for the study period and then their frequency was converted to quarterly basis. Table below gives the stock exchange and benchmark index which was chosen for each country.

| Country      | Stock Exchange              | Stock Index           |
|--------------|-----------------------------|-----------------------|
| Brazil       | Sao Paulo Stock Exchange    | Ibovespa              |
| Russia       | Moscow Stock Exchange       | RTSI INDEX            |
| India        | National Stock Exchange     | CNX NIFTY             |
| China        | Shanghai Stock Exchange     | Shanghai SE Composite |
| South Africa | Johannesburg Stock Exchange | FTSE/JSE Top40        |

### 3.2. Methodology

#### 3.2.1. Descriptive Statistics

Descriptive statistics such as Mean, Median, Maximum & Minimum values, Std. Dev., Skewness, Kurtosis and Probability has been used to quantitatively summarize the patterns and general trends of the dataset.

#### 3.2.2. Bi-variate Correlation

Bi-variate correlation has been computed for each pair of Stock Index values & inflation to establish the direction and magnitude of short term relationship between Stock returns and Inflation for all the sample five countries (Brazil, Russia, India, China and South Africa).

#### 3.2.3. Unit Root Tests

Stationarity of a data is a prerequisite for drawing meaningful inferences in a time series analysis and to enhance the accuracy and reliability of the models constructed. A time series data is stationary if its mean, variance and auto-covariance (at various lags) remain the same no matter at what point we measure them, i.e., they are independent of time or time invariant. Augmented Dickey Fuller (ADF), Phillips–Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests have been applied to test the stationary of time series data.

#### 3.2.4. Pedroni (Engle-Granger based) Co integration Tests<sup>1</sup>(1. Adapted from EViews 7 User guide 2)

Pedroni Co integration test (Engle-Granger Based) has been applied on panel data of stock index values and inflation to determine whether a long term co integrating or equilibrium relationship exists between stock return and inflation for BRICS nation stock markets. Co integration means despite being individually non-stationary, a linear combination of two or more time series can be stationary. Co integration of two or more time series suggests a long run or equilibrium relationship between them.

The Engle-Granger (1987) co integration test is based on an examination of the residuals of a spurious regression performed using I(1) variables.

Pedroni proposes several tests for co integration that allow for heterogeneous intercepts and trend coefficients across cross-sections. Consider the following regression:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \dots + \beta_{Mi} x_{Mi,t} + e_{i,t} \quad (\text{Eq. 1})$$

for  $t = 1, \dots, T$ ;  $i = 1, \dots, N$ ;  $m = 1, \dots, M$ ; where  $y$  and  $x$  are assumed to be integrated of order one, e.g. I(1). The parameters  $\alpha_i$  and  $\delta_i$  are individual and trend effects which may be set to zero if desired.

Under the null hypothesis of no co integration, the residuals  $e_{i,t}$  will be I(1). The general approach is to obtain residuals from Equation 1 and then to test whether residuals are I(1) by running the auxiliary regression,

$$e_{i,t} = \rho_i e_{i,t-1} + u_{it} \quad (\text{Eq.2})$$

for each cross-section. Pedroni describes various methods of constructing statistics for testing for null hypothesis of no co integration ( $\rho_i = 1$ ). There are two alternative hypotheses: the homogenous alternative, ( $\rho_i = \rho$ )  $< 1$  for all  $i$  (which Pedroni terms the within-dimension test or panel statistics test), and the heterogeneous alternative,  $\rho_i < 1$  for all  $i$  (also referred to as the between-dimension or group statistics test).

The Pedroni panel co integration statistic  $\hat{K}_{N,T}$  is constructed from the residuals from Equation 2. A total of eleven statistics with varying degree of properties (size and power for different  $N$  and  $T$ ) are generated. Pedroni shows that the standardized statistic is asymptotically normally distributed,

$$\frac{\hat{K}_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0, 1)$$

(Eq. 3)

where  $\mu$  and  $v$  are Monte Carlo generated adjustment terms.

### 3.2.5. Johansen Co integration Test

Johansen co integration test has been applied in this study to test the cointegrating

relationship between stock index values and inflation rate for BRICS countries individually. Johansen co integration test named after Søren Johansen is a procedure for testing co integration of several time series. The Johansen multivariate co integration approach is based on error correction representation of the  $p$  order Vector Autoregressive model with Gaussian error:

$$\Delta X_t = \phi + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-p} + \varepsilon_t$$

Where  $\Delta$  is the most first difference operator,  $r_1 = -(I - A_1 \dots - A_i)$  is coefficient matrix representing short-run dynamics, and  $\Pi$  defined by  $\Pi = -(I - A_1 \dots - A_i)$  is  $n \times n$  matrix, where  $I$  is an identity matrix, whose rank determines the number of cointegrating vectors. Two different likelihood ratio tests were developed by Johansen for testing the number of co integration vectors ( $r$ ): the trace test given by:

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

And Maximum eigenvalue test statistics given by:

$$\lambda_{\text{ax}}(r, r+1) = T \ln(1 - \lambda_{r+1})$$

The null hypothesis of the trace statistics tests is no co integration  $H_0: r = 0$  against the alternative of more than 0 co integration vector  $H_1: r > 0$  whereas the maximum Eigenvalue statistics test the null hypothesis of  $r$  cointegrating vectors against the alternative of  $r + 1$  cointegrating vectors.

#### 4. Empirical Analysis and Economic Interpretation

Table 1 gives the snapshot of the descriptive characteristics of the Index and Inflation series of BRICS stock markets. Among stock indices, Russia and South Africa gave the highest average return (0.03) followed by Brazil and India(0.02). While China had the lowest return (0.002). Risk in absolute terms (Std. dev.) was highest for Russia (0.22) followed by China (0.16) and Brazil (0.16). Relative risk measured by Coefficient of variation was very high for China (80%) followed by Brazil (7.5%), Russia (7.33%) and India (6.5%). It was lowest for South Africa (3%). As regards inflation, Russia had the highest inflation (10.39%) followed by China and South Africa. India had the lowest inflation among the group.

**Table 1 : Descriptive Statistics**

|                                    | Brazil<br>Index<br>Return | Brazil<br>Inflati<br>on | Russia<br>Index<br>Return | Russia<br>Inflatio<br>n | India<br>Index<br>Return | India<br>Inflatio<br>n | China<br>Index<br>Return | China<br>Inflatio<br>n | South<br>Africa<br>Index<br>Return | South<br>Africa<br>Inflation |
|------------------------------------|---------------------------|-------------------------|---------------------------|-------------------------|--------------------------|------------------------|--------------------------|------------------------|------------------------------------|------------------------------|
| Mean                               | 0.02                      | 0.46                    | 0.03                      | 10.39                   | 0.02                     | 0.02                   | 0.002                    | 2.66                   | 0.03                               | 5.89                         |
| Median                             | 0.02                      | 0.43                    | 0.08                      | 10.30                   | 0.01                     | 0.02                   | -0.01                    | 2.50                   | 0.05                               | 5.70                         |
| Maximum                            | 0.33                      | 2.10                    | 0.37                      | 16.80                   | 0.35                     | 0.06                   | 0.42                     | 8.30                   | 0.18                               | 12.40                        |
| Minimum                            | -0.31                     | -0.21                   | -0.65                     | 3.70                    | -0.28                    | -0.05                  | -0.47                    | -1.70                  | -0.24                              | 0.30                         |
| Std. Dev.                          | 0.15                      | 0.37                    | 0.22                      | 3.31                    | 0.13                     | 0.02                   | 0.16                     | 2.36                   | 0.09                               | 2.94                         |
| Coefficie<br>nt<br>of<br>Variation | 7.5                       | 0.80                    | 7.33                      | 0.32                    | 6.5                      | 1                      | 80                       | 0.89                   | 3                                  | 0.50                         |
| Skewnes<br>s                       | -0.27                     | 1.87                    | -1.18                     | -0.04                   | -0.02                    | -0.63                  | 0.03                     | 0.26                   | -1.05                              | 0.40                         |
| Kurtosis                           | 2.76                      | 10.00                   | 4.95                      | 1.99                    | 2.80                     | 7.31                   | 4.07                     | 2.56                   | 4.25                               | 2.87                         |

Table 2 provides the bi-variate correlation coefficients for stock index and inflation values of each country. There was a high negative correlation between stock index values and inflation for Russia (-0.71) and a low negative correlation for Brazil (-0.17). The correlation was positive for other three economies, with India having the highest positive correlation (0.89) followed by China (0.47) and South Africa (0.01).



**Table 2. Bivariate Correlation Between Index Values and Inflation**

| Variables                                     | Value  |
|---|--------|
| Brazil Index and Brazil Inflation             | - 0.17 |
| Russia Index and Russia Inflation             | - 0.71 |
| India Index and India Inflation               | 0.89   |
| China Index and China Inflation               | 0.47   |
| South Africa Index and South Africa Inflation | 0.01   |

Next, as a prerequisite to apply co integration test, we checked the available time series for stationarity using three popular unit root tests (ADF, PP and KPSS). The results obtained are shown in Table 3. Barring one or two exceptions, the inflation and stock index time series were non-stationary at level and first difference respectively for all 5 economies in all 3 tests.

**Table 3. Unit Root Tests Results**

| Variable         |               | Augmented Dickey Fuller (ADF) | Phillips–Perron (PP) | Kwiatkowski–Phillips–Schmidt–Shin (KPSS) |
|------------------|---------------|-------------------------------|----------------------|--|
| Brazil Index     | t-Statistic   | -1.15                         | -1.17                | 13.99                                    |
|                  | (Probability) | (0.69)                        | (0.68)               | (0.00)                                   |
| Brazil Inflation | t-Statistic   | -5.87                         | -5.89                | 9.64                                     |
|                  | (Probability) | (0.00)                        | (0.00)               | (0.00)                                   |
| Russia Index     | t-Statistic   | -1.65                         | -1.74                | 12.32                                    |
|                  | (Probability) | (0.45)                        | (0.41)               | (0.00)                                   |
| Russia Inflation | t-Statistic   | -1.82                         | -2.01                | 18.07                                    |
|                  | (Probability) | (0.37)                        | (0.28)               | (0.00)                                   |
| India Index      | t-Statistic   | -0.73                         | -0.82                | 13.55                                    |
|                  | (Probability) | (0.83)                        | (0.80)               | (0.00)                                   |
| India Inflation  | t-Statistic   | 4.57                          | 9.65                 | 30.18                                    |
|                  | (Probability) | (1.00)                        | (1.00)               | (0.00)                                   |
| China Index      | t-Statistic   | -2.51                         | -2.28                | 17.51                                    |
|                  | (Probability) | (0.12)                        | (0.18)               | (0.00)                                   |
| China Inflation  | t-Statistic   | -1.86                         | -2.71                | 7.45                                     |
|                  | (Probability) | (0.35)                        | (0.08)               | (0.00)                                   |
| South            | t-Statistic   | 0.48                          | 0.27                 | 15.90                                    |

|                        |               |         |        |        |
|------------------------|---------------|---------|--------|--------|
| Africa Index           | (Probability) | (0.98)  | (0.97) | (0.00) |
| South Africa Inflation | t-Statistic   | -3.73   | -2.66  | 15.69  |
|                        | (Probability) | (0.006) | (0.09) | (0.00) |

We next apply Pedroni Panel Co integration Test (Engle-Granger based) on a panel data of index and inflation values. The results have been reported in Table 4. The null hypothesis of no-co integration between stock index values and inflation rates is accepted by a significant margin in all cases implying that there is no long term co-integrating relationship between stock index values and inflation for BRICS markets during the study period.

**Table 4. Pedroni Panel Co integration Test**

|                     |               | Deterministic Intercept and No Deterministic Trend |          | Deterministic Intercept and Deterministic Trend |          | No Deterministic Intercept or Deterministic Trend |          |
|---------------------|---------------|--|----------|---|----------|---|----------|
|                     |               | Simple   | Weighted | Simple  | Weighted | Simple  | Weighted |
| Panel v-Statistic   | Statistic     | -1.21  | -0.26    | 0.58  | 0.61     | 0.53  | 0.33     |
|                     | (Probability) | (0.89)   | (0.60)   | (0.28)  | (0.27)   | (0.298)   | (0.37)   |
| Panel rho-Statistic | Statistic     | 1.22   | 0.71     | -0.24   | -0.24    | -1.61   | -0.92    |
|                     | (Probability) | (0.89)   | (0.76)   | (0.40)  | (0.40)   | (0.05)  | (0.18)   |
| Panel PP-Statistic  | Statistic     | 1.08   | 0.82     | -0.08   | -0.15    | -1.36   | -0.96    |
|                     | (Probability) | (0.86)   | (0.79)   | (0.47)  | (0.44)   | (0.09)  | (0.17)   |
| Panel ADF-Statistic | Statistic     | 0.64   | 0.65     | 0.27  | 0.23     | -1.88   | -1.21    |
|                     | (Probability) | (0.74)   | (0.74)   | (0.61)  | (0.59)   | (0.03)  | (0.11)   |
| Group rho-Statistic | Statistic     | 0.68   | NA       | 0.40  | NA       | 0.01  | NA       |
|                     | (Probability) | (0.75)   | NA       | (0.66)  | NA       | (0.50)  | NA       |
| Group PP-Statistic  | Statistic     | 0.88   | NA       | 0.29  | NA       | -0.77   | NA       |
|                     | (Probability) | (0.81)   | NA       | (0.61)  | NA       | (0.22)  | NA       |
| Group ADF-Statistic | Statistic     | 0.69   | NA       | 0.70  | NA       | -1.16   | NA       |
|                     | (Probability) | (0.75)   | NA       | (0.76)  | NA       | (0.12)  | NA       |

Finally we use Unrestricted Co integration Rank Test (Trace) within the Johansen framework

to test for presence of a cointegrating relationship between stock index values and inflation rates individually for BRICS countries. The test results are shown in Table 5. As per results regarding the presence of co integrating equations, we found no co integration between stock index values and inflation rates for Russia, India and South Africa. However, there was a significant co integrating relationship between stock return and inflation for Brazil and China.

**Table 5. Johansen Cointegration Test**

| Country      | Hypothesize<br>d<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical<br>Value | Probability |
|--------------|----------------------------------|------------|--------------------|---------------------------|-------------|
| Brazil       | None                             | 0.297      | 19.448             | 15.495                    | 0.012       |
|              | At most 1                        | 0.022      | 1.147              | 3.841                     | 0.284       |
| Russia       | None                             | 0.205      | 15.208             | 15.495                    | 0.055       |
|              | At most 1                        | 0.056      | 3.061              | 3.841                     | 0.080       |
| India        | None                             | 0.150      | 11.565             | 15.494                    | 0.179       |
|              | At most 1                        | 0.054      | 2.939              | 3.841                     | 0.087       |
| China        | None                             | 0.259      | 21.573             | 15.495                    | 0.005       |
|              | At most 1                        | 0.101      | 5.642              | 3.841                     | 0.018       |
| South Africa | None                             | 0.277      | 14.651             | 15.495                    | 0.067       |
|              | At most 1                        | 0.001      | 0.059              | 3.841                     | 0.808       |

## 5. Conclusion and Implications

The age old dictum that equity is a good hedge against inflation in recent times is put to empirical test in this paper. We have examined the long run relationship between inflation and stock returns using panel data for BRICS markets over the period 2000-2013, using Pedroni's panel co integration test and the traditional Johansen co integration test. We find that although there is a significant positive association between inflation and stock returns in India and China, there is a significant negative relationship in Russia and Brazil. Cointegration results for individual markets reveal no long term equilibrium relationship in case of Russia, India and South Africa whereas contrarian results establishing long term equilibrium relationship is obtained for Brazil and China. Further panel co integration test also reinforces the results of no long term co integration between inflation and stock returns.

These findings have important implications for policy makers, regulators and investment community at large. There may seem to be short term contemporaneous relationship between inflation and equity returns but in the long run they do not seem to be significantly integrated. Changes in inflation may bring some short run movement in stock return but certainly equity does not seem to be a good hedge against inflation in long run at least in emerging BRICS markets.

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