

# Inflation, Output, And Stock Prices: Evidence From Brazil

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## Abstract

*Research in economics and finance documents a puzzling negative relationship between stock returns and inflation rates in markets of industrialized economies. The present study investigates this relationship for Brazil. We show that the negative relationship between the real stock returns and unexpected inflation persists after purging inflation of the effects of the real economic activity. The Johansen and Juselius cointegration tests verify a long-run equilibrium between stock prices, general price levels, and the real economic activity. Furthermore, stock prices and general price levels also show a strong long-run equilibrium with the real economic activity and each other. The findings lend support to Fama's proxy hypothesis in the long-run.*

## I. Introduction

The evidence of a negative relationship between stock prices and inflation has intrigued researchers over the past two decades. Furthermore, there is some evidence that the negative relationship between inflation and stock returns in developed markets results from a so called "proxy hypothesis" (see Fama (1965)).

According to the proxy hypothesis, the negative relationship between stock returns and the inflation reflects the deleterious effects of the inflation on the real economic activity. There is evidence to show that equities in industrialized economies have failed to maintain their value during periods of high inflation. For example, during the rapid inflation years of 1970s, U.S. stocks prices did not keep pace with general price levels. According to Fisher (1930) asset values should be positively related with expected inflation, providing a hedge against rising prices. If the implied positive relationship between stock prices and the inflation does not hold, stock investors will be vulnerable to inflation.

This paper investigates the relationship between equity returns and inflation in the important emerging economy of Brazil. Since late 1980s, most emerging market economies have been characterized by a great deal of variation in inflation rates. For example, the annual inflation rates for the Latin American economies ranged from a low of zero percent for Panama to a high of nearly 3,400% for Mexico in 1989. The average annual inflation rate among thirteen major emerging markets was 627% in 1989, according to International Monetary Fund. Given high inflation rates among these economies, and a rising interest by investors in emerging markets, it is important to investigate the relationship between stock prices and inflation rates for Brazil.

Brazil is selected here because as the currency devaluation of the early January 1999 showed, it plays a significant role in world markets. Brazil's economy is considered the flagship of Latin American economies. It is the eleventh market for U.S. exports, and 450 of the top 500 U.S. corporations do business there. Latin America, anchored by the huge Brazilian economy, imported roughly \$118 billion in U.S. goods and services \_\_\_\_\_

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during the first ten months of 1998. This sum amounts to twenty percent of all U.S. exports. Furthermore, Brazil's equity market capitalization is roughly 10.1 percent of the world's emerging markets' total capitalization, making its equity markets and the economy a significant player in the world and the Latin America.<sup>1</sup>

The equity market of Brazil under performed the mature markets of the developed economies for quite some time.<sup>ii</sup> Inflation, a real threat in most emerging markets, has been in check since 1994. Equity prices have soared, almost uninterrupted since 1992, providing excellent opportunities for individual and institutional investors. While the equity prices in Brazil have soared, the annual inflation rate of inflation is roughly 17 percent, mostly as a result of the devaluation of the real in the early 1999. Despite these successes in curbing the inflationary threats, recent events in emerging markets require further research and analysis. For example, as events of Pacific Rim economies in mid and late 1997 and economic instability in Brazil in 1999 demonstrated, inflation and currency depreciation in these economies could occur with little warning and threaten the stability of equity markets and financial structure of emerging markets and the world.

The study contributes to the literature in several ways. First, the findings of this investigation should be important for portfolio managers and economic policy makers. The Brazilian economy has gained importance in the last few years. Several mutual funds have been formed to invest solely in this market as a means of international diversification. Furthermore, the local equity markets have been opened up to direct investment by foreigners. At the same time, several Brazilian corporations have joined ADR programs in the US market. However, potentially important relationships between macroeconomic variables and stock prices in these equity markets have not been studied, perhaps due to the data paucity.

Secondly, it is important to investigate whether negative relationships between stock price and inflation found for developed economies are present in Brazil. The proxy hypothesis is an explanation for the negative relationship between stock returns and inflation. The proxy hypothesis refers to the fact that the negative relationship between stock returns and inflation is not direct; but rather inflation negatively impacts the real economic activity, which in turn directly impacts equity returns. In other words, real economic activity is the channel by which inflation influences stock returns in most countries. The investigation of the proxy hypothesis for Latin American emerging market economies may be especially crucial in light of high past inflation rates that most economies of that region have experienced. Thus, our investigation of Brazil should serve to highlight the differences or similarities in the proxy hypothesis across the developed and emerging markets.

Third, Our paper also proposes a test for the Fisherian hypothesis. The Fisherian hypothesis argues that real returns in efficient markets are determined by real economic factors. The hypothesis has been tested and rejected for developed countries, but with a few exceptions, not for developing economies.<sup>iii</sup> The implication of the Fisherian hypothesis for stock returns is that real returns are expected to be uncorrelated with the expected inflation. This paper extends the investigation to the Brazil's emerging market. Our investigation of Brazil should serve to highlight the differences in the proxy-effect hypothesis across developed and developing markets. Finally, we also address the proxy hypothesis in the framework of cointegration tests. The traditional regression equations may be unable to capture long-run relationships between stock markets, inflation, and real activity.

The remainder of this paper is organized as follows. Section II presents the theoretical background. Data sources and the proposed empirical models are discussed in Section III. Empirical findings and their analysis are the subject of Section IV. Section V provides a brief summary and conclusions.

## **II. Theoretical Background**

Several studies have investigated the negative relationship between equity returns and inflation in the U.S. and other industrialized economies. However, very few papers have addressed the same issue for developing economies (see Chatrath et al 1997). Lintner (1975), Fama and Schwert (1977), Fama (1981, 1982), Geske and Roll (1983), and Wahlroos and Berglund (1986), among others, find evidence that stock returns are negatively affected by both expected and unexpected inflation in the U.S. More recently, Serletis (1993) and Thornton (1993) investigate a related issue of stock prices and money supply in the U.S. and UK. Fama (1981) and Geske and Roll (1983) offer an explanation for the negative relationship between stock returns and inflation, through a hypothesized chain of macroeconomic linkages, based on the money demand and the quantity theory of money.<sup>iv</sup> This explanation may be summarized as: (i) contrary to the suggestion of the Phillips curve, there is a negative relationship between inflation and real economic activity; and (ii) stock returns are directly related to the real economic activity.

Based on (i) and (ii), Fama, Geske, and Roll hypothesis predicts that rising inflation rates reduce real economic activity and demand for money.<sup>v</sup> A reduction in economic activity negatively affects the future corporate profits and stock prices. The resulting negative relationship between the stock returns and inflation is referred to as the “proxy effect,” in the sense that it reflects the detrimental consequence of inflation on real economic activity. Fama argues that the proxy effect vanishes when real activity does not fall because of inflation. Ram and Spencer (1983) discuss the negative relationship between stock returns and inflation and offer an explanation for this phenomenon. Their empirical tests based on an augmented Fisher- Phillips relationship, show that some of Fama’s findings may be reversed. However, they admit that the issue is not fully settled and further research is necessary.

In this paper we first test each of relationships (i) and (ii) directly and then offer a joint test for both. The theoretical foundations of the proxy effect are detailed in Fama (1980). We offer further theoretical explanation for the possible negative relationship between the inflation and real economic activity based on shifts in the Phillips curve. Phillips curve shows the relationship between a measure of real economic activity, such as the rate of growth of real output or unemployment, and a nominal variable, such as the inflation rate. Thus, according to the Phillips curve, higher rates of unemployment are associated with lower inflation rates and vice versa.<sup>vi</sup> It is well documented that the Phillips curve shifts to the right as inflationary expectations are formed. The shift occurs as demand for higher nominal wages reduce employment at any given inflation rate. That is, higher inflation rates may be associated with lower real economic activity because of the inflationary spiral. An alternative explanation for the same phenomenon may be derived from the Keynesian view. Higher rates of inflation may stunt new investments, thus reducing both the aggregate demand and aggregate supply. Therefore, the real output may fall. The positive relationship between the real economic activity and real stock returns is more obvious and plausible. The increased real economic activity is likely to contribute to increased profitability and, thus, rising stock prices. Based on the above explanations, it is reasonable to assume that inflation and real economic activities may be considered exogenous, and real equity returns endogenous variables in empirical models for this study.

**III. Data and Empirical Models**

To test the proxy hypothesis in a major Latin American emerging economy, we select Brazil. The period of this study covers from January 1986 through July 1997. The data for this paper are from the Brazilian Institute for Geography and Statistics.<sup>vii</sup> The index of industrial production is selected as a proxy for the real economic activity.

Prior to testing the negative relationship between inflation and stock returns with the real economic activity, the negative relationship between real-returns and inflation is investigated. It is expected that some portion of the inflation rate will be anticipated by economic agents and capital markets. However, the unanticipated portion of the inflation rate may surprise equity markets and affect real returns. The Fisherian hypothesis for stock returns, which addresses these issues, is expressed in Fama and Schwert (1977) by (1) stock markets are efficient, and (2) real returns in the market and expected inflation rate vary independently of each other. The empirical test of this hypothesis may be accomplished by estimating:

$$R_t - INF_t = \alpha + \beta (EINF_t | \Omega_{t-1}) + error_t, \tag{1}$$

where  $R_t - INF_t$  is the real return, the difference between the nominal return,  $R_t$ , and the inflation rate,  $INF_t$ ,  $EINF_t$ , is the expected inflation,  $\Omega_{t-1}$ , is the information set available at the time period t-1, and the error term is randomly and normally distributed with zero mean and constant standard deviation. However, equities and bonds are claims against real assets and are often considered a potential hedge against unexpected as well as expected inflation. The following extension of equation (1), which includes the unexpected inflation rate, may be a more appropriate formulation of the Fisherian hypothesis:

$$R_t - INF_t = \alpha_1 + \beta_1(EINF_t | \Omega_{t-1}) + \beta_2(UINF_t | \Omega_{t-1}) + error_t. \tag{2}$$

In Equations (2), the UINF is the INF-EINF. In the Fama and Schwert (1977) framework, equities are a hedge against expected inflation if  $\beta_1 = 0$  and a perfect hedge against expected and unexpected inflation if  $\beta_1 = \beta_2 = 0$ , which would support the Fisherian hypothesis. A number of researchers have rejected the first and often both of these hypotheses.<sup>viii</sup> The outcome of empirical tests of the Fisherian hypothesis sets the stage for the remainder of the empirical work in this paper. Specifically, if there is a negative relationship between the real stock returns and any component of inflation, it may be related to the proxy hypothesis.

To investigate the validity of the proxy hypothesis, relationships expressed as (i) and (ii) are tested separately by estimating the following set of equations

$$INF_t = \alpha + \sum_{i=-k}^k \psi_i GIP_{t+i} + \varphi D_t + error_t, \tag{3}$$

$$R_t - INF_t = \delta + \sum_{i=-k}^k \gamma_i GIP_{t+i} + \varphi D_t + error_t, \tag{4}$$

where all variables are defined as before, and GIP represents the growth rate in economic activity as measured by the industrial production. The leads and lags of GIP are included as explanatory variables due to the absence of a theory and any *a priori* evidence that inflation and real returns lead the economic activity. The dummy variable,  $D_t$  which takes values of one and zero, is included in equations (3) and (4) to capture the effects of possible structural changes in the economies under study. The dummy variable takes on values of zero prior to July 1994 and one after that date.<sup>ix</sup> In equations (3) and (4) negative  $\psi_i$  and positive  $\gamma_i$  coefficients would suggest that both relationships in (i) and (ii), and thus, the proxy hypothesis are supported.

Following previous studies (e.g., Chatrath et al. (1996)), equations (3) and (4) are estimated by OLS with Newey-West heteroscedastic and autocorrelation consistent covariance matrix (Newey and West (1987)).<sup>x</sup> The regression method rather than a vector autoregressive system is employed because the objective of the study is to isolate the relationship between variables as described in (i) and (ii) above.<sup>xi</sup>

To derive the expected and unexpected components of the inflation rate we employ two commonly used statistical approaches because series for expected inflation rate is often unavailable in developing economies. The first method involves the use of Hodrick-Prescott (HP) filter, suggested by Hodrick and Prescott (1980). This filter decomposes a series,  $x_t$ , into its trend and unexpected deviations from the trend. The second method requires finding the appropriate ARIMA models. The objective is to use the white noise residuals of the ARIMA model and treat them as the unexpected component of the series under question. The objective of this step is to verify the robustness of the statistical results derived from the HP Filter.

Only the results of HP will be reported in the interest of brevity. However, the results from ARIMA models are qualitatively identical to those obtained using HP filter. The HP filter requires minimizing

$$\sum_{t=0}^T (x_t - \bar{x}_t)^2 + \theta \sum_{t=0}^{T-1} [(\bar{x}_{t+1} - \bar{x}_t) - (\bar{x}_t - \bar{x}_{t-1})], \text{ for } \theta > 0.$$

The technique allows for a stochastic trend component while deriving the temporary or unexpected component.<sup>xii</sup> Under the assumption that market participants form rational expectations regarding inflationary trend, the off-trend or temporary portion of the series may be considered the unexpected inflation.

The returns in each market are the percentage change in the index value,  $R_t = \text{Ln}(\text{Ind}_t / \text{Ind}_{t-1})$ , where  $\text{Ind}$  is the value of the market index. Inflation rate and growth rate in industrial production are also computed in a simi-

lar manner. All variables are initially tested for stationarity by both the Augmented Dickey-Fuller (ADF, Dickey and Fuller (1979)) and Phillips-Perron (PP, Phillips and Perron (1990)) tests.

**IV. Empirical Results**

In this section we report the findings of the empirical tests of Fisher relationship between stock returns and inflation, the relationships explained in (i) and (ii), and finally, Fama’s proxy hypothesis. In order to avoid spurious regression results, all variables of the models are initially tested for unit roots.

**a. Unit Root Tests**

Table 1 reports the findings of the ADF and PP tests of unit roots. Panel A and B present unit root test results for level series and their percentage changes, respectively. The ADF test entails estimating  $\Delta x_t = \alpha + \beta x_{t-1}$

$+ \sum_{j=1}^L \gamma_j \Delta x_{t-j} + u_t$  and testing the null hypothesis that  $\beta=0$  versus the alternative of  $\beta<0$ , for any  $x$ . The lag length  $j$  in the ADF test regressions are determined by the Akaike Information Criterion (AIC). The PP test estimates  $\Delta x_t = \alpha + \beta x_{t-1} + u_t$  and tests the null hypothesis that  $\beta=0$  versus the alternative of  $\beta<0$ . Three variations

of the ADF and PP regressions are estimated: with intercept, trend and intercept, and neither trend nor intercept. The purpose of this approach is to insure that the test results are robust in the presence of drifts and trends. The PP test may be more appropriate if autocorrelation in the series under investigation is suspected. The statistics are transformed to remove the effects of autocorrelation from the asymptotic distribution of the test statistic. The formula for the transformed test statistic is given in Perron (1988). The lag truncation of the Bartlett Kernel in the PP test is determined by Newey and West (1987). In both the ADF and PP tests the MacKinnon (1990) critical values are used. Accepting the null hypothesis means that the series under consideration is not stationary and a unit root is present.

Panel A of Table 1 shows that the CPI, IP, and SI are generally nonstationary in the level, however, the rate of inflation (INF) and its expected component (EIF), index returns (R), and the growth in industrial production (GIP) are all stationary by both the ADF and PP tests as reported in Panel B. The evidence regarding the unexpected rate of inflation (UINF) is not conclusive, though even that variable is stationary in one of the cases. These findings indicate that almost all variables employed in regressions below are stationary and would not cause spurious regression outcomes.

**Table 1. Unit Root Tests**  
*Brazil Stock Index*

Panel A: Level Series			Panel B: Percentage Change Series		
<u>Variable</u>	<u>ADF</u>	<u>PP</u>	<u>Variable</u>	<u>ADF</u>	<u>PP</u>
CPI <sub>a</sub>	-0.242	-0.521	INF <sub>a</sub>	-2.574*	-3.120**
CPI <sub>b</sub>	-1.960	-1.608	INF <sub>b</sub>	-3.180*	-3.485**
CPI <sub>c</sub>	0.828	1.800	INF <sub>c</sub>	-1.773*	-2.297**
IP <sub>a</sub>	-5.980***	-5.000***	EINF <sub>a</sub>	-1.422	-0.471
IP <sub>b</sub>	-5.745***	-5.128***	EINF <sub>b</sub>	-2.488	-3.872**
IP <sub>c</sub>	-0.235	-0.274	EINF <sub>c</sub>	-1.356	-0.372
SI <sub>a</sub>	-0.611	-0.301	UINF <sub>a</sub>	-4.398***	-5.051***

SI <sub>b</sub>	-2.498	-2.178	UINF <sub>b</sub>	-4.383***	-5.037***
SI <sub>c</sub>	0.079	0.478	UINF <sub>c</sub>	-4.412***	-5.065***
			R <sub>a</sub>	-5.71***	-11.81***
			R <sub>b</sub>	-5.71***	-11.79***
			R <sub>c</sub>	-5.49***	-11.64***
			GIP <sub>a</sub>	-9.16***	-21.85***
			GIP <sub>b</sub>	-9.13***	-21.80***
			GIP <sub>c</sub>	-6.50***	-18.49***

Notes: SI, IP, and CPI represent stock index, industrial production and CPI in Brazil, respectively.  $R = \log(SI_t / SI_{t-1})$ ,  $GIP = \log(IP_t / IP_{t-1})$ , and  $INF = \log(CPI_t / CPI_{t-1})$  measure returns, growth in industrial production, and the inflation rate, respectively. (a), (b), and (c), represent Augmented Dickey Fuller(ADF) and Phillips-Perron (PP) unit root tests with intercept, with trend and intercept and with neither trend nor intercept, respectively.

The ADF entails estimating  $\Delta x_t = \alpha + \beta x_{t-1} + \gamma \sum_{j=1}^k \Delta x_{t-j} + u_t$  and testing the null hypothesis that  $\beta=0$  versus the alternative of  $\beta<0$ , for any x. The number of lags on the right-hand-side of ADF regressions as suggested by AIC and SIC. The PP test requires estimating  $\Delta x_t = \alpha + \beta x_{t-1} + u_t$  and testing the null hypothesis  $\beta=0$

versus the alternative of  $\beta<0$ . The PP test may be more appropriate if autocorrelation in the series under investigation is suspected. Lag truncation for Bartlett-kernel in Phillips-Perron test are suggested by Newey-West.

\*, \*\*, and \*\*\* represent 10 %, 5 %, and 1% significance levels, respectively.

**b. Stock Returns and Inflation**

Table 2 reports the results for equations (1) through (3). The test statistics are obtained by a method suggested by Newey and West (1987) which provides heteroscedastic and autocorrelation consistent standard deviations of the coefficients.

Table 2 present coefficient estimates of equations (1) through (3). The coefficient of the expected inflation is insignificant, indicating that real returns are not related the expected inflation rate. This finding shows support for the Fisherian hypothesis, i.e., real returns and expected inflation are not correlated. The negative dummy variable coefficients in three regressions point to the sharp drop in the inflation rate and improvement in real returns since the structural changes happened. Furthermore, more privatization and a drive toward free market in the Brazilian economy has been implemented since the early 1990s. Unexpected inflation is negatively and significantly related to real stock returns. Therefore, the negative relationship between inflation rates and real stock returns as shown in equation (3), seems to stem from the unexpected component of the inflation rate. Empirical findings suggest that equity investing may not be a perfect hedge for investors in this market. In other words, the Fisherian hypothesis is not supported for Brazil. In the following section the relationship between real returns, real economic activity, and inflation is investigated by examining Fama’s explanation summarized in (i) and (ii).

**Table 2: Stock returns versus inflationary trends**

$$R_t - INF_t = \alpha_1 + \beta_1 EINF_t + \varphi_1 D_t + error_t \tag{1}$$

$$R_t - INF_t = \alpha_2 + \beta_1 EINF_t + \beta_2 UINF_t + \varphi_2 D_t + error_t \tag{2}$$

$$R_t - INF_t = \alpha_3 + \beta_1 INF_t + \varphi_3 D_t + error_t \tag{3}$$

(1)

(2)

(3)

Constant	0.013 (0.17)	0.040 (0.540)	0.147*** (3.120)
INF <sub>t</sub>	-- ---	-- ---	-0.479*** (-2.770)
EINF <sub>t</sub>	0.118 (0.34)	0.035 (0.104)	--- ---
UINF <sub>t</sub>	--- ---	-0.630*** (-3.300)	--- ---
D <sub>t</sub>	-0.002 (-0.02)	-0.041*** (-5.640)	-0.126*** (-2.220)
Adj. R <sup>2</sup>	0.050	0.070	0.05

Notes: D represents a dummy variable which is set equal to one from July 1994 on, to account for the significant effects of the Real Plan on the rate of inflation in Brazil.

\*\* and \*\*\* represent 5 %, and 1% significance levels, respectively.

### c. Inflation and Real Activity

Table 3(a, b) reports the results from regression equations (3) and (4). Twelve lagging/leading and the contemporary values of GIP were initially included in the regressions in panel (A). Akaike's Information Criterion (AIC) was employed to reach an optimal dimension for the GIP. Two sets of regressions are estimated to ensure that statistical significance of coefficients is robust and possibility of multicollinearity is minimized. The estimation results are reported under columns (1: k=6) and (2: k=3). Panel A, Columns (1) and (2) suggest a negative correlation between real economic activity and inflation rate. One Lagging and one leading (future) values of GIP are statistically significant suggesting a possible negative correlation between inflation and the real economic activity.

Panel B of the Table 3 shows that there is some statistical support for the positive relationship between real returns and the real economic activity. One lagging and two leading GIP coefficients are positive and statistically significant. Therefore, evidence suggests that real returns are positively related to the real economic activity for Brazil. Liu et al. (1993) have found insignificant correlation between real returns and expected real activity for U.S., UK, Germany, and Canada, while Chatrath et al. (1996) find support for this relationship for India. Furthermore, these findings show that the real economic activity may be leading real returns.<sup>xiii</sup> To summarize, empirical findings suggest a negative relationship between real returns and inflation and a positive relationship between the real activity and real returns for Brazil.

### d. Stock Returns, Inflation, and Real Activity

Empirical findings summarized in Table 3 support a positive relationship between real return and real activity for Brazil. The results indicate a negative relation between inflation and real economic activity. Therefore, the proxy hypothesis explanation for the negative relationship between real returns and inflation may be supported for Brazil based on our data.

Our findings also show that the real economic activity and real returns show a unilateral causality, suggesting that real economic activity directly influences real returns by stimulating the stock market.<sup>xiv</sup>

### e. Combined Tests

To more directly test the proxy hypothesis, we test for hypotheses in one equation. To this end, we first purge the possible impact of GIP on inflation. We then employ the purged inflation variable ( $\xi_{ij}$ ) in the real re-

turns regression

$$R_t - INF_t = \alpha + \sum_{i=-k}^k \beta_i GIP_{t+i} + \theta_j \xi_{ij} + error_t, \quad j=1,2,3, \tag{5}$$

where  $\xi_{ij}$  are regression residuals alternatively obtained from

$$INF_t = \alpha_1 + \sum_{i=-k}^k \phi_i GIP_{t+i} + \xi_{t1}, \tag{6}$$

$$EINF_t = \alpha_2 + \sum_{i=-k}^k \phi_2 GIP_{t+i} + \xi_{t2}, \text{ and} \tag{7}$$

$$UINF_t = \alpha_3 + \sum_{i=-k}^k \phi_3 GIP_{t+i} + \xi_{t3}. \tag{8}$$

The results from the alternate estimation of equation (5), i.e., explanations (i) and (ii) combined, are reported in Table 4. The three columns show that even after controlling for the real economic activity and inflation correlation, there is a strong negative relationship between real returns and the purged inflation variable ( $\xi_{ij}$ ), contradicting the proxy hypothesis. As in Table 2, the negative correlation between real return and purged inflation stems from both the expected and unexpected components of the inflation, shown by the significance of the purged inflation variable in columns I, II and III. The positive effect of real economic activity and real returns found in Table 3 is also verified. Empirical findings summarized in Table 4 indicate that there is support for the positive relationship between the real economic activity and real returns, but not for the proxy hypothesis for Brazil.

**Table 3: Testing Propositions A and B of the proxy effect hypothesis**

$$A: \quad INF_t = \alpha + \sum_{i=-k}^k \beta_i GIP_{t+i} + \varphi D_t + error_t$$

$$B: \quad R_t - INF_t = \alpha + \sum_{i=-k}^k \beta_i GIP_{t+i} + \varphi D_t + error_t$$

	<b>Panel A</b> <i>Inflationary trends and real activity</i>		<b>Panel B</b> <i>Stock returns and real activity</i>	
	<b>k=6</b>	<b>k=3</b>	<b>k=6</b>	<b>k=4</b>
$\alpha$	0.25*** (20.77)	0.23*** (19.74)	0.03 (1.33)	0.03 (1.12)
GIP <sub>t-6</sub>	0.047 (0.238)	---	1.34*** (3.12)	---
GIP <sub>t-5</sub>	0.161 (0.787)	---	0.08 (0.20)	---
GIP <sub>t-4</sub>	0.265 (1.254)	---	0.07 (0.16)	---
GIP <sub>t-3</sub>	0.264 (1.219)	-0.134 (-0.999)	-0.28 (-0.61)	-0.08 (-0.23)
GIP <sub>t-2</sub>	0.200 (0.899)	-0.230* (-1.793)	0.04 (0.09)	-0.07 (-0.22)



GIP <sub>t-1</sub>	0.178 (0.811)	-0.164 (-1.324)	-0.17 (-0.36)	-0.42 (-1.44)
GIP	0.022 (0.098)	-0.183 (-1.497)	0.05 (0.11)	-0.32 (-1.13)
GIP <sub>t+1</sub>	-0.314 (-1.433)	-0.387*** (-3.121)	1.51*** (3.19)	0.87*** (3.06)
GIP <sub>t+2</sub>	-0.099 (-0.452)	-0.067 (-0.527)	0.82* (1.74)	0.29 (0.95)
GIP <sub>t+3</sub>	-0.075 (-0.350)	-0.044 (-0.331)	0.92** (2.00)	0.25 (0.77)
GIP <sub>t+4</sub>	0.118 (0.570)	---	-0.11 (-0.26)	---
GIP <sub>t+5</sub>	0.103 (0.511)	---	0.57 (1.32)	---
GIP <sub>t+6</sub>	0.124 (0.626)	---	-0.05 (-0.13)	---
D	-0.243*** (-11.914)	-0.223*** (-11.549)	-0.026 (-0.59)	-0.061 (-0.28)
	$\bar{R}^2 = 0.51$	$\bar{R}^2 = 0.04$	$\bar{R}^2 = 0.18$	$\bar{R}^2 = 0.05$

Notes: The lead/lag dimension of the independent variable is determined by the minimum AIC.  $R = \log(SI_t / SI_{t-1})$ ,  $GIP = \log(IP_t / IP_{t-1})$ , and  $INF = \log(CPI_t / CPI_{t-1})$  measure returns, growth in industrial production, and the inflation rate, respectively. D represents a dummy variable which is equal to one from July 1994 on, and captures the effects of economic reforms of early 90s on the declining inflation rate.

\*, \*\*, and \*\*\* represent 10 %, 5 %, and 1% significance levels, respectively.

**Table 4: Real returns, inflation, and real activity**

	<u>I</u>	<u>II</u>	<u>III</u>
$\alpha$	-0.02** (-2.41)	-0.02** (-1.94)	-0.02** (-2.48)
GIP <sub>t-6</sub>	1.224*** (3.276)	1.270*** (3.369)	1.181*** (3.202)
GIP <sub>t-5</sub>	-0.017 (-0.046)	0.013 (0.034)	-0.051 (-0.139)
GIP <sub>t-4</sub>	0.089 (0.239)	0.102 (0.273)	0.062 (0.170)
GIP <sub>t-3</sub>	0.171 (0.455)	0.209 (0.552)	0.216 (0.585)
GIP <sub>t-2</sub>	0.241 (0.634)	0.206 (0.536)	0.247 (0.659)
GIP <sub>t-1</sub>	-0.173 (-0.456)	-0.206 (-0.536)	-0.188 (-0.503)
GIP	0.048 (0.125)	0.020 (0.051)	0.024 (0.064)
GIP <sub>t+1</sub>	1.191*** (3.131)	1.186*** (3.081)	1.167*** (3.114)
GIP <sub>t+2</sub>	0.444	0.444	0.429

	(1.169)	(1.156)	(1.148)
GIP <sub>t+3</sub>	0.506 (1.353)	0.501 (1.324)	0.500 (1.357)
GIP <sub>t+4</sub>	-0.096 (-0.262)	-0.141 (-0.378)	-0.078 (-0.216)
GIP <sub>t+5</sub>	0.064 (0.175)	0.043 (0.115)	0.089 (0.244)
GIP <sub>t+6</sub>	-0.157 (-0.423)	-0.185 (-0.494)	-0.133 (-0.363)
DUM	-0.110 (-1.840)	0.067 (0.797)	-1.096 (0.49)
ξ	-1.47*** (-2.86)	-2.50*** (-2.56)	-1.17* (-1.80)

$$\bar{R}^2 = 0.14$$

$$\bar{R}^2 = 0.13$$

$$\bar{R}^2 = 0.17$$

Notes: \*, \*\*, and \*\*\* represent 10%, 5%, and 1% significance levels, respectively. The results are from the equation

$$R_t - INF_t = \alpha + \sum_{i=-k}^k \beta_i GIP_{t+i} + \theta_j \xi_{ij} + u_t, \quad j=1,2,3, \text{ where } \xi_{ij} \text{ is alternately obtained from}$$

$$\text{I. } \xi_{t1} = INF_t - \alpha_1 - \sum_{i=-k}^k \phi_i GIP_{t+i}, \quad \text{III. } \xi_{t2} = EINF_t - \alpha_2 - \sum_{i=-k}^k \phi_2 GIP_{t+i},$$

$$\text{and III. } \xi_{t3} = UINF_t - \alpha_3 - \sum_{i=-k}^k \phi_3 GIP_{t+i}, \text{ respectively.}$$

### f. Cointegration Tests and Long-run equilibrium

Given partial support for Fama's explanations summarized in (i) and (ii) above, we also test for the long-run equilibrium relationship among price level, industrial production, and stock prices employing Johansen and Juselius (1990) cointegration tests. Cointegration refers to the possibility that non-stationary variables may have a linear combination that is stationary. Such a linear combination, the cointegrating vector, implies that there is a long-run equilibrium relationship among variables, i.e., variables will not wander off apart from one another over extended periods of time. Therefore, cointegration between the stock index, price levels, and the industrial production implies a long-run relationship between these variables. The test of cointegration employed in this paper is a methodology suggested by Johansen (1988) and Johansen and Juselius (1990). This method is a multivariate generalization of the methodology suggested by Engle and Granger (1987). A brief description of the test is as follows. Let

$$\Delta x_t = \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-i} + \pi x_{t-1} + \varepsilon_t, \tag{9}$$

where  $x_t$  and  $\varepsilon_t$  are  $(n \times 1)$  vectors and  $\pi$  is an  $(n \times n)$  matrix of parameters. The Johansen (1988) methodology requires estimating the system of equations in (9) and examining the rank of matrix  $\pi$ . If  $\text{rank}(\pi) = 0$ , then there is no stationary linear combination of the  $\{x_{it}\}$  process, the variables are not cointegrated. Since the rank of a matrix is the number of non-zero eigenvalues ( $\lambda$ ), the number of  $\lambda > 0$  represents the number of cointegrating vectors among the variables. The test for the non zero eigenvalues is normally conducted using the following two test statistics:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \tag{10}$$

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{11}$$

where  $\hat{\lambda}_i$  is the estimated eigenvalues, and T is the number of valid observations. Note that  $\lambda_{trace}$  statistic is simply the sum of  $\lambda_{\max}$  statistic. In equation (10),  $\lambda_{trace}$  tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative.  $\lambda_{\max}$  statistic tests the null hypothesis of r cointegrating vectors against r+1 cointegrating vectors. Johansen and Juselius (1990) and Osterwal-Lenum (1992) derive the critical values of  $\lambda_{trace}$  and  $\lambda_{\max}$  by simulation method.

According to the results of various cointegration tests, reported in Table 5, there is some evidence suggesting a long-run equilibrium relationship among stock prices, inflation, and industrial production. There is strong evidence that stock prices and inflation, stock prices and real economic activity, and consumer price levels and real economic activity indicate long-run equilibrium relationships. These findings suggest that in the long-run propositions (i) and (ii) may be supported for Brazil. Furthermore, investigation of the short-term relationships among the variables under question is warranted.  $\lambda_{trace}$  and  $\lambda_{\max}$  tests indicate that there is at least one cointegrating vector among the three variables. Table 6 presents the normalized and non-normalized estimated cointegrating vectors. Table 7 presents the estimated cointegrating vector subject to exactly one indentifying restriction. Based on the results reported in Table 7, the long-run relationship among stock prices, price levels and the industrial production for Brazil may be written as

$$SI = -56.73 \text{ CPI} + 565.08 \text{ IP} + 127.90 \text{ Trend} \tag{12}$$

(-1.96) (12.04) (3.78)

Equation (12) shows that in the long-run price levels and industrial production are respectively, negatively and positively related to stock prices. To examine the long-run relationship between the real economic activity and the price index in Brazil, we test for cointegration between these two variables. The final long-run cointegrating vector is estimated and reported in Table 7. It shows that the long-run relationship between the price level and the industrial production for Brazil is negative. Therefore, the cointegration test results lend support for the proxy hypothesis, i.e., stock prices and price levels are negatively related, while there is also a negative relationship between price levels and the industrial production. Combined with the positive relationship between the industrial production and stock prices, Fama’s proxy hypothesis may be supported for Brazil in the long-run.

**g. Implications for Global Investors**

Our findings validate the negative relationship between inflation and real stock returns for Brazil. Rising inflation seems to have been correlated with the declining Bovespa in 1998 and early 1999. Given this relationship, one might be optimistic about the Bovespa’s performance in the near future. Brazil’s monetary and fiscal policies seem to have succeeded in curbing inflation: Banco de Brazil believes that inflation will be at 6 percent for the year 2000, well below the 9 percent in 1999. Moreover, the GDP growth is expected to be between 4 and 5 percent in 2000-2001.

A word of caution, however: The Bovespa’s performance is understandably linked to foreign funds flowing into Brazilian equity markets. Net foreign investments in the Brazilian stock market were at a hefty 4 billion dollars in 1996. Moreover, lesson learned from the Asian contagion is that stock investors are quick to react to any threats, especially those relating to currency valuation. While Brazil’s currency, the real, remains stable for now, the potential of a weak currency poses a major threat to equity performance in Brazil. Depreciation in the value of the real could have a two-pronged affect. First, a depreciating currency could spur higher inflation, thus, threatening the Bovespa’s performance. Second, a softer real can be expected to result in lower foreign investments, which will undo the progress in GDP growth over the last few years.

**V. Summary and Conclusions**

This paper investigates a widely reported negative relationship between real stock returns and inflation for a major emerging market, Brazil. The empirical tests are conducted within Fama’s proxy hypothesis framework, which states that (i) there is a negative relationship between inflation and real activity; and (ii) the relationship between the real stock returns and real economic activity is positive. Our findings support the negative relationship between inflation and real stock returns. However, the evidence does not unequivocally validate the proxy effect. The negative relationship between the real stock returns and inflation rate for Brazil persists even after the negative relationship between inflation and real activity is purged. Therefore, real stock returns may be adversely affected by inflation because (a) inflationary pressures may threaten future corporate profits; and (b) nominal discount rates rise under inflationary pressures, reducing current value of future profits, and thus, stock returns.

On the other hand, we do find some evidence of a long-run equilibrium relationship between price levels, stock prices and real activity, consistent with the proxy effect hypothesis. These results support the interesting notion that the proxy effect may be valid in the long-run and yet not in the short-run.

**Table 5: Long-Term Equilibrium:  
Johansen-Juselius Maximum Likelihood Procedure**

Cointegration LR Test Based on Maximal Eigenvalue and Trace of the Stochastic Matrix

		Variables included in the cointegrating vector			
		<u>CPI&amp;SI</u>	<u>CPI&amp;IP</u>	<u>SI&amp;IP</u>	<u>CPI&amp;SI&amp;IP</u>
<i>Ho</i>	<i>Ha</i>			$\lambda_{max}$	
r=0	r=1	118.936 <sup>a***</sup>	66.161 <sup>a***</sup>	52.114 <sup>a***</sup>	117.919 <sup>a***</sup>
		118.934 <sup>b***</sup>	65.913 <sup>b***</sup>	42.450 <sup>b***</sup>	117.830 <sup>b***</sup>
		102.190 <sup>c***</sup>	55.251 <sup>c***</sup>	52.113 <sup>c***</sup>	101.140 <sup>c***</sup>
r ≤ 1	r=2	5.660 <sup>a</sup>	52.413 <sup>a***</sup>	6.900 <sup>a***</sup>	56.912 <sup>a***</sup>
		5.543 <sup>b</sup>	40.773 <sup>b***</sup>	4.012 <sup>b</sup>	43.048 <sup>b***</sup>
		4.320 <sup>c</sup>	45.726 <sup>c***</sup>	6.340 <sup>c</sup>	56.854 <sup>c***</sup>
r ≤ 2	r=3	---	---	---	5.821 <sup>a</sup>
		---	---	---	5.754 <sup>b</sup>
		---	---	---	4.670 <sup>c</sup>
				$\lambda_{trace}$	
r=0	r ≥ 1	124.600 <sup>a***</sup>	118.574 <sup>a***</sup>	59.013 <sup>a***</sup>	180.653 <sup>a***</sup>
		124.480 <sup>b***</sup>	106.686 <sup>b***</sup>	46.461 <sup>b***</sup>	166.632 <sup>b***</sup>
r ≤ 1	r ≥ 2	2.640 <sup>a</sup>	6.49 <sup>a</sup>	4.240 <sup>a</sup>	62.733 <sup>a***</sup>
		0.0240 <sup>b</sup>	2.640 <sup>b</sup>	1.740 <sup>b</sup>	48.802 <sup>b***</sup>
		2.670 <sup>c</sup>	0.680 <sup>c</sup>	3.980 <sup>c**</sup>	61.523 <sup>c***</sup>
r ≤ 2	r=3	---	---	---	5.821 <sup>a</sup>
		---	---	---	5.754 <sup>b</sup>
		---	---	---	4.670 <sup>c</sup>

Notes: CPI, IP and SI stand for the consumer price index, industrial production index, and the stock index.  
 r stands for the number of cointegrating vectors.  
 Critical values are taken from Oterwald-Lenum (1992).  
 a. Unrestricted intercepts and restricted trends in the VAR.  
 b. Unrestricted intercepts and no trend in the VAR.  
 c. Unrestricted intercept and unrestricted trends in the VAR.  
 The lag number in VAR=3 is based on the adjusted loglikelihood ratio test and Akaike and Schwarz criteria.

Eigenvalues of the stochastic matrix are computed and available, but not reported. The hypothesis of  $r \leq 2$  is accepted.

\*, \*\*, and \*\*\* represent 10%, 5%, and 1% significance levels, respectively.

**Table 6: Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)  
Cointegration with unrestricted intercepts and restricted trends in the VAR**

Order of VAR = 3, chosen  $r = 1$ .  
List of variables included in the cointegrating vector:  
SI, CPI, IP, Trend

Vector 1	
SI	0.45E-4
CPI	0.0025
IP	-0.025
Trend	-0.006

**Table 7: ML estimates subject to exactly identifying restriction(s)  
List of variables included in the cointegrating vector:  
(SI,CPI,IP,Trend) and (CPI,IP,Trend)**

List of imposed restriction(s) on cointegrating vectors:  $A1=1$


Vector 1		
SI	1.00	---
	---	---
CPI	56.73**	1.00
	(1.96)	---
IP	-565.08***	-5.64***
	(-12.04)	(-5.03)
Trend	-127.90***	1.11***
	(-3.78)	(7.4)

Notes: Estimates of restricted cointegrating relation (t-statistics in brackets), cointegration with unrestricted intercepts and restricted trends in the VAR. Order of VAR = 3, one cointegrating vector is chosen.

\*\* and \*\*\* indicate significance at 5 and 10 percent levels.

LL subject to exactly identifying restrictions= -2035.4

## VI. Suggestions For Future Research

Our empirical results indicate that the proxy effect may be a long-run phenomenon in some markets. Following our findings, it may be interesting to reexamine the proxy hypothesis for other countries in the framework of cointegration tests. Furthermore, most studies in the past have employed broad equity market indices to test the proxy hypothesis. It may be a useful exercise to investigate the validity of the proxy hypothesis in the short- and long-run, by examining sector equity indices or individual equity price trends. This line of research is valuable because the countervailing effects of inflation on various sectors of the economy may offset one another in the computation of the overall market index. Thus, statistical tests may spuriously conclude that equity indices are not affected by changes in inflation. 

*Financial support from the DR. Robert B. Pamplin, Jr. School of Business Administration, University of Portland, is greatly appreciated.*

## VI. Endnotes

- i. The statistics presented here are taken from various issues of The Emerging Stock Market Factbook, International Finance Corporation.
- ii. Economic policies initiated by the government of Brazil are finally bearing fruits. Inflation is under control and GDP growth rate is on the rise, especially considering that the 1980s in Brazil are known as a “lost decade”. Furthermore, there are no speculative bubbles in the stock market and the currency and the banking systems are relatively healthy.
- iii. The Fisherian hypothesis, maintains that real returns in efficient markets are determined by real variables such as capital productivity and are unrelated to nominal variables such as inflation, money supply, etc. For more on this see Fisher (1930).
- iv. On the other hand, there are relatively few studies on emerging markets. Chatrath et al. (1996) study the proxy hypothesis in India and find only partial support for this hypothesis.
- v. Mortley (1993) provides evidence from the U.S. economy that persistent inflation could lower the real GDP growth .
- vi. For more on Phillips curve see Macroeconomics by Robert Barro (1990), pp. 46-474.
- vii. It should be noted that equity market data for a majority of emerging markets are unavailable or unreliable prior to mid 1980s. Furthermore, important markets such as Argentina are excluded because their monthly data are not available from IFS and other reliable sources. The price index series for Brazil is the so-called “General Price Index”, known here as IGP – Índice Geral de Preços, which is 60% consumer prices, 30% wholesale prices, and 10% cost of construction.
- viii. In addition to Fama and Schwert (1977), Gultekin (1983), and Kaul (1987) find that equities are not a hedge against inflation. A number of researchers attempt to find explanations for these findings, notably Feldstein (1980), Fama (1981), and Geske and Roll (1981).
- ix. The dummy variable takes on values of zero prior to July 1994. This date is chosen because the Brazilian economy has been quite stable since that time. Specifically, inflation, historically a major threat to the Brazilian economy, has been in check since mid 1994.
- x. In the presence of autocorrelation and heteroscedasticity it is crucial to obtain unbiased estimator of the coefficient standard errors. For more information on this subject see Greene (1993).
- xi. Inflation rate, its expected, and unexpected components are tested for the possibility of being endogenous employing Hausman test (see Berndt (1991), p. 379). The coefficients of the predicted measures of inflation are insignificant in equation (1), showing that inflation rate, and its predicted and unexpected components are not endogenous. Similar tests show that GIP is not endogenous in equations (5) through (8). These results are not reported, but available from the authors.
- xii. It is now widely recognized that all decompositions are statistical, and therefore there is an infinite number of ways to decompose a series into permanent and transitory components. An advantage of HP method is that it relies on a minimum number of assumptions and, hence, is more defensible (e.g. Kyland and Prescott (1990)). We select the value of  $\theta=14400$  for monthly data, as suggested by Hodrick and Prescott (1980).
- xiii. Estimated VAR models and Granger causality tests show that real economic activity Granger causes real returns in Brazil and there is no feedback.
- xiv. Granger causality results are not reported but are available from the authors.

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#### Notes





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