The causal relationship between the macroeconomic variables and the stock price: the case of Brazil

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Abstract

This study attempts to investigate the direction of causal relationship between the Brazilian stock market index (the Bovespa market index) and selected macro-economic indicators, namely interest rate, money supply (M2), and Brazilian Real exchange rate to the US dollar. A number of studies investigated the causal relationship between macro-economic indicators and stock market indices in the developed countries. But in the context of developing countries in South America such as Brazil, few studies can be traced in the literature. Thus, this study focuses on this issue by applying the standard time series techniques. The results of the study indicate that the variables under analysis are in fact cointegrated, which proves the existence of a long-term theoretical relationship among the variables. As regards the direction of causality, the results tend to indicate that the interest rate variable is the most exogenous (or leading) variable and the exchange rate is the most endogenous (or lagging) variable. These findings imply that the interest rate variable played a significant role in affecting the stock returns of the Bovespa Market Index and hence a special attention should be given to its management. Furthermore, strong evidence points to the relative exogeneity of the Bovespa Market Index, which means that the Brazilian stock returns can be used in predicting the endogenous macroeconomic indicators analyzed in this study.

Keywords: stock returns, macroeconomic variables, Granger-causality, VECM, VDC

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1.0 Introduction

Stock market plays an important role in the economic development of both developed and developing countries by channeling idle funds from surplus to deficit units in the economy. Therefore, understanding the factors that influence the behavior of stock markets and whether stock markets can be used in predicting macroeconomic indicators has attracted the attention of economists, policy makers and other interested parties. The focus on such an issue resulted in a number of studies that investigated the causal relationship between macro-economic indicators and the stock market in both the developed and developing countries. Contributing to the literature on this issue, this study will explore such relationship in the context of the Brazilian economy.

Section two is devoted to the main objectives and motivation behind the study, while section three reviews some of the empirical studies that investigated the causal relationship between macro-economic indicators and the stock market in a number of developed and developing countries. This is followed by section four which focuses on the theoretical framework, while section five discusses the methodology to be used in this study. Data, empirical results and discussions are dealt with in section six and the study ends with section seven that contains the major conclusions and the policy implications of the study.

2.0 Objectives and Motivation

The main objective of the study is to find out the nature of the relationship between macro-economic indicators and the stock market in Brazil. Moreover, the study aims to find out whether macro-economic indicators lead the stock market or the other way around. Thus, the study tries to answer the following research questions:

1. Is there a relationship of cointegration between the macro-economic indicators and the stock market?
2. Do macro-economic indicators lead the stock market? Or does the stock market lead the economic indicators?

The main motivation behind this study is the fact that the Brazilian economy is currently the largest in Latin American nations and the second largest in the western hemisphere[1]. Therefore, understanding the determinants of its stock market is important for policy makers, investors and various stakeholders. Moreover, there is still a debate regarding the role a stock market plays in the economy of a country. Some argue that the stock market can predict economic activity through what is known as the wealth effect, which contends that when the stock market is climbing, the household wealth will increase and this will result in more spending, which in turn leads to the expansion of the economy. On the other hand, when the stock prices decline, the household wealth will decrease and this will result in less spending, which in turn leads to the contraction of the economy[2]. On the other hand, some argue that the stock market has previously generated false signals about the economy, and therefore should not be relied upon as an economic indicator. Another reason why the stock market does not lead economic activities is because of investors' expectations about future economic activity which are subject to human error[3]. Thus, the role played by the stock market in the economy and its relationship with other macro-economic indicators is still a debatable one, and therefore examining such an issue in the Brazilian context is justified. Finally, only a handful of studies have been devoted to investigate the relationship between macroeconomic variables and the stock markets in developing and emerging countries

[1] See: http://en.wikipedia.org/wiki/Economy_of_Brazil#cite_note-13.
[2] Pearce, Douglas K., (1983), Stock prices and the economy, federal reserve bank of Kansas City, pp. 7-22.
[3] Comincioli, Brad, (1995), **The stock market as a leading economic indicator: an application of Granger causality**, Illinois Wesleyan University, honors projects paper 54, pp. 1-19.

such as Brazil. As such there is a need to investigate the nature of relationship between macroeconomic variables and stock prices in the context of Brazil.

3.0 Literature Review

Several studies have been conducted in order to determine the nature of relationship between the macro-economic indicators and the stock market in several developed countries. Among these studies is an article by Mukherjee and Naka (1995)[4] that found the Japanese stock market is cointegrated with a group of six macroeconomic variables, which are exchange rate, inflation, money supply, real economic activity, long-term government bond rate, and call money rate. Another study is authored by Nasseh and Strauss (2000)[5] in which the authors concluded the existence of a significant, long-run relationship between stock prices and domestic and international economic activity in six European countries and that stock prices are determined by macroeconomic activity. A third study by Lovatt and Parikh (2000)[6], investigated the relationship between real stock returns and a number of financial and economic variables for the United Kingdom economy and showed that a plausible relationship exists between real stock returns and most of the financial and economic variables. Finally, a study authored by Hondroyiannis and Papapetrou (2001)[7], focused on the dynamic interactions of macro-economic indicators, such as industrial production, interest rate, exchange rate, the performance of the foreign stock market, and oil prices with the stock market in Greece. The empirical evidence suggested that stock returns

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[4] Mukherjee, Tarun K., & Naka, Atsuyuki, (1995), **Dynamic relations between macroeconomic variables and the Japanese stock market: An application of a vector error correction model,** Journal of financial research, Vol. 18, issue 2, pp. 223-237, retrieved from http://www.allbusiness.com/personal-finance/investing-stock-investments/514746-1.html.

[5] Nasseh, Alireza, & Strauss Jack, (2000), **Stock prices and domestic and international macroeconomic activity: A cointegration approach,** The quarterly review of economics and finance, Vol. 40, issue 2, pp. 229-245.

[6] Lovatt, David, & Parikh Ashok, (2000), **Stock returns and economic activity: The UK case,** The European journal of finance, Vol. 6, issue 3, pp. 280-297.

[7] Hondroyiannis, George, & Papaetrou Evangelia, (2001), **Macroeconomic influences on the stock market,** Journal of economics and finance, Vol. 25, issue 1, pp. 33-49.

do not lead changes in real economic activity while the macroeconomic activity and foreign stock market changes explain only partially stock market movements. Additionally, researchers have examined similar relationships in developing countries. Among such studies Maysami and Koh (2000)[8] examined such relationship in Singapore. They found that inflation, money supply, changes in short and long-term interest rate and variations in exchange rate formed a cointegrating relation with changes in Singapore's stock market. Also Maghyereh (2002)[9] investigated the long run relationship between the Jordanian stock prices and selected macroeconomic variables by using Johansen's methodology in cointegration analysis. The study finds that macroeconomic variables are reflected in the stock prices of the Jordanian capital market. Another study by Islam (2003)[10], examined the short-run dynamic adjustment and the long-run equilibrium relationships between the Kuala Lumpur stock exchange composite index, and four macroeconomic variables, namely interest rate, inflation rate, exchange rate, and industrial production. The results support the existence of short-run dynamic adjustment and the long-run, equilibrium relationships between the macroeconomic variables and the Kuala Lumpur stock market. Moreover, the impact of macroeconomic indicators on Vietnamese stock prices was investigated in a paper by Hussainey & Ngoc (2009)[11], which concluded that there is a statistically significant association between domestic production sector, money market and stock prices in Vietnam. More recent studies

[8] Maysami, Ramin Cooper, & Koh, Tiong Sim, (2000), **A vector error correction model of the Singapore stock market,** International review of economics & finance, Vol. 9, issue 1, pp. 79-96.
[9] Maghyereh, Aktham Issa, (2002), **Causal relations among** stock prices and macro-economic variables in the small open economy of Jordan, retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=317539.
[10] Islam, Mazher M., (2003), **The Kuala Lumpur stock market and economic factors: A general to specific error correction modeling test,** Journal of academy of business and economics, retrieved from http://www.allbusiness.com/personal-finance/investing-stock-investments/752251-1.html.
[11] Hussainey, Khaled & Ngoc, Le Khanh, (2009), **Impact of macro-economic indicators on Vietnamese stock prices,** Journal of risk finance, Vol. 4.

include Tunali (2010)[12] which analyzed the relationship between macroeconomic variables and stock returns in the Turkish stock market index. The study showed that there is a long run relationship between basic macroeconomic indicators of Turkish economy and stock returns on different levels. Another study by Asaolu and Ogunmuyiwa (2010)[13] investigated whether changes in macroeconomic variables explain movements in stock prices in Nigeria, and concluded that a long run relationship does exist between stock prices in Nigeria and macro-economic variables. Finally, Ali et al. (2010)[14] examined the causal relationship between macro-economic indicators and stock market prices in Pakistan. The set of macro-economic indicators includes; inflation, exchange rate, balances of trade and index of industrial production, whereas the stock exchange prices have been represented by the general price index of the Karachi Stock Exchange. The study found no causal relationship between macro-economic indicators and stock exchange prices in Pakistan, which means the performance of macro-economic indicators, cannot be used to predict stock prices in Pakistan.

As far as Brazil is concerned Davey (2007)[15] examined the relationship between the Brazilian stock market and global economic indicators, specifically the US stock market, the Mexican stock market, the exchange rate of the US dollar in terms of Brazilian Real and oil prices. The study used regression analysis and concluded that whilst a relationship appears to exist between the Brazilian stock market and these variables, the nature of the relationship is not consistent and is changing over time.

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[12] Tunali, Halil, (2010), **The analysis of relationships between macro-economic factors and stock returns: Evidence from Turkey using VAR model,** International research journal of finance and economics, issue 57, pp. 169-182.

[13] Asaolu, T. O., & Ogunmuyiwa, M. S., (2011), **An econometric analysis of the impact of macroeconomic variables on stock market movement in Nigeria,** Asian journal of business management, Vol. 3, issue 1, pp. 72-78.

[14] Ali, Imran et al., (2010), **Causal relationship between macro-economic indicators and stock exchange prices in Pakistan,** African journal of business management, Vol. 4, issue 3, pp. 312-319.

[15] Davey, Paul Philip, (2007), **Analyzing the changing relationship between the Brazilian stock market and global economic indicators,** Master thesis dissertation.

As we can see from the above, many studies have been conducted with the aim of examining the relationship between macro-economic indicators and the stock market in developed and developing countries. However, none of these studies looked at such a relationship in the context of Brazil, with the exception of the last study, which focused on the impact of global economic indicators on the Brazilian stock market. Thus, it can be said that this study will contribute to the literature in the field by focusing on the analysis of the relationship between local macro-economic indicators and the stock market in Brazil. Moreover, the study will utilize various econometric techniques in examining such relationship, which are more rigorous in comparison with the regression analysis used in the last study.

4.0 Theoretical Framework

There is still a debate regarding the role a stock market plays in the economy of a country. Some argue that the stock market can predict economic activity through what is known as the wealth effect, which contends that when the stock market is climbing, the household wealth will increase and this will result in more spending, which in turn leads to the expansion of the economy. On the other hand, when the stock prices decline, the household wealth will decrease and this will result in less spending, which in turn leads to the contraction of the economy[16]. However, some argue that the stock market has previously generated false signals about the economy, and therefore should not be relied upon as an economic indicator. As for the relationship between interest rate, money supply (M2), and exchange rate with the stock price variable, the following relationships are hypothesized.

[16] Pearce, Douglas K., (1983), **Stock prices and the economy**, federal reserve bank of Kansas City, pp. 7-22.

4.1 Interest Rate:

A low interest rate is good for businesses, since it reduces the cost of borrowing and makes it cheaper to borrow funds, invest in projects and expand supply. This will have a positive effect on future expected returns for businesses, pushing the stock prices up. On the other hand, an increase in interest rate means investors will require a higher rate of return before investing. Thus, investment will become less attractive. This will reduce the earning expectations of businesses, and will reduce the demand for stocks, which will push the stock prices down[17].

4.2 Money Supply (M2):

The growth rate of money supply would affect the aggregate economy and hence the expected stock returns. Therefore, an increase in money supply (M2) growth would indicate excess liquidity, which results in lower interest rates. The lower interest rate reduces the cost of borrowing and makes it cheaper to borrow funds, invest in projects and expand supply. This will have a positive effect on future expected returns for businesses, pushing the stock prices up. A decrease in money supply (M2) would result in a decrease in the supply of funds for working capital, and would raise market interest rate and hence the firm's cost of capital making it less attractive to invest, which will reduce the demand for stocks, which in turn will push the stock price down[18]. Thus, a positive relation between money supply (M2) and stock price is hypothesized in this study.

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[17] Mukherjee, Tarun K., & Naka, Atsuyuki, (1995), **Dynamic relations between macroeconomic variables and the Japanese stock market: An application of a vector error correction model,** Journal of financial research, Vol. 18, issue 2, pp. 223-237, retrieved from http://www.allbusiness.com/personal-finance/investing-stock-investments/514746-1.html.

[18] Friedman, Milton, & Schwartz, Anna Jacobson, (1963), **A monetary history of the United States, 1867-1960,** Princeton university press.

4.3 Exchange Rate:

A positive relationship between the exchange rate and stock prices is hypothesized. Thus, a depreciation of the currency creates expectations of inflation for the future. Inflation is seen as negative news by the stock market, because it tends to curb consumer spending and therefore company earnings, which in turn will push the stock prices down. Alternatively, an appreciation of the currency would result in attracting investments and this rise in demand will push up the stock prices[19].

5.0 Methodology

The study will rely upon various econometric techniques in examining the relationship between the macro-economic indicators and the stock market in Brazil. The first of such techniques is the unit root test, whereby the variables are tested to ensure that they are non-stationary in their level form and stationary in their differenced form. For the purpose of conducting this study the Augmented Dickey Fuller test (ADF) will be used to test each variable in its level and differenced form. This will be followed by the selection of the order of the VAR, by relying upon the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). Once the order of the VAR is selected, the Johansen cointegration test will be applied to examine the long run relationship among the variables and to rule out any spurious relationship. The cointegrating estimated vectors will then be subjected to exactly identifying and over identifying restrictions. The next step will be the use of the vector error correction model (VECM) to determine which variable is exogenous and which variable is endogenous. This will be followed by the use of variance decomposition

[19] Mukherjee, Tarun K., & Naka, Atsuyuki, (1995), **Dynamic relations between macroeconomic variables and the Japanese stock market: An application of a vector error correction model,** Journal of financial research, Vol. 18, issue 2, pp. 223-237, retrieved from http://www.allbusiness.com/personal-finance/investing-stock-investments/514746-1.html.

technique (VDC) to indicate which variable is the most exogenous and which one is the most endogenous. The impulse response function (IRF) will then be applied to map out the dynamic response paths of the variables due to a one period shock to another variable. Finally, the persistence profile will be applied, whereby the cointegrating estimated vectors will be subjected to an external shock, in order to determine the time horizon required for the cointegrating variables to go back to equilibrium.

6.0 Data, Empirical Results and Discussions

The study will rely on monthly time series data from January 1997 to December 2010. The four variables under analysis are the Bovespa Market Index (BSP), interest rate (BIR), money supply (BM2), and Brazilian Real exchange rate to the US dollar (BEX). The source of the data for all the variables is data stream database, with the exception of interest rate the data for which was collected from the website of the central bank of Brazil.

6.1 Unit Root Test

In this stage the variables are tested to ensure that they are non-stationary in their level form and stationary in their differenced form. As a result, the variables are first transformed into logarithms to achieve stationarity in variance. The variables are then tested in their log form using the Augmented Dickey Fuller test (ADF), with the null hypothesis being that all the variables are non-stationary. The results in table (1) show that all the variables are non-stationary in their log level form since the test statistics are below the critical value, and as a result the null hypothesis is accepted.

Table 1: Non-stationarity of the variables in the log level form

Variable	Test Statistic for Highest AIC	Test Statistic for Highest SBC	Critical Value	Result
LBSP	2.8553	2.8553	3.4382	Non-stationary
LBIR	1.7430	1.9369	3.4382	Non-stationary
LBM2	1.3675	0.96047	3.4382	Non-stationary
LBEX	1.8352	1.6828	3.4382	Non-stationary

The next step involved the differencing of the variables once, and testing their stationarity using the same test, with the null hypothesis being the same. The results in table (2) indicate that all the variables are stationary, since the test statistics are above the critical value, which means that the null hypothesis is rejected. Thus, it can be said that all the variables are integrated of one order I (1) on the basis of the Augmented Dickey Fuller Test (ADF).

Table 2: Stationarity of the variables in the differenced form

Variable	Test Statistic for Highest AIC	Test Statistic for Highest SBC	Critical Value	Result
LBSP	12.8476	12.8476	2.8794	Stationary
LBIR	3.1566	4.4727	2.8794	Stationary
LBM2	5.5177	11.3923	2.8794	Stationary
LBEX	10.6224	10.6224	2.8794	Stationary

6.2 Selection of the Order of the VAR

The aim of this step is to determine the optimal order of the VAR. Therefore, at this stage it is important to select a high enough order so as to ensure that the optimal order will not exceed it. Hence, lag 9 was

chosen. The results in table (3) show that the p-value for order 8 and 6 are above 10%, which means that the selection of the optimal lag is restricted to order 8 and 6. However, by looking at the highest value for both AIC and SBC, it can be confirmed that the optimal order of the VAR is 6.

Table 3: Selection of the order of the VAR

Order of the VAR	AIC	SBC	p-value
9	1080.2	853.5	----
8	1085.3	883.1	**0.405**
7	1083.8	906.1	0.085
6	**1089.0**	**935.9**	**0.116**
5	1086.7	958.1	0.025

6.3 Johansen Cointegration Test

The standard Johansen cointegration test is applied and the results in table (4) indicate the existence of one cointegrating vector at the 95% significance level on the basis of both the maximal eigenvalue and trace statistics.

Table 4: Johansen cointegration test

Maximal Eigenvalue				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
R=0	R=1	34.70	31.79	29.13
R ≤ 1	R=2	**17.04**	**25.42**	23.10
Trace Statistics				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
R=0	R ≥ 1	66.60	63.00	59.16
R ≤ 1	R ≥ 2	**31.90**	**42.34**	39.34

As shown in table (4) above the test statistic based on the maximal eigenvalue shows a value of 34.70 which is greater than the critical value of 31.79 at the 95% significance level, which means that the null hypothesis of zero cointegration is rejected. Moreover, the null hypothesis of R ≤ 1 is accepted, because the test statistic shows a value of 17.04 which is lower than the critical value of 25.42 at the 95% significance level. Similarly, the results of trace statistics indicate the same conclusion that is drawn from the results of the maximal eigenvalue. Therefore, it can be said the relationship among the variables is not spurious, which means that there is a theoretical relationship among the variables and that they are in equilibrium in the long run.

6.4 Long Run Structural Modeling

The LRSM procedure is applied by imposing exact identifying and over identifying restrictions. First of all an exact identifying restriction is imposed on our variable of interest, which is the Brazilian stock market index by making its coefficient equal to one. The results in table (5) show that three of the variables are statistically insignificant along with the time trend, due to the fact that their t-ratio is less than 2.

Table 5: Exact and over identifying restrictions on the cointegrating vector

	Exact Identifying	**Over Identifying**			
	Panel A	**Panel B**	**Panel C**	**Panel D**	**Panel E**
LBSP	1.0000 (*NONE*)	1.0000 (*NONE*)	1.0000 (*NONE*)	1.0000 (*NONE*)	1.0000 (*NONE*)
LBIR	1.5113 (1.9343)	0.0000 (*NONE*)	-0.42748 (0.12441)	-0.58514 (0.12255)	-0.68308 (0.15366)
LBM2	11.5088 (11.3060)	3.5875 (0.83863)	0.0000 (*NONE*)	-1.0953 (0.36509)	-1.3803 (0.10806)
LBEX	4.5365 (4.1009)	1.6335 (0.27874)	0.32837 (0.12262)	0.0000 (*NONE*)	-0.18535 (0.15089)
Trend	-0.14848 (0.13019)	-0.058271 (0.010474)	-0.015559 (0.0011689)	-0.0029216 (0.0046041)	0.0000 (*NONE*)
		p-value 0.005	**p-value** 0.000	**p-value** 0.001	**p-value** 0.001

Based on the above results of panel A, over identifying restrictions are imposed on each of the statistically insignificant variables in addition to the time trend by equaling each of their coefficients to zero, in order to confirm whether the variables and the time trend are statistically insignificant or not, with the null hypothesis being that our over identifying restriction is correct. By observing the results in panel B, C, D and E it can be concluded that the restrictions imposed on the variables and the time trend can be rejected at the 99% significance level, since the p-value in each case is less than 1%, and therefore the percentage of error we are making when we reject the null hypothesis is less than 1%. In short, the results indicate that we have to proceed with panel

A, which means that the coefficients of all the variables along with the time trend coefficient will be included in the error correction model.

6.5 Vector Error Correction Model (VECM)

The vector error correction modeling technique is applied to determine which variable is exogenous (independent) and which variable is endogenous (dependent).

Table 6: Results of the vector error correction model (VECM)

Dependent Variables	DBSP	DBIR	DBM2	DBEX
DBSP (1)	-0.043 (0.087)	0.013 (0.029)	0.092 (0.014)	-0.119 (0.047)
DBIR (1)	-0.341 (0.258)	0.094 (0.086)	0.034 (0.044)	0.100 (0.140)
DBM2 (1)	-0.245 (0.462)	-0.153 (0.154)	0.058 (0.078)	0.558 (0.250)
DBEX (1)	-0.096 (0.163)	-0.006 (0.054)	0.045 (0.027)	0.196 (0.088)
ECM (-1)	0.028 (0.016)	0.002 (0.005)	-0.014 (0.002)*	-0.019 (0.009)*
Chi-sq SC (1)	19.25 [0.08]	31.88 [0.00]	57.26 [0.00]	8.08 [0.77]
Chi-sq FF (1)	0.87 [0.34]	5.29 [0.02]	0.87 [0.34]	31.61 [0.00]
Chi-sq N (2)	152.78 [0.00]	2021.8 [0.00]	13.03 [0.00]	1053.2 [0.00]
Chi-sq Het (1)	0.02 [0.88]	1.04 [0.30]	0.00 [0.96]	89.54 [0.00]

As we can see table (6) above shows that the interest rate variable is exogenous, while both the money supply and the exchange rate variables are endogenous. As for the stock price variable the results are not conclusive. This is because the t-ratio for the error correction term is less than 2, which means that the deviation of the variables represented by the error correction term does not have a significant feedback effect on the stock price variable. This implies that the stock price variable is exogenous. However, if we look at the p-value we will notice that it is 9.90%, which is

slightly less than 10%. This means that we are making a slightly less than 10% error when we reject the null hypothesis of the error correction term not having a significant effect on the variable, which enables us to proceed with the rejection of the null hypothesis. This implies that the error correction term does have a significant feedback effect on the stock price variable, which makes it endogenous. Having said that, it is important to note that the error we are making when we are rejecting the null hypothesis of the error correction term having no effect on the stock price variable is almost 10% which is a high percentage of error. Moreover, the wealth effect theory, lends support to the idea of the stock market being exogenous and having an impact on the economy. Thus, the evidence pointing to the exogeneity of the stock market is somewhat stronger than the evidence pointing to its endogeneity.

6.6 Variance Decomposition (VDC)

In this step we apply the generalized variance decomposition technique in order to find out the relative exogeneity and endogeneity of the variables under analysis.

As we can see table (7) below, shows the results of the generalized variance decomposition, and it indicate that the most exogenous variable in all of the three periods is the interest rate as its own past shocks explains most of its forecast error variance. Moreover, it explains 14.76% of the variance of the stock price variable in period 50. This is in line with the results of the previous step which signaled the interest rate as an exogenous variable. The results also show that the most endogenous variable is the money supply (M2), as the proportion of its forecast error variance explained by its own past is the lowest in all of the three periods. This is also in line with the results of the previous step which indicated that the variable is endogenous. As for the stock price variable we can clearly observe the high percentage of its forecast error variance that is explained by its own past shocks, which exceeds 70% in all of the three periods.

Table 7: Generalized variance decomposition (VDC) results

	Period	DBSP	DBIR	DBM2	DBEX
Relative Variance in DBSP	15	86.57	6.00	2.62	4.80
	35	78.68	12.88	3.30	5.13
	50	**76.47**	14.76	3.46	5.30
Relative Variance in DBIR	15	8.77	88.47	0.98	1.77
	35	5.08	90.14	1.53	3.25
	50	4.50	**90.49**	1.53	3.47
Relative Variance in DBM2	15	2.90	6.63	31.50	58.96
	35	2.85	13.61	17.40	66.13
	50	2.86	15.13	**14.49**	67.51
Relative Variance in DBEX	15	31.91	3.17	11.52	53.39
	35	31.61	5.88	15.19	47.31
	50	31.52	6.58	16.14	**45.75**

6.7 Impulse Response Function (IRF)

The impulse response function is applied in order to depict graphically the effects of a variable specific shock on all other variables. The results in table (8) show that when the interest rate variable, which is the most exogenous, is shocked all the other variables will deviate considerably from the equilibrium. This is consistent with the earlier results, which indicated the exogeneity of the variable. Moreover, it can be observed that the stock price variable deviates by 0.030 standard

deviation when the interest rate variable is shocked. On the other hand, the interest rate variable deviates from equilibrium by 0.020 standard deviation when the stock price variable is shocked. Thus, the stock price variable is more sensitive to a shock imposed on the interest rate variable compared with the sensitivity of the interest rate variable to a shock imposed on the stock price variable. Furthermore, the sensitivity of the stock price variable to shocks imposed on the money supply variable and the exchange rate variable is less than its sensitivity to a shock imposed on the interest rate variable. This means that the interest rate variable is the most important in terms of its effect on the stock price variable.

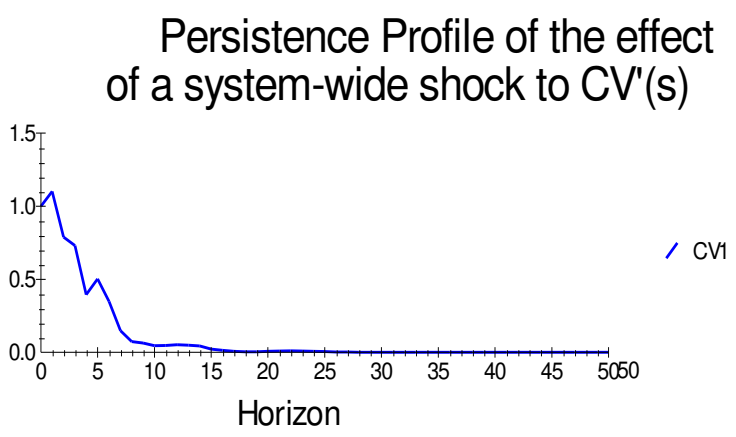
As for the reaction of the stock price variable to the shocks imposed on the other variables, it can be observed that the reaction is positive, which implies that the stock price variable has a positive relationship with the interest rate, money supply and exchange rate variables. Such a positive relationship with money supply and exchange rate variables is in line with the hypothesized theoretical relationship. However, the positive relationship with interest rate is not in line with the theoretical expectation of such relationship, as the theory states that an inverse relationship exists between the two variables. One possible explanation can be that an increase in interest rate may encourage international investors to deposit their money in Brazilian banks, and with this capital inflow the economy will give positive signals which will benefit the stock prices as well.

Table 8: Impulse response function (IRF) results

	Shocked Variables (Period 15)			
	BSP	**BIR**	**BM2**	**BEX**
BSP	**----**	0.030	0.018	0.020
BIR	0.020	----	0.014	0.020
BM2	0.002	-0.010	----	0.020
BEX	-0.030	-0.020	-0.026	----

6.8 Persistence Profile (PP)

This test is designed to show how much time the entire cointegrating vector needs to get back to equilibrium when a wide system shock is imposed on it. As we can see, figure (1) indicates that the whole cointegrating relationship takes about 15 months to get back to equilibrium.



7.0 Conclusions and Policy Implications

The focus of this study was to investigate the relationship between the stock price and macro-economic indicators namely money supply (M2), interest rate, and Brazilian Real exchange rate to the US dollar. Moreover, the study tried to find out if the macro-economic indicators lead the stock market, or if the stock market leads such variables. In dealing with these issues various econometric techniques were applied such as augmented dickey fuller (ADF) test, Johansen cointegration test, long-run structural modeling (LRSM), vector error correction modeling (VECM), variance decomposition (VDC), and impulse response function (IRF). Our findings suggest that there is a long term relationship among the variables and that they are in equilibrium in the long run. Moreover, results of the vector error correction modeling, variance decomposition and impulse response function suggests that the interest rate variable is the most exogenous and that it affects the stock price variable via a positive relationship. Furthermore, the evidence related to the exogeneity of the stock price variable is somewhat stronger than the evidence related to its endogeneity. The major policy implication of the findings is that the interest rate variable can be used as a monetary policy tool in affecting the behavior of the stock price. However, the positive relationship between the two needs further research so as to determine the causes of such a positive relationship, which is not line with the theoretical negative relationship that should exist between the two. As for the evidence pointing to the exogeneity of the stock price variable it implies that the variable may play a role in affecting the behavior of the endogenous variables under analysis.

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