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Do Macro-economic Variables Move in Tandem: Evidence from India and Sri Lanka

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ABSTRACT

Macroeconomic variables like Economic output, Unemployment and Inflation etc. play a vital role in the economic performance of a country. For the past three decades, evidence of key macroeconomic variables helping predict the time series of stock returns has accumulated in direct contradiction to the conclusions drawn by the Efficient Market Theory. This paper studied the pattern of Consumer Price Index (CPI), Wholesale Price Index (WPI), Gross Domestic Product (GDP), Gross National Income (GNI) and rate of interest in India and Sri Lanka. Monthly data from 2002 onwards to 2009 has been used in case of all the variables. The econometrics tools i.e., unit root test, Granger causality test, cointegration test, vector auto regression and variance decomposition analysis have been used for the analysis purpose. All the tools don't lead us to any common result. Granger model and VAR model indicates that CPI, WPI and exchange rate does not have any influence on each other in the case of both of the countries but the Variance decomposition model shows visible impact of macroeconomic variables on each other in some of the cases in Indian and Sri Lankan data. The present study finds that the macro-economic variables i.e., exchange rates, bank rates, WPI, CPI, GNI and balance of payments play a pivotal role in determining the Gross Domestic Product (GDP) in India and Sri Lanka.

Key words: Macroeconomic variables, unit root test, Granger causality test, cointegration test, vector auto regression, variance decomposition analysis

INTRODUCTION

The performance of an economy is largely affected by monetary, fiscal and exchange rate policies. These policies establish the growth of public and private sector in the economy and determine the successive investment patterns. The monetary policies and macroeconomic events effect the general economic actions. There has been evidence of significant linkages between the macro-economic variables of the country in the studies of Fama and French (1989), Schwert (1990) and Black *et al*. (1997).

Gross Domestic Product (GDP), inflation rate and unemployment are three extensively noticed macroeconomic variables of economic activity. The other important macroeconomic variables include Interest Rate, International trade balance and Productivity. These variables impact the growth, employment and the inflation rate in the country. GDP is considered as the main indicator of economic movement. The periodic change in GDP shows the growth rate of overall economic output.

The periodic changes i.e., Monthly, Quarterly, Yearly of GDP growth can be reasonably unpredictable. The Inventory and net export swings are the major variables, which affects the GDP volatility (MACROECONOMICS, World Scientific Publishing Co. Pvt. Ltd.).

A good amount of research has concentrated on finding out the impact of macro-economic variables on the stock prices in various countries. Chen *et al.* (1986), Mukherjee and Naka (1995), Liljeblom *et al.* (1997), Maysami and Koh (2000), Arora and Vamvakidis (2001), Paul and Mallik (2001), Sharma and Wongbangpo (2002), Blomberg *et al.* (2004), Patra and Poshakwale (2006), Humpe and Macmillan (2005), Bialkowski *et al.* (2008), Liu and Shrestha (2008), Chiang and Kee (2009), Hasan and Javed (2009) and Aizenman and Noy (2009) attempted to observe the relationship between the stock returns and the macro-economic variables such as interest rates, inflation and real activity. However, there have been few researches that have concentrated on observing the co-movement between the macro-economic variables interest. This study attempted to comment on the causal linkages and the co-movement of different macro-economic variables. The study of this co-movement is important because it would give us an insight as to whether the variables would usually move in the same direction and if those do not move in the same direction, which variables have a larger impact on the GDP growth, the most reputed measure of economic performance.

Figure 1 depicts the comparison of real GDP growth of world, advance and emerging economies. The world GDP is the document of the World Bank in which the GDP calculated is the combined GDP for all countries. The GDP of advance economies is the combined GDP of the countries which are developed i.e., USA, UK, Germany and France. The combined GDP of the countries, i.e., India, Russia, Brazil, Hong Kong, Singapore, China refers to the Emerging economies' GDP. Further the figure shows that the GDP growth of the emerging and developing countries is better than the GDP growth of the advanced countries as well as the growth of the world GDP. The figure depicts that in the year 2009 the GDP growth of the world as well as the advance economies was negative while the GDP growth of the emerging and developing countries was in the positive. The figure supports the fact that there is a need of research on the linkages between the macro-economic variables in the developing countries. India and Sri Lanka are two South Asian Nations that count among the developing economies of the world. However, India is significantly larger than Sri Lanka in terms of various geographical and economic factors. In terms of Economy, Indian economy stands at $1.846 trillion, which is around 31 times more than that of Sri Lankan Economy that values $59 Billion (September 2011, IMF, World Economic Outlook). In this way, the two countries are significantly different from each other in terms of economic and geographical figures. Attempting

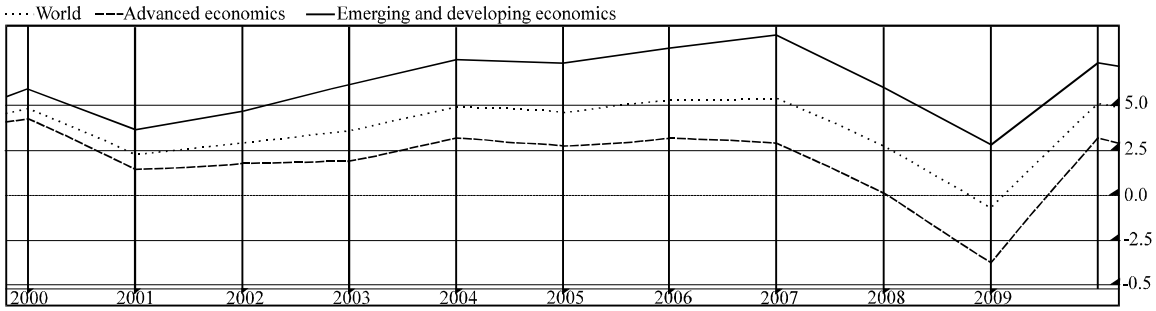

Fig. 1: The real GDP growth comparison of the world, advance and emerging economies

to find out if various macro-economic indicators move in tandem with each other in two countries that are so different in their size would provide a good insight as regards the issue. Therefore, the study focuses on understanding the extent of co-movement of macroeconomic variables in India and Sri Lanka.

The paper studies the pattern of macro-economic variables including Consumer Price Index (CPI), Wholesale Price Index (WPI), Gross Domestic Product (GDP), Gross National Income(GNI) and Rate of interest in India and Sri Lanka for the year 2002-2009 and analyzes the impact of these variables on the GDP growth in India vis-à-vis Sri Lanka. While CPI is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services (Bureau of Labor Statistics), WPI is the price of a representative basket of wholesale goods and GNI consists of: the personal consumption expenditures, the gross private investment, the government consumption expenditures, the net income from assets abroad (net income receipts) and the gross exports of goods and services, after deducting two components: the gross imports of goods and services and the indirect business taxes.

Numerous studies investigate the relationship between the stock returns, interest rates, inflation and real activity. Chen *et al.* (1986) investigated the systematic event influence on US stock market return by several economic variables. Aizenman and Noy (2009) investigate the impact of natural disasters on GDP. Mukherjee and Naka (1995) examine relationship between the Japanese stock market and several macroeconomic variables. Liljeblom *et al.* (1997) studied the impact of macroeconomic variables on the stock price in Finland. Maysami and Koh (2000) investigates the inter linkage amongst macroeconomic variables (exchange rate, long and short term interest rates, inflation, money supply, domestic exports and industrial production) and Stock market of Singapore. Arora and Vamvakidis (2001) investigated the impact of US growth on other countries. Paul and Mallik (2001) explored the long run relationship among macroeconomic factors and equity prices in Australian banking and finance sector. Sharma and Wongbangpo (2002) investigated the interaction of stock price and macroeconomic variables in five ASEAN countries stock market. Blomberg *et al.* (2004) evaluated the effect of wars on GDP. Gan *et al.* (2006) evaluated whether the New Zealand stock index reflects the changes in the analyzed macroeconomic variables. Patra and Poshakwale (2006) examined the short-run relationship and the long-run equilibrium relationship among selected macroeconomic variables and Athens stock exchange. Humpe and Macmillan (2005) evaluated the effect of the macroeconomic variables on stock prices in US and Japan. Bialkowski *et al.* (2008) examined whether national elections would cause higher stock market volatility. Liu and Shreshta (2008) investigated the relationship between the Chinese stock market indices and a set of macroeconomic variables, including money supply, industrial production, inflation, exchange rate and interest rates. Hasan and Javed (2009) explored the long-term dynamic relationship between equity prices and monetary variables in Pakistan.

Mixed results have been produced by the past research. Chen *et al.* (1986), Liu and Shrestha (2008) and Hasan and Javed (2009) reveal the existence of a long-term relationship between the equity market and monetary variables, such as, money supply, treasury bill rates, foreign exchange rates and the consumer piece index. Aizenman and Noy (2009) revealed that there was a negative GDP growth rate during the period of disaster. Mukherjee and Naka (1995) found a positive relationship between share price and money supply accompanied by exchange rate and industrial production. Liljeblom *et al.* (1997) indicated a predictive power from stock market volatility to macroeconomic volatility in Finland was higher than US. Maysami and Koh (2000) used the vector

correlation model on the data of variables from 1988 to 1995 and unearth that the change in the macroeconomic variables affects the Singapore stock market, thus there is a cointegration relation exist between the two. Arora and Vamvakidis (2001) found that the impact significant considering the United States is a global trading partner. Paul and Mallik (2001) reveal that interest rate has a significant negative effect on equity prices and GDP growth has a significant a positive effect on the equity prices of banking and finance sector. However, no significant effect of inflation is observed on equity prices. Sharma and Wongbangpo (2002) observed that the past macroeconomic variables in the ASEAN countries were able to predict future changes in the stock price indices. Blomberg *et al.* (2004) found that the outbreak of external war or internal conflict has a significant negative impact on real GDP growth in the year of the event and terrorist attacks have a smaller but nonetheless significant negative impact. Patra and Poshakwale (2006) concluded about presence of both short-term and long-term relationship between inflation, money supply and trading volumes and the stock prices. Conversely, no relationship was found between exchange rate and stock prices. Humpe and Macmillan (2005) revealed that the data for US are consistent with a single cointegrating vector, where stock prices are positively related to industrial production and negatively related to both the consumer price index and long-term interest rate. They also find an insignificant (although positive) relationship between US stock prices and the money supply. Bialkowski *et al.* (2008) revealed that the highly volatility and correlation between stock returns and elections.

The current study contributes to the literature in numerous ways. First, this is the study concentrating on the developing yet differently poised economies of India and Sri Lanka. Second, this research studies the linkages between the macro-economic variables rather than the impact of macro-economic variables on the stock market activity (as has been the case with previous studies). Third, it studies the linkages within the developing economies rather than with the developed world. Fourth, it uses a combination of the various methods used empirically to analyze the data.

MATERIALS AND METHODS

Data used for analysis: This study uses the monthly data from 2002 onwards to 2009 has been used in case of all the variables like, GDP (Gross Domestic Product), GNI (Gross National Income), wholesale price index (WPI), consumer price index (CPI), exchange rates, bank rates and balance of payments. The major source of data of all the above macro economic variables is International Monetary Fund on-line data source. Index Number (2000 = 100) is used as the base index for the whole research data.

Hypothesis of the study: The following hypothesis are formed for the purpose of the study:

(i) H_0 = Macro-economic variables including CPI, WPI, GDP, GNI and Rate of interest are independent of each other and hence the movement of any one variable does not replicate the movement in the other

(ii) H_0 = The GDP growth rate does not have any impact on the macro-economic variables as mentioned in (i) above and

where, H_0 is the impact as mentioned in (ii) above is non-existent in the case of both India and Sri Lanka.

Tools used for data analyzing: Data have been analyzed using econometric tools. The analysis of econometrics can be performed on a series of stationary nature. In order to check whether or not the series are stationary, the study performs the Augmented Dickey-Fuller test under the unit root test to finally confirm whether or not the series are stationary. For the basic understanding of Unit root testing, a look at the following equation would help:

$$y_t = \rho\, y_{t-1} + x_t'\delta + \epsilon_t \tag{1}$$

where, x_t are optional exogenous regressors which may consist of constant, or a constant and trend, ρ and δ are parameters to be estimated and the ϵ_t are assumed to be white noise. If $|\rho| \geq 1$, y is a nonstationary series and the variance of y increases with time and approaches infinity. If $|\rho| < 1$, y is a (trend-)stationary series. Thus, the study evaluates the hypothesis of (trend-)stationarity by testing whether the absolute value of $|\rho|$ is strictly less than one.

The Standard Dickey-Fuller test is carried out by estimating (Eq. 2) after subtracting y_{t-1} from both sides of the equation:

$$\Delta y_t = \alpha\, y_{t-1} + x_t'\delta + \epsilon_t \tag{2}$$

where, $\alpha = \rho - 1$. The null and alternative hypotheses may be written as:

$$H_0 : \alpha = 0 \tag{3}$$

$$H_1 : \alpha < 0 \tag{4}$$

In order to make the series stationary, the paper takes the log of the six series and arrive at the daily return of the six series. All the remaining analysis is performed at the daily return (log of the series) of the six exchanges. These variables are names as dindia, dsrilanka, dbangladesh, dpakistan, dnepal and dmaldives.

At the stationary log series of the six stock exchanges, the paper performs the Granger's causality model in order to observe whether the return at each stock exchange granger causes the return at the remaining five stock exchanges.

The (Granger and Swanson, 1996) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x 's are statistically significant. It is pertinent to note that two-way causation is frequently the case; x Granger causes y and y Granger causes x. It is important to note that the statement "x Granger causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. In Granger's Causality, there are bivariate regressions of the under-mentioned form:

$$y_t = \alpha_0 + \alpha_1\, y_{t-1} + \ldots\ldots + \alpha_1\, y_{t-1} + \beta_1\, x_{t-1} + \ldots\ldots + \beta_1 x_{t-1} + \epsilon_t \tag{5}$$

$$x_t = \alpha_0 + \alpha_1\, x_{t-1} + \ldots\ldots + \alpha_1\, x_{t-1} + \beta_1\, y_{t-1} + \ldots\ldots + \beta_1 y_{t-1} + \mu_t \tag{6}$$

for all possible pairs of (x, y) series in the group. In (Eq. 6), the paper takes lags ranging from 1 to l. In Granger's model, one can pick a lag length, l that corresponds to reasonable beliefs about the longest time over which one of the variables could help predict the other.

The reported F-statistics are the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \ldots\ldots\ldots = \beta_t = 0 \quad (7)$$

for each equation. The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression.

The paper follows the application of Granger's causality with the Vector Autoregression (VAR) Model. The vector autoregression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \ldots\ldots + A_p y_{t-p} + Bx_t + \epsilon_t \quad (8)$$

where, y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $A_1, \ldots\ldots, A_p$ and B are matrices of coefficients to be estimated and ϵ_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

The study also applies the Variance Decomposition Analysis in order to quantify the extent upto which the six indices are influenced by each other. While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

RESULTS AND DISCUSSION

Descriptive statistics of the macro-economic variables: Table 1 shows that the mean of the first four variables, i.e., Exchange Rates, Bank rates, WPI and CPI is higher in Sri Lanka when compared with India while the same for the remaining three variables, i.e., GDP, GNI and Balance

Table 1: Descriptive statistics of the macro-economic variables

	Mean		SD		Coefficient of variation		Skewness		Kurtosis	
Variable	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka
Exchange rates	45.40	104	2.46	7	5.424	6.5846	-0.168	0.39081	-0.474	-1.01195
Bank rates	6.03	15	0.09	1	1.465	6.8986	2.828	2.82843	8.000	8.00000
WPI	130.63	187	17.01	61	13.021	32.4499	0.176	0.57728	-1.195	-1.41353
CPI	129.58	181	19.26	51	14.859	28.4163	0.835	0.62302	-0.125	-1.21344
GDP	40485.45	2969408	13132.69	1196728	32.438	40.3019	0.449	0.54621	-1.004	-1.24436
GNI	40437.96	2927948	13346.42	1173843	33.004	40.0910	0.452	0.54585	-1.118	-1.21101
Balance of payments	-1383.60	-279017	1110.41	163888	-80.255	-58.7378	-0.952	-1.04250	0.174	1.26959

Table 2: Correlation matrix of the macro-economic variables

	Exchange rates		Bank rates		WPI		CPI		GDP		GNI		Balance of payments	
	Ind	SL	Ind	SL	Ind	SL	Ind	SL	Ind	SL	Ind	SL	Ind	SL
Exchange rates	1.00	1.00	0.53	-0.49	-0.30	0.92	-0.11	0.93	-0.22	0.95	-0.23	0.95	0.33	-0.71
Bank rates	0.53	-0.49	1.00	1.00	-0.55	-0.42	-0.45	-0.44	-0.49	-0.45	-0.49	-0.45	0.41	0.43
WPI	-0.30	0.92	-0.55	-0.42	1.00	1.00	0.97	0.99	0.99	0.99	0.99	0.99	-0.94	-0.88
CPI	-0.11	0.93	-0.45	-0.44	0.97	0.99	1.00	1.00	0.99	1.00	0.99	1.00	-0.89	-0.84
GDP	-0.22	0.95	-0.49	-0.45	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	-0.92	-0.82
GNI	-0.23	0.95	-0.49	-0.45	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	-0.93	-0.81
Balance of payments	0.33	-0.71	0.41	0.43	-0.94	-0.88	-0.89	-0.84	-0.92	-0.82	-0.93	-0.81	1.00	1.00

Ind: India, SL: Sri Lanka

of Payments is higher in the case of India. The first four variables being on the higher side gives two important implications-(1) a weaker currency and (2) higher interest rates in Sri Lanka than in India. The last three variables being higher for India, on the other hand, signal the strength of the Indian Economy vis-à-vis the Sri Lankan economy. The comparison of India and Sri Lanka on the front of Standard Deviation and Co-efficient of Variation shows the variables to be higher for Sri Lanka than for India. This implies that the Sri Lankan economy is more volatile than the Indian economy. The skewness for all the variables in both the countries being other than 0 and the kurtosis statistic other than 3 signal that the variables form a non-normal distribution.

Table 2 shows that in case of Sri Lanka, Exchange rates have a significant positive relationship with the WPI, CPI, GDP and GNP while for none of these variables is there a significant relationship in the case of India. The same results have been produced by Chen *et al.* (1986), Liu and Sharma (2008) and Hasan and Javed (2009) in their research in which the revealed the fact about there respective countries that there is of a long-term relationship between the equity market and monetary variables. In the current study the Balance of Payments is observed to find a negative relationship with most of the other variables in case of both the countries. Paul and Mallik (2001) also found the negative relationship between interest rate and equity prices in the case of Australia.

Table 2 leads us to reject the first Null Hypothesis and implies that the variables under study other than Bank rate and Balance of payments are positively correlated with each other.

Regression with GDP as dependent variable: From Table 3, the study formulates the regression equation Y= a+bX, where in Y is the dependent variable (GDP) and X is the independent variable (Exchange rates, Bank rates, WPI, CPI, GNI and Balance of Payments). In the case of India, the paper arrives at the regression equation GDP = -5371.526+(-7.066) Exchange Rates+(568.306) Bank Rates+(23.592) WPI+(-16.876) CPI+(1.079) GNI+(1.298) Balance of Payments. Similarly for Sri Lanka, the research arrives at the regression equation GDP = -199957.986+(-203.156) Exchange Rates+(4508.881) Bank Rates+(-854.678) WPI+(3164.948) CPI+(0.911) GNI+(-0.151) Balance of Payments. The results of regression show that there is a visible effect of the independent variable Exchange Rates, Bank Rates, WPI on the GDP in the case of India. Aizenman and Noy (2009) also revealed the fact in his research that there is a negative cause effect relationship between war and GDP and the GDP rate decline during war, has produced the similar kind of result.

Table 3: Exchange rates, Bank rates, WPI, CPI, GNI and Balance of Payments regressed on GDP

	Unstandardized coefficients				Standardized coefficients					
	B		SE		Beta		T		Sig.	
Model	Ind	SL	Ind	SL	Ind	SL	Ind	SL	Ind	SL
(Constant)	-5371.526	-199957.986	22912.473	227360.801			-0.234	-0.879	0.853	0.541
Exchange rates	-7.066	-203.156	82.443	1830.257	-0.001	-0.001	-0.086	-0.111	0.946	0.930
Bank rates	568.306	4508.881	1987.636	1747.712	0.004	0.004	0.286	2.580	0.823	0.235
WPI	23.592	-854.678	105.386	599.947	0.031	-0.043	0.224	-01.425	0.860	0.390
CPI	-16.876	3164.948	102.537	1370.841	-0.025	0.136	-0.165	2.309	0.896	0.260
GNI	1.079	0.911	0.254	0.046	1.097	0.893	4.244	19.712	0.147	0.032
Balance of payments	1.298	-0.151	0.263	0.040	0.110	-0.021	4.928	-03.750	0.127	0.166

Ind: India, SL: Sri Lanka

Table 4: Exchange rates, bank rates, WPI, CPI, GNI and balance of payments regressed on GDP

	Sum of squares		Mean square		F		Sig.	
Model	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka
Regression	1.207E9	1.003E13	2.012E8	1.671E12	5542.540	185498.790	0.010	0.002
Residual	36302.156	9007333.846	36302.156	9007333.846				
Total	1.207E9	1.003E13						

Table 4 shows the sum of squares, mean square, f statistic and level of significance for regression equation as also for the residuals. The first important value that needs to be looked at is the level of significance the value of which is found to be 0.010 and 0.002 for India and Sri Lanka respectively. Both of these values are significant at 5% level of significance. Looking at the sum of squares, the paper finds that the regression equation in both the countries account for a major proportion of the values of the dependent variable (GDP). Paul and Mallik (2001) showed in his study that there is a significant impact of the GDP on the equity prices in the case of Australia.

For performing the econometric analysis, it is very essential for the researcher to make sure that the series under reference are stationary. In order to make the series stationary, the paper takes log of the three series on which the further analysis shall be performed. In this way, three new variables are created and the study assigns those, names LOGExchange, LOGWPI and LOGCPI which denote the LOG of Exchange rate, WPI and CPI, respectively. Going further, the paper discusses the linkages between the logs of exchange rate, WPI and CPI.

Table 5 presents the descriptive statistics of the series of log Exchange, log WPI and log CPI for India and Sri Lanka.

Table 5 exhibits the descriptive statistics of changes in exchange rates, WPI and CPI respectively. It can be observed from the table that the changes in macro-economic variables are higher in case of Sri Lanka than those in India. The standard deviation, variance and coefficient of variation are also higher in the case of Sri Lanka than those in India. This signals a higher volatility in the macro-economic performance of Sri Lanka than that in India.

Econometric analysis of macro-economic variables: Stationarity tests are carried out on the variables because to apply econometric analysis, first the series have to be made stationary. Augmented Dickey Fuller (ADF) test have been done and after the application of these tests all the

Table 5: Descriptive statistics of the changes in exchange rates, WPI and CPI

	log Exchange		log WPI		log CPI	
	India	Sri Lanka	India	Sri Lanka	India	Sri Lanka
Mean	45.4384	103.9292	130.7451	184.4419	133.9192	186.0590
Median	45.5355	102.7625	128.9000	168.3500	127.5890	167.2500
Variance	7.57660	43.07700	266.5260	3036.495	311.2582	2224.671
Std.Dev.	2.75256	6.563290	16.32562	55.10440	17.64251	47.16642
Coef.Var.	6.05778	6.315160	12.48660	29.87630	13.17400	25.35025
Skewness	-0.45629	0.263307	0.217605	0.529218	1.302944	0.525176
Kurtosis	-0.29634	-1.18682	-1.07108	-1.10259	0.943650	-1.27886

Table 6: Unit-root tests for macro-economic variables

Null hypothesis	Coefficient	SE	t-statistic	Prob.
Log Exchange (India) has a unit root	-0.991078	0.104187	-9.512455	0.0000
Log Exchange (Sri Lanka) has a unit root	-0.792874	0.102070	-7.767954	0.0000
Log CPI (India) has a unit root	-0.954503	0.104062	-9.172398	0.0000
Log CPI (Sri Lanka) has a unit root	-0.983429	0.125938	-7.808820	0.0000
Log WPI (India) has a unit root	-0.931885	0.104279	-8.936453	0.0000
Log WPI (Sri Lanka) has a unit root	-1.212027	0.101879	-11.89667	0.0000

Table 7: Granger causality-exchange rate, WPI and CPI of India

Null hypothesis	F-statistic	Prob.
LOGXCHNG_NA does not Granger Cause LOGCPI_NA	0.01602	0.9841
LOGCPI_NA does not Granger Cause LOGXCHNG_NA	1.42415	0.2462
LOGWPI_NA does not Granger Cause LOGCPI_NA	0.19801	0.8207
LOGCPI_NA does not Granger Cause LOGWPI_NA	0.53034	0.5903
LOGWPI_NA does not Granger Cause LOGXCHNG_NA	0.66470	0.5170
LOGXCHNG_NA does not Granger Cause LOGWPI_NA	1.11568	0.3323

Table 8: Granger causality-exchange rate, WPI and CPI of Sri Lanka

Null hypothesis	F-statistic	Prob.
LOGEXCHNG_NA does not Granger Cause LOGCPI_NA	0.86114	0.4262
LOGCPI_NA does not Granger Cause LOGEXCHNG_NA	0.08428	0.9193
LOGWPI_NA does not Granger Cause LOGCPI_NA	2.11268	0.1270
LOGCPI_NA does not Granger Cause LOGWPI_NA	0.49521	0.6111
LOGWPI_NA does not Granger Cause LOGEXCHNG_NA	1.12065	0.3307
LOGEXCHNG_NA does not Granger Cause LOGWPI_NA	1.07596	0.3454

series have been found stationary at various significance levels. The unit-root test is performed on the three series in order to test the null hypothesis that the series has a unit root. The findings of the unit-root test and the augmented Dickey-Fuller test are shown below in the following tables.

Table 6 tests the null hypothesis that the series under reference have a unit-root. This null hypothesis implies that the series are non-stationary in nature. The probability value for all the six cases is found to be below 0.05, which implies that the null hypothesis can be rejected at 5% level of significance. This means that the series under reference are stationary in nature.

Table 7 and 8 presents the results about the application of Granger's Causality model to the WPI, CPI and Exchange Rates of India and Sri Lanka, respectively. The tables test the hypotheses

Table 9: Vector auto regression for macro-economic variables-India

	LOGCPI_NA	LOGWPI_NA	LOGXCHNG_NA
LOGCPI_NA(-1)	0.037950	-0.049043	0.129684
	(0.109030)	(0.059840)	(0.146490)
	[0.348070]	[-0.819500]	[0.885250]
LOGCPI_NA(-2)	-0.007443	-0.032575	0.179728
	(0.110100)	(0.060430)	(0.147930)
	[-0.067600]	[-0.539050]	[1.214970]
LOGWPI_NA(-1)	0.058476	0.059458	-0.100699
	(0.194990)	(0.107030)	(0.261990)
	[0.299890]	[0.555540]	[-0.384350]
LOGWPI_NA(-2)	0.098758	0.201064	0.237570
	(0.196860)	(0.108050)	(0.264500)
	[0.501670]	[1.860820]	[0.898180]
LOGXCHNG_NA(-1)	0.006020	-0.000821	0.000317
	(0.079470)	(0.043620)	(0.106780)
	[0.075760]	[-0.018830]	[0.002960]
LOGXCHNG_NA(-2)	0.008605	-0.063557	-0.042913
	(0.078940)	(0.043330)	(0.106060)
	[0.109010]	[-1.466880]	[-0.404600]
C	0.003794	0.003678	-0.002482
	(0.00217)	(0.00119)	(0.00292)
	[1.74748]	[3.08648]	[-0.85084]

about the three variables in pairs. The results in case of India show that the probability value for the hypotheses 'Exchange rate does not Granger Cause LOGCPI' and 'LOGCPI does not Granger Cause LOGEXCHNG' is more than 0.05 which means that in both the cases null hypotheses can be accepted. And the same results are observed in the case of LOGWPI and LOGCPI and LOGWPI and LOGEXCHNG. Similarly, the null hypothesis can be accepted for all the six cases in the case of Sri Lanka.

Now the Vector Auto Regression (VAR) model is applied on the series under reference in order to further confirm the results produced by the Granger's Causality model. In Table 9, the study presents the application of Vector Auto Regression (VAR) Model at the three Macro-economic variables.

By the application of VAR Model for India, the research observes that the integration of macroeconomic variables with the other can be established if the p-value is more than 1.96. Table 10 shows that the LOGCPI at the lag of 1 and 2, does not have any influence on LOGCPI, LOGWPI and LOGEXCHNG.. Similarly, LOGWPI at a lag of 1 and 2 does not have any influences on the LOGCPI, LOGWPI and LOGXHNG. In LOGXCHNG, the table reveals that LOGXCHNG at a lag of 1 and 2 does not have any effect on the LOGCPI, LOGWPI and LOGXCHNG.

Table 10 shows the application of VAR in case of Macro-economic variables for Sri Lanka. The table shows that the LOGCPI at the lag of 1 and 2, does not have any influence on LOGWPI and LOGEXCHNG. However, it influences the returns at LOGCPI in period 0. Similarly, LOGEXCHNG at a lag of 1 and 2 does not have any influences on the LOGCPI, LOGWPI and LOGEXHNG. LOGWPI at the lag 1 does not have any influence on LOGCPI and LOGEXCHNG but it influences the return at LOGWPI in period 0. LOGWPI at lag 2 LOGWPI have influence on LOGCPI but it does not influence LOGEXCHNG and LOGWPI.

Table 10: Vector auto regression for macro-economic variables of Sri Lanka

	LOGCPI_NA	LOGEXCHNG_NA	LOGWPI_NA
LOGCPI_NA(-1)	0.276479	0.015195	0.141757
	(0.100830)	(0.043760)	(0.170740)
	[2.741990]	[0.347250]	[0.830270]
LOGCPI_NA(-2)	-0.296388	0.018369	-0.041587
	(0.100470)	(0.043600)	(0.170120)
	[-2.950020]	[0.421320]	[-0.244450]
LOGEXCHNG_NA(-1)	0.369838	0.2019050	0.165298
	(0.244860)	(0.106260)	(0.414620)
	[1.510390]	[1.900100]	[0.398680]
LOGEXCHNG_NA(-2)	-0.160170	-0.036185	0.493158
	(0.246070)	(0.106780)	(0.416660)
	[-0.650920]	[-0.338860]	[1.183600]
LOGWPI_NA(-1)	0.069514	-0.032033	-0.222476
	(0.063170)	(0.027410)	(0.106960)
	[1.100470]	[-1.168560]	[-2.079990]
LOGWPI_NA(-2)	0.133537	-0.034492	0.014252
	(0.063270)	(0.027460)	(0.107130)
	[2.110640]	[-1.256270]	[0.133030]
C	0.005549	0.001896	0.006310
	(0.002650)	(0.001150)	(0.004490)
	[2.092720]	[1.647510]	[1.405300]

Table 11: Variance decomposition analysis of India

Period	SE	LOGCPI_NA	LOGWPI_NA	LOGXCHNG_NA
LOGCPI_NA				
1	0.016740	100.00000	0.000000	0.000000
2	0.016764	99.88856	0.104968	0.006467
3	0.016793	99.54793	0.431889	0.020176
4	0.016795	99.53270	0.444589	0.022712
5	0.016797	99.50979	0.458547	0.031663
6	0.016797	99.50889	0.459146	0.031967
7	0.016797	99.50841	0.459344	0.032243
8	0.016797	99.50839	0.459348	0.032259
9	0.016797	99.50839	0.459348	0.032264
10	0.016797	99.50839	0.459348	0.032264
LOGWPI_NA				
1	0.009188	2.360903	97.63910	0.000000
2	0.009233	2.975686	97.02392	0.000397
3	0.009505	2.963575	94.76938	2.267042
4	0.009513	3.076295	94.64900	2.274704
5	0.009523	3.178698	94.48968	2.331623
6	0.009523	3.184630	94.48252	2.332855
7	0.009523	3.187336	94.47914	2.333527
8	0.009523	3.187458	94.47900	2.333538
9	0.009523	3.187478	94.47899	2.333537
10	0.009523	3.187478	94.47899	2.333537
LOGXCHNG_NA				
1	0.022492	0.051339	0.818124	99.13054
2	0.022602	0.856645	0.973590	98.16977

Table 11: Continue

Period	SE	LOGCPI_NA	LOGWPI_NA	LOGEXCHNG_NA
3	0.022984	3.134815	1.764871	95.10031
4	0.022986	3.135866	1.773601	95.09053
5	0.022993	3.142175	1.818193	95.03963
6	0.022994	3.142716	1.819371	95.03791
7	0.022994	3.143564	1.820026	95.03641
8	0.022994	3.143676	1.820051	95.03627
9	0.022994	3.143726	1.820051	95.03622
10	0.022994	3.143729	1.820050	95.03622

Table 12: Variance decomposition analysis of Sri Lanka

Period	SE	LOGCPI_NA	LOGEXCHNG_NA	LOGWPI_NA
LOGCPI_NA				
1	0.022772	100.00000	0.000000	0.000000
2	0.024161	96.51089	2.261100	1.228008
3	0.025031	93.01309	2.117113	4.869802
4	0.025200	92.95173	2.168757	4.879512
5	0.025229	92.76467	2.180776	5.054553
6	0.025245	92.75595	2.185437	5.058613
7	0.025246	92.75185	2.185334	5.062813
8	0.025247	92.74894	2.186027	5.065036
9	0.025247	92.74892	2.186094	5.064990
10	0.025247	92.74873	2.186116	5.065150
LOGEXCHNG_NA				
1	0.009882	0.544881	99.45512	0.000000
2	0.010166	0.697640	97.82953	1.472829
3	0.010253	0.856835	96.17923	2.963936
4	0.010256	0.857207	96.16613	2.976659
5	0.010260	0.867678	96.15021	2.982117
6	0.010260	0.870224	96.14645	2.983325
7	0.010260	0.870247	96.14643	2.983320
8	0.010260	0.870455	96.14619	2.983358
9	0.010260	0.870466	96.14618	2.983358
10	0.010260	0.870471	96.14617	2.983359
LOGWPI_N				
1	0.038559	0.225725	0.001937	99.77234
2	0.039644	0.763915	0.178602	99.05748
3	0.040088	0.749457	1.943572	97.30697
4	0.040104	0.766544	1.947060	97.28640
5	0.040110	0.767313	1.946547	97.28614
6	0.040110	0.768456	1.946880	97.28466
7	0.040110	0.768456	1.947305	97.28424
8	0.040110	0.768561	1.947306	97.28413
9	0.040110	0.768578	1.947306	97.28412
10	0.040110	0.768580	1.947308	97.28411

Finally, the Variance Decomposition Analysis of the three macro economic variables is presented in Tables 11 and 12. The results decompose the values at the three macro economic variables for a period ranging from 1 to 10. Table 11 implies that on LOGCPI, the impact of other two macro economic variables is negligible. Rather the LOGCPI itself with the lag of 1 through 10 impacts the

LOGCPI in the current period. However, the Table 11 reveals that in the case of LOGWPI, there is visible impact of LOGCPI for periods 1 to 10 and LOGEXCHNG for the periods 2 to 10. In LOG WPI the impact on LOGCPI is more than the LOGEXCHNG. In the case of LOGEXCHNG, there is also visible impact of LOGCPI and LOGWPI for the periods of 2 to 10. The impact is more in the case of LOGCP than the LOGWPI. Variance Decomposition Analysis shows that the macro economic variables under study are not much influenced by each other.

The Variance Decomposition Analysis for Sri Lanka is presented in Table 12. It implies that on LOGCPI, the impact of other two macro economic variables is visible. The impact is near about constant in the LOG of Exchange rate but in LOG of WPI impact increases step by step than the previous one. However, the table reveals that in the case of LOGEXCHNG, there is visible impact of LOGWPI for periods 2 to 10 and no impact on LOGCPI. In the case of LOGWPI, there is also visible impact of LOGEXCHNG for the periods of 3 to 10. Variance Decomposition Analysis shows that the macro economic variables under study are not much influenced by each other.

CONCLUSION

The study observes that the development of Indian economy is by far ahead of that of the Sri Lankan economy. While on one hand the Sri Lankan economy witnesses a weaker currency and higher interest rates, on the other hand, the Indian economy demonstrates higher Gross Domestic Product, Gross National Income and Balance of Payments. The application of Regression analysis shows that the macro-economic variables including exchange rates, bank rates, Wholesale Price Index, Consumer Price Index, Gross National Income and Balance of Payments play a pivotal role in determining the Gross Domestic Product in India and Sri Lanka. Patra and Poshakwale (2006), Sharma and Wongbangpo (2002) and Mukherjee and Naka (1995) also support the fact that there is a significant impact of the macroeconomic variables on the stock prices and GDP. The current study further finds that the changes in macro-economic variables are higher in case of Sri Lanka than those in India. The standard deviation, variance and coefficient of variation are also higher in the case of Sri Lanka than those in India. This signals a higher volatility in the macro-economic performance of Sri Lanka than that in India.

The application of econometric tools gives contrasting results so far as the impact of WPI, CPI and Exchange rate for India and Sri Lanka are concerned. The application of Unit-root test (Augmented Dickey-Fuller test) reveals the series of WPI, CPI and Exchange rates of India and Sri Lanka to be stationary in nature. Granger's causality model shows no impact of any variable on the other in both the countries. Chen *et al.* (1986), Liu and Shrestha (2008) and Hasan and Javed (2009) shows the presence of a long-term relationship between the equity market and monetary variables, such as, money supply, treasury bill rates, foreign exchange rates and the consumer piece index in the U.S., China and Pakistan. The application of the VAR model implies that the in the case of Sri Lanka, Consumer Price Index at the lag of 1 and 2 influences the CPI at lag 0. Similarly Wholesale Price Index at the lag 1 influences the WPI at lag 0. The Variance Decomposition Analysis (for India) implies that the impact of WPI and Exchange rate on CPI is negligible. Rather the CPI itself with the lag of 1 through 10 impacts the CPI in the current period. However, in the case of LOGWPI, there is visible impact of CPI for periods 1 to 10 and Exchange rate for the periods 2 to 10. In WPI the impact on CPI is more than the Exchange rate. In the case of Exchange, there is also visible impact of CPI and WPI for the periods of 2 to 10. The impact is more in the case of CPI than the WPI. Variance Decomposition Analysis (for Sri Lanka) implies that on CPI, the impact of other two-macro economic variables is visible. The impact is near about constant in the case of Exchange rate but in the case of WPI impact increases step by step than the

previous one. However, on the Exchange rate, there is visible impact of WPI for periods 2 to 10 and no impact of CPI. In the case of WPI, there is also visible impact of Exchange rate for the periods of 3 to 10.

IMPLICATIONS

The research observes that the Sri Lankan economy is in the dire need of some measures that help the economy to move faster on the development path. Highly volatile economy of Sri Lanka is too risky for the investors to consider investing in Sri Lanka. Further, the research also points to the fact that there is a need for the economy managers of India and Sri Lanka to try improving on different macro-economic indicators separately since there are few linkages between the performances with regard to these different indicators. The paper will go a long way in assisting the economic policy makers of the countries who may be interested in finding out whether an improvement in one macro-economic variable will get replicated in the other macro-economic variable as well. Further, the study will also comment on the present state of the Indian and Sri Lankan economies and which macro-economic fronts of the two economies call for policy-makers attention.

LIMITATION

The present study studied the effect of the macroeconomic variables on the economic output by using the CPI, WPI, GDP and GNI as the variables. But there are certain other factors such as political conditions; global economic environment etc also affects the economic performance.

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