Impact of Short-Term Interest Rates on Stock Prices: Evidence from Sri Lanka

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Abstract Study attempts to identify the impact of short-term interest rates which are measured by 91 days, 182 days and 364 days Treasury bill rates on stock prices of Sri Lanka. By this investigation, Multiple Regression Analysis is employed as the key tool and Augment Dickey-Fuller (DF) Unit Root Test, Autocorrelation, and Multicollinearity support the regression results. Study founds that there are weak relationships between short-term interest rates and stock prices of Sri Lanka and correlation between 364 Treasury bill rate and the stock prices indicates a negative relationship. Granger Causality Test reveals that the existence of causality between 364 days Treasury bill rates and stock prices. Findings of this paper provide the literature for prospective researches to investigate the impact of other macroeconomic variables on stock prices of Sri Lanka.
Key words Short-term interest rates; Stock prices; Sri lanka

1 Introduction

"Sri Lanka's Stock Market Value Climbs to Record as War Ends" (P. Thakur, 2009). The end of the nearly three decade terrorism in Sri Lanka has shown improvements in key macroeconomics indicators. In the year 2009 the International Monitory Fund has named Sri Lanka as a middle income emerging market as per the Gross Domestic Product (GDP) at purchasing power party (PPP) per capita. Similarly as an emerging stock market Colombo Stock Exchange (CSE) is breaking its own records being the best performer in the Asia region in the year 2009. In achieving these performances by the CSE, stability of macroeconomic variables of the economy is important and studying the extent to which influenced by macroeconomic variables is also important. The purpose of the present study is to examine the impact of short-term interest rates measured by Treasury bill rates on share prices of CSE.

A number of studies has been undertaken to examine the relationship between macroeconomic variables and the indicators of stock markets; stock return or stock prices or market capitalization (R.C.Maysami, L.C.Howe and M.A. Hamzah, 2004; K. Hussainey and L.K. Ngoc, 2009; C. M. Bilson, T. J. Brailsford and V. J. Hooper, 2001; M.A. Hooker, 2004; M.J. Flannery and A.A. Protopapadakis, 2001). It has included interest rate, industrial production, inflation, GDP, exchange rates, money supply and so on. There are few studies in the literature to identify the effects of interest rate on stock prices and there is less number of studies carried out to investigate this relationship based on the CSE in Sri Lanka. Economic theory says that there is a negative relationship between interest rates and stock prices. This study attempts to empirically test this relationship only taking short-term Treasury bill rates as proxy for the short-term interest rates to narrow down the investigation.

The CSE has been established in 1984 and which is the only stock exchange in Sri Lanka. It has 232 listed companies representing 20 business sectors as at 31st December 2009. Public Companies incorporated under the Companies Act No.7 of 2007 are eligible to list on the CSE to raise Debt or Equity through Public offerings or introductions. Presently, CSE has 15 institutional members, all of whom are licensed to act as stock brokers. It has two main price indices; All Share Price Index (ASPI) and Milanka Price Index (MPI). While the ASPI indicates the price fluctuations of all the listed companies and covers all the traded companies during a market day the MPI comprises of 25 companies called "Blue-Chip Companies" selected by considering their performances over the past four quarters.

Governments issue treasury bills "T-Bills" to fulfill their short-term financial requirements with the maturity period usually does not exceed more than one year. Sri Lankan Governments also issues three types of treasury bills with the maturity period 91 days, 182 days and 364 days respectively. Weighted average yield rate of Treasury bill is important in the investment point of view because CSE takes government Treasury bill yield rate as the Risk-free interest rate in the Irvin Fisher's Security Market Line to calculate the Beta factor of listed companies. Therefore there is a rationality of using short-term Treasury bill rates as the proxy in the process of examining the impact of short-term interest rate on share prices of CSE and empirically testing this relationship is important.

2 Literature Review

(Hasan and Samarakoon 2000) study the ability of interest rates, as measured by the treasury bill rates of three maturities; 3, 6 and 12 months, to track the expected monthly, quarterly and annual returns in the Sri Lankan stock market for the period 1990-1997. Stock return is measured by the continuously compounded monthly returns on the ASPI and Sensitive price index. Results of the Ordinary Least Squares suggest that the short-term interest rates are positively related to future returns and they are able to reliably track expected returns horizons. It further suggests that the 12 months maturity is the most powerful tool to track monthly and quarterly expected return among all three maturities.

A study undertaken by (Banerjee and Adhikary 2009) investigates the dynamic effects of interest rate: weighted average interest rate on bank deposit, and exchange rate changes on ASPI stock market return from January 1983 to December 2006 in Bangladesh. It is applied the Johansen-Juselius procedure and the Vector Error Correction Model (VECM) respectively to test the co- integrating relationship and the existence of long –run equilibrium relationship among the variables. While Trace statistics suggests that there is no co-integrating relationship among variables and ECM concludes that a long-run equilibrium relationship exists among the variables. Research findings specifically point out that the interest rate and exchange rate changes affect for the stock market in the long run and there is no significant influence in the short-run. (Amaresh das 2005) documents a paper to investigate interrelationship between the stock prices represented by market index and interest rates measured by three months Treasury bills for monthly observations from January 1985 to January 2003 sampling three Asian countries including Bangladesh. Codependence among variables shows that the relationship between stock prices and interest rate is not significant for Bangladesh and Pakistan except India. Results further suggest that the time series data for Bangladesh and Pakistan reflects strongly common cycles.

With the purpose of providing empirical evidence of stock market sensitivity to interest rates and inflation in UK, (T. Nicholas 2003) examines the behavior of nominal and real interest rates and monthly total return of 35 industry indices and 10 sector indices as well as four financial times indices. Results of the linear regressions reveal that interest rate movements are important determinants of equity return variability and all the industries other than forestry and paper, sectors and market portfolios are negatively related to interest rate changes. Utilities have the highest sensitivity to movements in nominal interest rates because of their high exposure to inflation. Statistical outputs conclude that there are significant differences between interest rate and inflation sensitivities across all economic sectors.

3 Data and Methodology

To identify the impact of short-term interest rate on stock prices of Sri Lanka, treasury bills with the maturity period 91 days (TB 91), 182 days (TB 182) and 364 days (TB 364) are taken as the explanatory variables and All Share Price Index (ASPI) and Milanka Price Index (MPI) are considered as the respond variables. Monthly data from January 2002 to December 2009 for each variable is gathered from the Annual Reports published by CBSL as the secondary data source. In this investigation following tests are expected to be employed.

3.1 Multiple regressions

Study tests three explanatory variables with each respond variable separately because composition of share prices included in each index varies. In this sense two models are built up in line with the multiple regression analysis; $API_t = a + b_1TB_{91} + b_2TB_{183} + b_3TB_{364}$ and $MPI_t = a + b_1TB_{91} + b_2TB_{183} + b_3TB_{364}$. Coefficients of each equation are found using the method of Ordinary Least Squares (OLS). Results of the regressions are analyzed by Coefficient of Correlation (R), Coefficient of Multiple Determination (R^2) and Adjusted Coefficient of Determination (R^2_{adj}). In addition the OLS draws inferences for both cases in testing following hypotheses and F distribution is employed to test the null hypothesis.

H_0: $\beta_1 = \beta_2 = \beta_3 = 0$ H_1: Not all the β_i's are 0

3.2 Unit root test

All explanatory variables and respond variables used in the study are time series in nature. To prevent generating spurious results from above regression models and to balance the models all the time series are expected to be stationary. So study performs Dickey-Fuller (DF) Unit Root Test to decide whether those time series are stationary or non-stationary where three regression forms are generated by the DF unit root test; $\Delta Y_t = \delta Y_{t-1} + u_t$ (None), $\Delta Y_t = \alpha + \delta Y_{t-1} + u_t$ (With Constant) and $\Delta Y_t = \alpha + \beta T + \delta Y_{t-1} + u_t$ (With Constant and Trend).These regressions test hypotheses separately on existence or non-existence of unit root;H_0: $\delta = 0$ (Unit root exists) and H_1: $\delta \neq 0$ (unit root does not exist). In case of non-stationary time series study will transform them in to stationary using Difference-Stationary Process (DSP) in which another regression is applied; $\Delta(\Delta Y_t) = \alpha + \delta\Delta Y_{t-1} + e_t$.

3.3 Autocorrelation

Successive residuals are independent is one of the most important assumptions made in regression analysis. If the successive residuals are correlated there is a condition of autocorrelation for time series data and it will create problems in testing hypotheses on regression coefficients. Durbin-Watson statistic (d) is applied to check whether there is an autocorrelation problem for the sample data set. Where, $\mathbf{d} = \sum_{t=2}^{N} (e_t - e_{t-1})^2 / \sum_{t=1}^{N} (e_t)^2$ and $e_t = (y_t - \hat{y}_t)$. However SPSS output directly provides the Durbin-Watson statistic by its own. Based on the d value, the nature of the autocorrelation is explained. When the d value equals to 2 there is no autocorrelation among the residuals and if the d value is close to zero it indicates a positive autocorrelation. Likewise the value exceeds 2 indicates a negative autocorrelation.

3.4 Multicollinearity

Study executes the test for Multicollinearity to check whether the explanatory variables are correlated that enables to ensure the validity of multiple regression models in predicting stock prices. The rule of thumb (-0.70 to 0.70) on correlation between two independent variables is tested in the study. In addition Variance Inflation Factor (VIF: $1/1-R_j^2$) is used as a precise measure for Multicollinearity which is directly given by the SPSS output. If the VIF is higher than ten, relevant explanatory variable is excluded from the regression model.

3.5 Causality test

To determine whether the changes in the short –term interest rates (x) cause changes in stock prices (y), study carries out the (Granger and Sims's 1969) causality test where study tests two conditions; x should help to predict y and y should not help to predict x, to conclude that "x causes y". Accordingly, to satisfy these two conditions hypotheses are tested separately based on the unrestricted and restricted regressions. Condition 01: H_0: Short-term interest rate does not cause stock prices; Unrestricted Regression[①]: $y = \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{i=1}^{m} \beta_i x_{t-i} + \square_t$ and Restricted Regression[②]: $y = \sum_{i=1}^{m} \alpha_i y_{t-i} + \square_t$. Condition 02: H_0: Stock prices does not cause short-term interest rate; Unrestricted Regression: $x = \sum_{i=1}^{m} \alpha_i x_{t-i} + \sum_{i=1}^{m} \beta_i y_{t-i} + \square_t$ and Restricted Regression: $x = \sum_{i=1}^{m} \alpha_i x_{t-i} + \square_t$.

4 Results

4.1 Unit root test and autocorrelation

Result of DF Unit Root Test (Table 1) shows that the time series data of all explanatory variables and respond variables has a unit root as per the first regression because test statistics of each variable are higher than at least one critical value at any significant level accepting the null hypothesis. So they show non-stationary time series which will generate spurious results for the multiple regression models. This result is further ensured by the probability values of each condition being higher than 0.05 at 5 percent significant level.

Table 1 DF Unit Root Test

First DF Regression	TB91	TB182	TB364	ASPI	MPI
Augmented Dickey-Fuller Test Statistic	-0.8910	-0.8505	-0.7558	1.6457	0.9222
Test Critical Values: 1% Level	-2.5895	-2.5903	-2.5898	-2.5895	-2.5895
5% Level	-1.9442	-1.9444	-1.9443	-1.9442	-1.9442
10% Level	-1.6145	-1.6144	-1.6145	-1.6145	-1.6145
Probability	0.3276*	0.3449*	0.3864*	0.9752*	0.9039*
Durbin-Watson Statistic	1.8537	1.9621	2.1008	1.6121	1.6543

*Insignificant at 1%, 5% and 10% levels

Likewise the first regression of DF test, second regression and third regression also ensure that all the time series are non-stationary further accepting the null hypothesis. Results of each regression are reliable because Durbin-Watson statistics are near to 2 reflecting non-existence of autocorrelation problem. In the process of transforming non-stationary time series in to stationary time series by DSP,

① Unrestricted Regression: y is regressed against lag values (m) of y and lag values of x

② Restricted Regression: Y is regressed only against lagged values of y time series become stationary on either first difference or second difference (Table 2).

Accordingly DF test statistics are lower than the critical values of each variable at different significant levels. So it is concluded to reject the null hypothesis. Time series like TB364, ASPI, and MPI are made stationary by their first difference under the equation with a constant. TB91 and TB182 become stationary at their second difference under the equation with a constant. This result is further ensured by the probability values of each condition being lower than 0.05 at 5 percent significant level. These regression results also reliable because Durbin-Watson statistics are very near to 2 indicating non existence of an autocorrelation problem. Differentiated time series are the inputs to the multiple regression models.

Table 2 Difference-Stationary Process

First or Second DF Regression	TB91	TB182	TB364	ASPI	MPI
Augmented Dickey-Fuller Test Statistic	-10.4920	-12.1914	-6.1510	-7.7441	-8.0166
Test Critical Values: 1% Level	-3.5039	-3.5030	-3.5014	-3.5014	-3.5014
5% Level	-2.8936	-2.8932	-2.8925	-2.8925	-2.8925
10% Level	-2.5839	-2.5837	-2.5834	-2.5834	-2.5834
Probability	0.0000*	0.0001*	0.0000*	0.0000*	0.0000*
Durbin-Watson Statistic	2.0305	2.0181	2.0991	1.8988	1.9561

*Significant at 1%, 5% and 10% levels

4.2 Multicollinearity

At 90 percent significant level Pearson's Correlation matrix (Table 3) among explanatory variables satisfies the rule of thumb of multicollinearity besides the correlation (0.714) between TB91 and TB182 because it exceeds the 0.7 limit. However VIF values of all variables are less than the upper limit of 10. It indicates that there is no multcolinearity problem among explanatory variables and there is an ability to use all the explanatory variables in both regression models.

Table 3 Pearson's Correlation Matrix and VIF

Variables	TB91	TB182	TB364	Co- linearity Statistics (VIF)
TB91	-	0.714	0.391	2.037
TB182	0.714	-	0.554	2.489
TB364	0.391	0.554	-	1.442

4.3 Multiple regressions

Results of the multiple regressions (Table 4) show that R and R^2 of both models represent low values. Accordingly 0.072 of model 1 indicates that explanatory variables account for 7.2 percent of the variation in the dependent variable and in the model 2, explanatory variables explain 5.3 percent of the variation in the dependent variable. Likewise R^2, adjusted R^2 is also low for both cases. When it is compared the R^2 and adjusted R^2 of both model, difference is relatively low. It indicates that the effect of explanatory variables on R^2 is low. While the coefficients of b_1 and b_2 of both models shows positive values, b_3 of both cases takes negative values.

Table 4 Multiple Regressions

Model	R	R^2	R^2_{adj}	F	Sig (P)	a	b_1	b_2	b_3
1	0.268	0.072	0.041	2.325	0.080*	26.082	0.126	0.108	-0.301
2	0.230	0.053	0.021	1.675	0.178*	25.947	0.073	0.135	-0.264

*Insignificant at 5% level

At 0.05 of significance level the critical value relating to 3 degrees of freedom in the numerator and 90 degrees of freedom in the denominator is 2.7058 which is higher than the computed F values 2.325 in model 1 and 1.675 in model 2. These F values are in the region where H_0 is not rejected. The null hypothesis that all the multiple regression coefficients are zero is therefore accepted. Same result is given by the P value of both models. They also support to accept null hypothesis exceeding 0.05 at 95 percent significant level.

4.4 Causality test

As per the table 5 there are sufficient evidences to accept almost all the null hypotheses whose F statistics are lower than the critical value 2.7058 and P values are higher than the 0.05 at 95 percent significant level. Even though the P values of "DTB364 does not Granger Cause DASPI" and "DTB364 does not Granger Cause DMPI" are little higher than 0.05, their F statistics are higher than the critical value. Thereby it could be concluded to reject only these two null hypotheses.

Table 5 Granger and Sims's Causality Test

ASPI			MPI		
Null Hypothesis	F	P	Null Hypothesis	F	P
D[①]ASPI not Cause DTB91	0.88694	0.41561	DMPI not Cause DTB91	0.83446	0.43755
DTB91 not Cause DASPI	0.33682	0.71496	DTB91 not Cause DMPI	0.23573	0.79050
DASPI not Cause DTB182	1.43377	0.24398	DMPI not Cause DTB182	1.39756	0.25269
DTB182 not Cause DASPI	0.25748	0.77358	DTB182 not Cause DMPI	0.41063	0.66451
DASPI not Cause DTB364	0.40874	0.66574	DMPI not Cause DTB364	0.29487	0.74536
DTB364 not Cause DASPI	**2.97630**	**0.05614***	DTB364 not Cause DMPI	**2.74454**	**0.06978***

*Significant at 10% level

5 Conclusion

To determine the relationship between short-term interest rates and stock prices of Sri Lanka study used three time series data relating to short-term Treasury bill rates (TB91, TB182 and TB364 days) and two time series relating to price indices of the Colombo Stock Exchange (ASPI and MPI)**.** These all the time series are non-stationary time series with unit root problems as per the Dickey-Fuller Unit Root Test. However Durbin-Watson statistic reveals that these time series do not have an autocorrelation problem. In the process of converting non-stationary time series in to stationary time series TB364, ASPI, and MPI become stationary at their first difference and TB91 and TB182 become stationary at their second difference.

Non-existence multicolinearity problem among TB91, TB182 and TB364 enhances the validity of applying both regression models in the study. However these explanatory variables just account for 7.2 percent of the variation in the ASPI and 5.3 percent of the variation in the MPI. It means that 92.8 percent of the variation in the ASPI and 94.7 percent of the variation in the MPI is due to other sources or variables not included in the analysis. In the both multiple regression models coefficients of correlation relating to TB91 and TB182 show a weak positive relationship with ASPI and MPI and that is of TB364 reflects a weak negative relationship with both ASPI and MPI. In applying the sample results in to the entire population of each variable the null hypothesis says that there is hardly relationship between short-term interest rates measured by Treasury bill rates and stock prices in Sri Lanka.

Granger and Sims's Causality Test suggests that 364 days Treasury bill rate cause both All Share Price Index and Milanka Price Index.

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① "D" is added at the beginning of each variable because of differentiated time series