MARKET EFFICIENCY, THIN TRADING AND NON-LINEAR BEHAVIOUR: EMERGING MARKET EVIDENCE FROM SRI LANKA

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Introduction

The trend of investing in the stock markets of developing countries has increased significantly due to two reasons. One is the low correlation of stock returns between developing markets and developed markets. The second, returns and risks in emerging markets have generally been found to be higher relative to developed markets [8]. Therefore, investments in emerging markets increase the opportunity set for investors allowing them to improve the risk-return-trade-off in their portfolios [7].

However, as the emerging markets have gained considerable attention, the questions arise as whether these markets are functionally efficient. Financial literature proposes two types of market efficiencies. First, Fama [9] points out the conventional test of efficiency where efficiency has been developed for testing markets which are characterized by high levels of liquidity, sophisticated investors with access to high quality and reliable information and few a institutional impediments. The other version of market efficiency addresses the issues of whether market anomalies exist. [3] [4]

Both of the above versions of market efficiency share several common features. Market efficiency implicitly assumes that investors are capable of gathering, analyzing and interpreting all types of information on the companies having an impact on the value of securities which are being traded. When the market is efficient stock prices response to new information in a linear fashion with large volume and frequent trading of securities.

However, whether the security prices response linearly to new information in emerging markets is an empirically testable issue. Antonios et al. [2] point out that emerging markets, especially during the early years of trading, may be characterized by investors who do not have the characteristics of efficient market participants. For example, they point out that investors may be lose averse than risk averse. In addition, investors may place too much faith in their own forecasts that lead to bias in their actions (over-reaction and under--reaction). Similarly, investors do not always respond instantaneously to new information. In particular, uninformed investors may delay their response to see how the response of the informed investors in the market to new information because the former do not have either information or the facilities to analyze them.

Empirical studies have revealed that even though market behaviour is assumed as linear, there is an unexplained variation in the emerging markets. Hence it is assumed that a number of factors may contribute towards the non--linear behaviour of stock returns in emerging markets. First, the characteristics of the market microstructure may lead to nonlinearities because of the difficulties in carrying out arbitrage transactions (e.g. absence of derivative securities). Second, nonlinearities could arise because of the presence of market imperfections such as transaction costs and taxes. Due to the barriers of transaction costs and taxes investors may not respond to new information promptly. Third, even though the capital market theory assumes that investors are rational, in reality they are risk lovers who make subjective forecasts and not react to information instantaneously.

Another feature that may cause inefficiency to appear is the thin trading behaviour of markets. Thin trading and illiquidity are features found mostly in emerging markets and they prevent trades from being carried out at the price shown in the data. Thin trading introduces serial correlation. Anthonios et al. [2] report that observed dependence is not necessarily evidence of predictability, but rather may be a statistical illusion brought about by thin trading. Therefore, test statistics which ignore trading behaviour may be unreliable.

Finally, market regulation changes in emerging markets may affect the testing efficiency of those markets. Therefore, it is necessary to examine market efficiency at different stages of development to reflect changes in regulations.

Hence this study is to test the efficiency of the Colombo Stock Exchange (CSE) which is one of the rapidly developing markets in the South Asian region. The study examines the market efficiency taking into account nonlinearities, thin trading and market regulatory changes.

1. Colombo Stock Exchange (CSE)

Although share trading in Sri Lanka commenced in the 19th century, formalization of the market was started with the establishment of the "Colombo Securities Exchange (Gte) Limited" in 1985, which took over the operations of the stock market from the Colombo Share Brokers' Association. It was renamed 'Colombo Stock Exchange' (CSE) in 1990. The CSE is a company limited by guarantee, established under the Companies Act No. 17 of 1982 and is licensed by the Securities and Exchange Commission of Sri Lanka (SEC). The CSE is a mutual exchange and has 15 Full Members and 6 Trading Members licensed to trade both equity and debt securities. All members are licensed by the SEC to operate as stockbrokers.

The Colombo Stock Exchange (CSE) has 232 listed companies representing 20 business sectors as at 30th September 2009. CSE recorded its highest market capitalization of Rs. 1,008.5 billion (approx. US $ 8.8 billion) on the 13th October 2009 and the CSE recorded its highest daily turnover of Rs. 33.4 billion on the 1st of April 2008.

The SEC was established under the Securities Council Act No. 36 of 1987, to regulate the securities Market in Sri Lanka. The SEC grants licences to stock exchanges, stock brokers, stock dealers and unit trusts which engage in the business of trading in securities.

The CSE was one of the first Exchanges in the region to successfully automate its clearing and settlement functions in 1991, with the installation of a Central Depository and an electronic clearing and settlement system for share transactions, and an Automated Trading System (ATS) in 1997. This

Tab. 1: Yearly Statistics for the CSE: 1990-2009

Year	ASPI (Rs.)	Value of annual transactions (Mn. Rs)			Market Capitalization (Bn. Rs.)
		Total	Domestic	Foreign	
1990	384.40	1,563.00	-	-	36.90
1992	605.30	6,159.00	4,687.00	1,472.00	66.20
1994	986.70	34,505.00	20,699.00	13,806.00	143.70
1996	603.00	7,395.00	3,347.00	4,048.00	104.20
1998	597.30	17,912.00	11,525.00	6,387.00	116.60
2000	447.57	10,624.00	7,497.00	3,128.00	88.83
2001	621.03	13,905.00	11,281.00	2,624.00	124.00
2002	815.11	30,183.00	23,926.00	6,256.00	162.60
2003	1,062.39	73,837.00	59,818.00	13,839.00	262.80
2004	1,506.89	59,052.00	48,327.00	10,724.00	382.10
2005	1,922.21	114,599.20	89,959.08	24,640.13	584.00
2006	2,722.36	105,153.70	70,675.11	34,478.61	834.76
2007	2,540.99	104,985.40	63,815.72	41,169.68	820.65
2008	1,503.02	110,453.90	50,796.94	59,656.95	488.81
2009	3,052.68	142,462.60	99,010.80	43,451.80	1,008.50

Source: CSE data library

has notably enhanced the transparency and efficiency of the securities market in Sri Lanka. Further, in 1991 CSE took measures to liberalize the investment in the stock market with the abolition of 100 percent transfer of property tax on share purchase by non-nationals and the relaxation of exchange control on inward remittances for share purchases and outward remittances of surpluses on dealings in listed shares.

Trading on the Internet is about empowering the individual investor. Web access to market data, company information, and educational materials are available to investors online, which greatly reduces the intermediation issues of investing. Internet trading was started by one brokerage firm in June 2003. At present Internet Trading at the CSE is facilitated via eighteen Broker Firms.

The new CSE website, www.cse.lk, was launched in October 2007. This website provides access to a comprehensive array of real time market information, order book information includes charts and graphs of Market and Company performance in order to help existing and potential investors to make investment decisions. The new website is designed with the view to making primary communication channel for the CSE and most information with downloadable facilities with the formats of Excel, CSV and XTML. The CSE website also facilitates fast access to individual listed company profiles, as well as links to Online Trading platforms offered by stock broker firms.

However, there are some weak points at CSE. One of the lacking components in the CSE is not allowing short selling under the rules of the CSE. The other drawback is the absence of derivative securities at CSE. Investor participation in share trading increase if there is a derivative market simultaneously with the equity market.

Table 1 shows the trading statistics of Colombo Stock Exchange from year 1990. According to the table All Share Price Index (ASPI) comes to its lowest in the year 2000 and after that it gradually increases. During the period 1990 to 2000 the returns of ASPI have gradually decreased followed by an upward trend except in the year 2008. The average annual returns of ASPI is 23.04 percent during the period of 1990-2009 whilst in the last year (2009) it was 103.10 percent which is one of the highest when compared with worldwide exchanges. The total value of transactions clearly follows an upward trend during the last decade. Foreign stock trading started at CSE since 1991 with the abolition of 100 percent transfer of property tax on share purchase by non-nationals and the relaxation of exchange control on inward remittances for share purchases and outward remittances of surpluses on dealings in listed shares. The most important change in share transactions is the gradual increase of percentage of foreign transactions during this period. Foreign trading is 54 percent of the total value of annual transactions in the year 2009. The total market capitalization of the CSE listed companies amounted to Rs. 36.9 billion. in the year 1990 and with fluctuations from time to time it ends up with Rs. 1,008.5 billion (approx. US $ 8.8 billion) on the 13th October 2009.

2. Survey of Literature

Antonios et al. [2] examine the issue of efficiency using data form the Istanbul Stock Exchange from 1988 to 1993. Unlike most previous studies on emerging markets the paper recognizes the importance of taking into account the institutional features of the market when examining pricing efficiency. The results show that up to 1990 the market was inefficient but the inefficiency manifested itself through non-linear behaviour. The results further reveal that from 1991 onwards the market is not characterized by predictability and is therefore informationally efficient.

Siriopoulos et al. [19] provide additional empirical evidence on the importance of the right regulatory changes in the efficiency of Istanbul Stock Exchange for the period of 1989 to 1999. They report that the inefficiency observed up to 1993 was manifested through non-linear behaviour. However, after 1993 the market became more efficient and they justify it as a result of the institutional and regulatory changes.

More recently, Charles et al. [5] examine the efficiency of New Zealand's stock market by assessing the prevalence of thin trading, non-linearity and information asymmetry using Barclays Index data from January 5, 1970 to June 27, 1991, and its successor, the NZSE – 40 capital index from June 28, 1991 through March 31, 2004. They find that during the 1970s and 1980s, the stock market appears to have been inefficient with thin trading and non linearity. However, they strongly suggest that the New Zealand stock market has become more efficient since 1990.

Hassan [13] examines efficiency of Dhaka Stock Exchange by taking into consideration the problems of non-linearity, thin trading and structural change. Their evidence shows that parameter uncertainty is a major consideration when developing any successful trading strategy in Bangladesh Stock Market. Even though they do find non-linearity after correcting for thin-trading in some of the years under study, the ability to execute profitable trading strategies is confounded by parameter instability.

There are few Sri Lankan studies found relating to random walk hypothesis and market efficiency. Samarakoon [17] examines the autocorrelations of daily, weekly and monthly returns of CSE for sample period of 1985-1995 using market indices. The study finds significant autocorrelations in the order of 50 percent and coefficient of determination (R^2) of about 30 percent in daily market returns during the sample period. But he does not decompose the findings to find out reasons for the autocorrelation.

Gunasekarage and Power [12] examine the stock market overreaction hypothesis using monthly share returns for the equity shares traded on the CSE from 1989-2003. They use the market model to estimate the coefficients but adjusted for thin trading using the Dimsion's aggregated coefficient method. They find that investors overreact in the CSE. Further, they point out that month of the year seems to be affecting the overreaction findings.

In addition to the above, there are a few event studies which use daily returns data to compute the beta (β) coefficient of stock returns using linear market model. Dissabandara and Samarakoon [6] examine the semi-strong form efficiency test of informational content of dividend announcements during 1993 to 1998 taking a sample of 123 dividend announcements [6]. They find that CSE is efficient in semi-strong form of market efficiency. Further, Pathirawasam [16] made the same conclusion for the semi-strong form efficiency test of informational content of stock announcements in Sri Lanka. Both of the above studies use linear market model to compute parameters without taking into account thin trading and non linearities into account.

3. Data and Methodology

This paper investigates the efficiency of the CSE by considering the non-linearities in the price time series and thin trading characteristics of the CSE. This study uses the data of the ASPI for the period from January 1990 to December 2009. We use the ASPI because it represents the price variations of all the listed companies in the market.

Daily closing index returns (R_t) are calculated using the first log difference for daily ASPI.

$$R_t = \ln(P_t / P_{t-1}) \quad (1)$$

Where, P_t and P_{t-1} represent the current and previous daily market price index.

An augmented logistic equation model is used [2] as the basis for investigating non linearity effect of data set. The logistic equation also has the advantage of capturing capability of feedback mechanism:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_n R_{t-1}^n + \varepsilon_t \quad (2)$$

Where R is the return calculated as the difference of log price, and n = 2, 3. For the efficient markets hypothesis that all the regression coefficients to be equal to zero($\alpha_0 = \alpha_1 = \alpha_2 = \alpha_3 = 0$) and error term ($\varepsilon$) approaches to white noise process.

Non-synchronous trading was first proposed by Fisher [10], and then it was further developed by the research of Scholars and William [18] and Lo and MacKinlay [14]. Non-synchronous trading is based on the differences in the adjustment speeds of different stock prices to new information. Different stocks have different price adjustment speeds to new information arrival into the market. According to this hypothesis, new information is reflected to highly traded stock prices earlier than thinly traded ones. As a result, information affects the price of larger stocks first, and then the smaller stocks when they trade subsequently. This lag in price response leads to a positive autocorrelation in index returns [1].

To incorporate thin trading into the analysis, Miller et al. [15] propose an AR(1) model [14]. This autoregressive model involves estimating the residuals of the AR(1) equation, and adjusting the returns as follows.

$$R_t = \alpha_1 + \alpha_2 R_{t-1} + \varepsilon_t \quad (3)$$

$$R_t^{adj} = \frac{\varepsilon_t}{(1 - \alpha_2)} \quad (4)$$

The model above assumes that the appropriate adjustment for thin trading is constant over time.

Tab. 2: Random walk model for uncorrected index returns for thin trading

	Coefficient	Std. Error	T-Statistic	Probability
Panel A. $R_t = \alpha_1 + \alpha_2 R_{t-1} + \varepsilon_t$				
α_1	0.0384	0.0001	2.9600***	0.0031***
α_2	0.2734	0.0120	22.8704***	0.0000***
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	9.7648
			Probability	0.0000
Panel B. $R_t = \alpha_1 + \alpha_2 R_{t-1} + \alpha_3 R^2_{t-1} + \varepsilon_t$				
α_1	0.0408	0.0001	3.1087***	0.0019***
α_2	0.2760	0.0121	22.7237***	0.0000***
α_3	-0.2178	0.1841	-1.1830	0.2368
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	7.1294
			Probability	0.0008
Panel C. $R_t = \alpha_1 + \alpha_2 R_{t-1} + \alpha_3 R^3_{t-1} + \varepsilon_t$				
α_1	0.0376	0.0001	2.9035***	0.0037***
α_2	0.3139	0.0135	23.1799***	0.0000***
α_3	-9.0547	1.4385	-6.2946***	0.0000***
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	37.4444
			Probability	0.00000

Source: own

*** denotes statistically significant at 1% level

However, Charles et al. [16] report that this assumption is unlikely for emerging markets which undergo structural changes [15]. Therefore, equation (3) will be estimated recursively. In testing for efficiency, equation (3) is estimated using corrected returns calculated recursively from equation (4).

We employ the Breusch-Godfrey (BG) test [11] of higher order autocorrelation to test whether all auto regression coefficients of random error term are simultaneously equal to zero and which measure whether the random error term follows a white noise process.

4. Empirical Results

Panel A, B and C of the table 2 present the results of the random walk test using the unadjusted equation of returns, for the period 1990 to 2009. Panel a of the table shows that intercept coefficient (α_1) is statistically significant at 1 percent level, which implies that changes in variable to be, on average, non zero. Thus this shows that CSE is inefficient since the random walk is rejected. Furthermore, the diagnostic test shows that the hypothesis that the error term is not a white noise process because the series is found to be serially correlated. As suggested by Antoniou et al. [2], this serial correlation may be due to the presence of non-linearity that is omitted [2]. Therefore, we include non-linear terms R^2_{t-1} and R^3_{t-1} to the equation 3 in order to test if the inclusion of the non-linear terms alter the results and to see the nature of the non-linear term.

Panel B of the table 2 shows that the introduction of a non-linear term (R^2_{t-1}) does not make any change to the earlier finding since the coefficient of non-linear term (R^2_{t-1}) is not statistically significant. R_{t-1} is still significant after adding the non-linear term and serial correlation is not removed. Thus, we can conclude that the inclusion of the non-linear term has not removed the error term having white noise properties. There is no change in the initial results even after including second non-linear term (R^3_{t-1}) to the model 2. Both the coefficients of R_{t-1} and R^3_{t-1} are still

Tab. 3: Random walk model for corrected index returns for thin trading

	Coefficient	Std. Error	T-Statistic	Probability
Panel A. $R_t^{adj} = \alpha_1 + \alpha_2 R_{t-1}^{adj} + \varepsilon_t$				
α_1	0.0000	0.0002	0.0005	0.9996
α_2	0.0027	0.0124	0.2214	0.8248
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	1.9070
			Probability	0.1486
Panel B. $R_t^{adj} = \alpha_1 + \alpha_2 R_{t-1}^{adj} + \alpha_3 R_{t-1}^{adj2} + \varepsilon_t$				
α_1	0.0000	0.0001	0.3226	0.7470
α_2	0.0072	0.0126	0.5681	0.5700
α_3	-0.2814	0.1362	-2.0663**	0.0388**
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	9.9153
			Probability	0.0000
Panel C. $R_t^{adj} = \alpha_1 + \alpha_2 R_{t-1}^{adj} + \alpha_3 R_{t-1}^{adj3} + \varepsilon_t$				
α_1	0.0000	0.0002	0.0843	0.9328
α_2	0.0430	0.0141	3.0367***	0.0024***
α_3	-9.5785	0.7759	-5.9010***	0.0000***
Breusch-Godfrey (BG) Serial Correlation LM Test			F-statistic	31.8524
			Probability	0.0000***

Source: own

** denotes statistically significant at 5% level
*** denotes statistically significant at 1% level

Tab. 4: Estimation on a yearly basis of the equation $R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \varepsilon_t$ ***(Part 1)***

Year	α_0	α_1	LM test	Year	α_0	α_1	LM test
1990	0.000 (0.02)	-0.052 (-0.84)	2.349	2000	0.000 (0.05)	-0.016 (-0.26)	0.079
1991	0.000 (0.08)	-0.027 (-0.44)	0.800	2001	-0.000 (-0.02)	0.044 (0.71)	0.785
1992	-0.000 (-0.06)	-0.076 (-1.22)	9.905***	2002	0.000 (0.03)	0.009 (0.14)	0.959
1993	0.000 (0.05)	0.053 (0.84)	0.491	2003	0.000 (0.00)	0.009 (0.16)	2.986*
1994	-0.000 (-0.04)	0.056 (0.90)	1.186	2004	-0.017 (-0.14)	0.036 (0.59)	6.540***
1995	-0.000 (-0.06)	0.044 (0.71)	2.366	2005	-0.000 (-0.06)	0.054 (0.86)	8.683***
1996	0.000 (0.04)	-0.022 (-2.35)**	0.438	2006	-0.000 (-0.02)	-0.001 (-0.02)	2.631

Tab. 4: Estimation on a yearly basis of the equation $R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \varepsilon_t$ ***(Part 2)***

Year	α_0	α_1	LM test	Year	α_0	α_1	LM test
1997	0.000 (-0.01)	0.012 (0.19)	0.359	2007	-0.000 (-0.07)	-0.003 (-0.42)	0.072
1998	0.000 (0.02)	0.013 (0.21)	0.173	2008	-0.000 (-0.05)	-0.013 (-0.20)	1.169
1999	-0.000 (-0.10)	0.006 (0.09)	0.116	2009	0.0000 (0.10)	0.020 (0.31)	0.352

Source: own

The t-statistics are reported in parenthesis
* denotes statistically significant at 10% level
** denotes statistically significant at 5% level
*** denotes statistically significant at 1% level

Tab. 5: Panel A: Estimation on a yearly basis of the equation $R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \alpha_2 R_{t-1}^{(adj)2} + \varepsilon_t$

Year	α_0	α_1	α_{20}	LM test	Year	α_0	α_1	α_{20}	LM test
1990	-0.000 (-0.01)	-0.055 (-0.80)	0.089 (0.10)	2.329*	2000	0.017 (-0.27)	-0.017 (-0.27)	2.193 (0.83)	0.201
1991	-0.023 (-0.29)	-0.046 (-0.69)	2.233 (0.82)	1.937	2001	0.021 (0.15)	0.118 (1.24)	-0.494 (-1.03)	3.296***
1992	-0.026 (-0.38)	-0.076 (-1.23)	2.291 (0.79)	5.230***	2002	0.000 (0.10)	0.012 (0.18)	-0.380 (-0.17)	0.835
1993	0.031 (0.24)	0.061 (0.92)	-0.831 (-0.37)	0.177	2003	0.083 (0.66)	-0.030 (-0.48)	-2.102 (-2.94)***	16.60***
1994	-0.111 (-0.76)	0.075 (1.19)	2.277 (1.78)*	1.732	2004	-0.052 (-0.41)	0.075 (1.05)	0.901 (1.09)	6.929***
1995	-0.129 (-1.17)	0.104 (1.60)	4.465 (2.95)***	0.686	2005	0.058 (0.54)	0.003 (0.04)	-2.31 (-2.03)**	16.37***
1996	-0.051 (-0.88)	0.229 (0.04)	8.126 (1.84)*	0.696	2006	-0.018 (-0.24)	-0.012 (-0.19)	1.222 (0.79)	0.212
1997	-0.000 (-0.08)	0.010 (0.16)	0.404 (0.19)	0.744	2007	0.000 (0.14)	0.000 (0.01)	-1.368 (-0.49)	0.094
1998	0.075 (0.63)	0.003 (0.06)	-2.534 (-1.35)	0.629	2008	-0.111 (-1.31)	0.024 (0.38)	6.519 (3.32)***	3.039**
1999	-0.014 (-0.21)	0.005 (0.07)	0.869 (0.28)	0.083	2009	-0.013 (-0.13)	0.009 (0.15)	1.109 (0.63)	0.041

Source: own

The t-statistics are reported in parenthesis
* denotes statistically significant at 10% level
** denotes statistically significant at 5% level
*** denotes statistically significant at 1% level

significant and Breusch-Godfrey serial correlation LM test shows that still random error term does not follow a white noise. As most of the non-intercept terms in the panel B and C of the table are significant and error terms do not follow white noise properties, based on results for the uncorrelated data, we can provisionally reject the null hypothesis that the market is efficient and conclude that the CSE is inefficient.

Next panel A, B and C of the table 3 show predictable behaviour of stock returns after adjusting for the thin trading. Panel a of the table shows that the adjustment of returns for thin trading appears to have removed the predictability. Both α_1 and α_2 are not statistically significant and error term does not show any significant serial correlation. Hence we can come to a temporary conclusion that market inefficiency drawn in the panel a of table 2 is due to thin trading behaviour and after adjusting for thing trading market follows a random walk. However, Siriopoulos et al. [19] point out that even though the market is by nature non-linear, it may look like random walk but the use of a linear model leads to wrong inferences. Therefore, we introduce nonlinear components to the above model.

To investigate the evolution of market efficiency in CSE over time, we estimate equation 3 and 4 on annual sub-sets of the index data. These results appearing in the table 4 does not include the non-linear term.

The table 4 shows that none of the coefficients of thin trading adjusted lag returns are significantly different from zero. Further, except in three times in all the other cases error term follows a white noise properties. This finding is same as the results drawn in panel a of table 3. This finding clearly shows that the predictability of returns in the panel a of table 2 is due to thin trading behaviour of CSE. Thus using the linear model, it appears that CSE is weak form efficient subject to thin trading problem.

The table 5 shows yearly estimates obtained after applying the non-linear model to thin trading adjusted data. Panel a of the table 5 reveals that all lag linear coefficients of the model are not significantly different from zero. However, coefficients of the non-linear term is statistically significant more than at 5 percent level in years 1995, 2003, 2005 and 2008. LM test shows that error term does not follow white noise properties in 6 years (1990, 1992, 1995, 2003, 2004 and 2005).

Findings of the panel B of the table 5 verify the findings drawn in the panel C of the table 3. After incorporating second non-linear term, around 50 percent of the coefficients in the model become statistically significant. This finding is different from the findings of Antoniou et al. [2], Siriopoulos et al. [19] and Charles et al. [5]. They find that those markets become efficient in the latter parts of the sample. But this study reveals that market inefficiency prevails throughout the whole sample period. It implies that structural changes introduced by the authorities have not been performing adequately yet in the CSE.

5. Discussions and Conclusion

This study examines the weak form efficiency of the CSE taking into account the thin trading, non-linearity and structural changes. The study period is from 1990 to 2009. The study finds that for the unadjusted returns for thin trading, stock returns are predictable based on past returns. However, after adjusting for the thin trading, liner model does not show any predictability based on past returns. This finding gives a conclusion for the findings of Samarakoon [18]. He finds that stock returns are predictable based on the past returns. This study concludes that predictability of returns find by Samarakoon is due to thin trading behavior of equity shares in CSE.

After incorporating non-linear components into the model, we find that statistically significant non linearities in the CSE after and before adjusting returns for thin trading. Further, we can conclude that the inefficiency observed at CSE during the sample period is manifested through non-linear behaviour of stock returns. This finding is in line with Antoniou et al. [2], Siriopoulos et al.[19]. Further, this non-linearity may be due to the over-reaction of Sri Lankan investors to new information as revealed by Gunasekarage and Power [12]. Further, our yearly analysis of returns shows the same findings as in the full sample. It clearly shows that structural changes introduced to uplift the position of the market is not adequate and non linearity of stock returns at CSE reveals that there are market imperfections. Therefore, we suggest that CSE should take steps to encourage more investors to participate in share trading. In this regard introduction of risk hedging instruments and allowing for short sales would be much effective.

Tab. 6: Panel B: Yearly basis estimation of the equation $R_t^{adj} = \alpha_0 + \alpha_1 R_{t-1}^{adj} + \alpha_2 R_{t-1}^{(adj)3} + \varepsilon_t$

Year	α_0	α_1	α_{20}	LM test	Year	α_0	α_1	α_{20}	LM test
1990	0.079 (0.52)	0.197 (2.05)**	-40.78 (-3.35)	3.307**	2000	0.000 (0.07)	0.244 (2.72)***	-399.4 (-3.95)***	2.038
1991	0.022 (0.31)	0.086 (0.92)	-156.4 (-1.62)	0.463	2001	0.013 (0.09)	0.131 (1.35)	-2.182 (-1.70)	3.670**
1992	-0.000 (-0.06)	-0.034 (-0.38)	-74.26 (-0.63)	10.41***	2002	0.013 (0.16)	0.081 (0.93)	-73.60 (-1.20)	1.956
1993	0.000 (0.07)	0.059 (0.54)	-5.89 (-0.08)	0.551	2003	-0.016 (-0.31)	0.186 (2.18)**	-21.29 (-2.97)***	22.32***
1994	-0.024 (-0.18)	0.202 (2.43)**	-50.51 (-2.62)***	5.556***	2004	-0.011 (-0.09)	0.009 (0.10)	3.518 (0.44)	6.242***
1995	-0.040 (-0.39)	0.329 (2.68)***	-92.29 (-3.02)***	4.954***	2005	0.013 (0.12)	-0.064 (-0.66)	31.47 (1.57)	13.60***
1996	0.000 (-0.19)	0.142 (1.62)*	-602.3 (-2.63)***	0.332	2006	0.000 (0.12)	0.144 (1.79)*	-77.83 (-2.84)***	0.335
1997	-0.000 (-0.01)	0.007 (0.09)	4.923 (0.09)	0.578	2007	-0.000 (-0.15)	-0.125 (-1.55)	205.7 (2.05)**	0.434
1998	-0.014 (-0.13)	0.209 (2.17)**	-138.6 (-2.65)***	0.785	2008	-0.022 (-0.28)	0.238 (2.60)***	-214.4 (-3.68)***	0.395
1999	-0.000 (-0.06)	0.108 (1.22)	-205.9 (-1.61)*	0.493	2009	0.023 (0.26)	0.142 (1.59)	-74.02 (-1.97)**	3.107**

Source: own

The t-statistics are reported in parenthesis
* denotes statistically significant at 10% level
** denotes statistically significant at 5% level
*** denotes statistically significant at 1% level

References

[1] ALTAY, E. Autocorrelation in capital markets: Feedback trading in Istanbul Stock Exchange. *Journal of Financial Management and Analysis.* 2006, Vol. 19, Iss. 2, pp. 10-21. ISSN 0970-4205.

[2] ANTONIOU, A.; ERGUL, N.; HOLMES, P. Market efficiency, thin trading and non-linear behavior: evidence from an emerging market. *European Financial management.* 1997, Vol. 3, Iss. 2, pp. 175-190. ISSN 1354-7798.

[3] BANZ, R. Relationship between return and market value of common stocks. *Journal of Financial Economics.* 1981, Vol. 9, pp. 3-18. ISSN 0304-405X.

[4] BASU, S. Investment performance of common stocks in relation to their price earnings ratios: a test of the efficient market hypothesis. *Journal of Finance.* 1977, Vol. 32, pp. 663-682. ISSN 0022-1082.

[5] CHARLES, R.; KABIR, H.M; JUNG-SUK, YU.; KENNETH, R.J. Emerging market efficiencies New Zealand's maturation experience in the presence of non-linearity, thin trading and asymmetric information. *International Review of Finance.* 2007, Vol. 7, Iss. 1, pp. 21-34. ISSN 1468-2443.

[6] DISSABANDARA, D.B.P.H; SAMARAKOON, L.P. Dividend announcements firm size and dividend growth in the Sri Lanka stock market. *Sri Lanka Journal of Management.* 2002, Vol. 14,

Iss. 3&4, pp. 228-245. ISSN 1391-1503.
[7] DIVECHA, A.; DRACH, J.; STEFAK, D. Emerging markets: a quantitative perspective. *Journal of Portfolio Management*. 1992, Vol. 4, pp. 41-50. ISSN 0095-4918.
[8] ERRUNZA, V. Emerging markets: a new opportunity for improving global portfolio performance. *Financial Analysts Journal*. 1983, Vol. 39, p. 51-58. ISSN 0015-198X.
[9] FAMA, E.F. Emerging markets: a new opportunity for improving global portfolio performance. *Journal of Finance*. 1970, Vol. XXV, Iss. 2, pp. 34-105. ISSN 0022-1082.
[10] FISHER, L. Some new stock market indexes. *Journal of Business*. 1966, Vol. 39, pp. 191-225. ISSN 0021-9398.
[11] GUJARATI, D.N. *Basic econometrics*, 3rd ed. Singapore: McGraw-Hill Books co., 2003. p. 377-8. ISBN 0-07-025214-9
[12] GUNASEKARAGE, A; POWER, D.M. Stock market overreaction: some evidence from the Colombo Stock Exchange. *Journal of Emerging Markets*. 2005, Vol. 10, Iss. 1, pp. 5-17. ISSN 1083-9798.
[13] HASSAN, M.K; NEAL, M.C. Thin trading, non-linearity and market efficiency of a small emerging stock market: evidence from Bangladesh. *International Journal of Applied Business and Economic Research*. 2004, Vol. 2, Iss. 2, pp. 129-46. ISSN 0972-7302.
[14] LO, A.W.; MACKINLAY, A.C. An econometric analysis of nonsynchronous trading. *Journal of Econometrics*. 1990, Vol. 45, pp. 181-211. ISSN 0304-4076.
[15] MILLER, M.H.; MUSTASWAMY, J.; WHALEY, R.E. Mean reversion of standard and poor 500 index basis changes, arbitrage-induced or statistical illusion? *Journal of Finance*. 1994, Vol. 49, pp. 479-513. ISSN 0022-1082.
[16] PATHIRAWASM, C. The information content of stock dividend announcements: evidence from Sri Lanka. *Central European review of Economic Issues*. 2009, Vol. 12, Iss. 1, pp. 103-114. ISSN 1212-3951.
[17] SAMARAKOON, L.P, Predictability of short-horizon returns in the Sri Lankan stock market. *Sri Lankan Journal of Management*. 1996, Vol. 1, pp. 1-27. ISSN 1391-1503.
[18] SCHOLES, M.; WILLIAMS, E. J. Estimating beta from nonsynchronous data. *Journal of Financial Economics*. 1977, Vol. 5, Iss. 1, pp. 3-21. ISSN 0304-405X.
[19] SIRIOPOULOS, C.; TSOTSOS, R; KARAGIANNI, S. The Impact of non linearities, thin trading and regulatory changes in the efficiency of an emerging capital. *Journal of Applied Business Research*. 2001, Vol. 17, Iss. 4, pp. 81-92. ISSN 0892-7626.

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ABSTRACT

MARKET EFFICIENCY, THIN TRADING AND NON-LINEAR BEHAVIOUR: EMERGING MARKET EVIDENCE FROM SRI LANKA

Chandrapala Pathirawasam, I M S K Idirisinghe

This paper investigates the efficiency of Colombo Stock Exchange (CSE) taking into account the possibility of non-linearities in the price time series, and thin trading characteristics of the Sri Lankan stock market. We use the data on the All Share Price Index (ASPI) for the period from January 1990 to December 2009. We use an AR(1) model to estimate the residuals of the AR(1) equation, and then adjust the returns for thin trading. In addition to that an augmented logistic equation model is used as a basis for investigation to take into account the nonlinearity in the data. The study finds significant autocorrelations in the unadjusted daily market returns for thin trading for the period of 1990 to 2009. However, the above predictability is removed when we use thin trading adjusted returns to the model. After incorporating non- linear components into the model, we find that statistically significant non linearity in the CSE after and before adjusting returns for thin trading. Therefore, we can conclude that the inefficiency observed at CSE during the sample period is manifested through non-linear behaviour of stock returns. We further examine the models on annual sub-sets of the index data in order to investigate the effectiveness of market regulatory changes on market efficiency at CSE. Unlike the other emerging markets we do not see that regulatory changes have significantly encouraged investor participation, improved information quality and reflected new information more rapidly in share prices. Therefore, further measures are necessary to improve the informational efficiency of the CSE. In this regards allowing short sales and introducing risk hedging derivative securities to the market would be effective.

Key Words: *Colombo stock exchange, efficiency, thin-trading, non-linearity.*

JEL Classification: *G14, G17.*