

## Volume 29, Issue 2

### Is Malaysian Stock Market Efficient? Evidence from Threshold Unit Root Tests

Qaiser Munir

*School of Business and Economics, Universiti Malaysia Sabah*

Kasim Mansur

*School of Business and Economics, Universiti Malaysia Sabah*

#### Abstract

This paper investigates the behavior of Kuala Lumpur Stock Exchange Composite Index (KLCI) for the period from 1980:1 to 2008:8 using a two-regime threshold autoregressive (TAR) model with an autoregressive unit root developed by Caner and Hansen [Threshold autoregression with a unit roots, *Econometrics* 69 (6) (2001) 1555-1596] which allows testing nonlinearity and nonstationarity simultaneously. Our finding indicates that the KLCI is a nonlinear series that is characterized by a unit root process, consistent with the efficient market hypothesis.

---

We are grateful to Bruce Hansen for making available his Gauss Programme to estimate and make inferences on the TAR model. The usual disclaimer applies.

**Citation:** Qaiser Munir and Kasim Mansur, (2009) "Is Malaysian Stock Market Efficient? Evidence from Threshold Unit Root Tests", *Economics Bulletin*, Vol. 29 no.2 pp. 1359-1370.

**Submitted:** Apr 29 2009. **Published:** June 08, 2009.

## 1. Introduction

The stock market efficiency hypothesis is among the most popular research topic in the international macroeconomic literature. Stock market efficiency implies that prices respond quickly and accurately to relevant information. Information in the efficient market hypothesis is defined as anything that may affect prices which is unknowable in the present and appears randomly in the future. This random information is the cause of future price changes. In other words, an efficient stock market is characterized by a random walk (unit root) process, which indicates that stock market returns cannot be predicted based on its historical observations. If stock price follows a random walk process, any shock to stock price is permanent, and there is no tendency for the price level to return to a trend path over time. In contrast, a mean reverting process (trend stationary) means that any shock to stock price is transitory and there is tendency for the price level to return to a trend path over time. The random walk property implies that future returns are unpredictable based on previous observations and that volatility of stock price can grow without bound in the long-run. Hence, testing for mean reversion in stock prices is one avenue for examining market efficiency (see Fama and French, 1988a, 1988b).

There is a large body of the literature that investigates the efficient market hypothesis using a variety of methodology and found mixed results. Many studies have found that stock indexes are not characterized by a unit root (see Lo and MacKinlay, 1988; Poterba and Summers, 1988; Urrutia, 1995; Grieb and Reyes, 1999; Chaudhuri and Wu, 2003; Shively, 2003; Narayan, 2008), while others have found stock indexes to be a unit root process (Huber, 1997; Liu *et al.*, 1997; Ozdemir, 2008; Narayan, 2005, 2006; Narayan and Smyth, 2004, 2005; Qian *et al.*, 2008;). Two important features characterize these studies.

First, the majority of these studies are based on univariate unit root tests. However, one strong criticism of the univariate unit root tests, such as the Dickey and Fuller test used by the most studies, is that it lacks power if the true data generating process of a series exhibits structural breaks (Perron, 1989). Therefore, the majority of these studies adopt new developed unit root test with structural breaks (Zivot and Andrews, 1992; Lumsdaine and Papell, 1997; Lee and Strazicich, 2003; Im *et al.*, 2005) to investigate the stationary property of stock prices. For example, Chaudhuri and Wu (2003) investigate mean reversion in stock prices in emerging markets, including one break unit root tests. Their findings, when compared to previous findings, show that there is no consensus among economists regarding market efficiency. Narayan and Smyth (2004) apply the Zivot and Andrews (1992) one break and the Lumsdaine and Papell (1997) two break unit root tests to examine the random walk hypothesis for stock prices in South Korea. Their results provide strong evidence that stock prices in South Korea are characterized by a unit root, which is consistent with the efficient market hypothesis. Lean and Smyth (2007) apply univariate and panel Lagrange Multiplier (LM) unit root tests with one and two structural breaks (Lee and Strazicich, 2003; Im *et al.*, 2005) to examine the random walk hypothesis for stock prices in eight Asian countries. The results from the univariate LM unit root tests and panel LM unit root test with one structural break suggest that stock prices in each country is characterized by a random walk, but the findings from the panel LM unit root test with two structural breaks suggest that stock prices in the eight countries are mean reverting. Narayan (2008) provide evidence on the unit root hypothesis for G7 stock price indices using the Lagrangian multiplier (LM) panel unit root

test that allows for structural breaks. His main finding is that stock prices are stationary processes, inconsistent with the efficient market hypothesis.

Second, however, following the work of (Abhyankar *et al.*, 1995, 1997; Atchison and White, 1996; Kohers *et al.*, 1997; Schaller and van Norden, 1997; Qi, 1999; Kanas, 2001; Sarantis, 2001; Shively, 2003; Narayan, 2005, 2006; Qian *et al.*, 2008; among others), who find stock prices to be consistent with a nonlinear data generating process, the reliability of the findings from existing studies is questionable. Shively (2003) examines the six stock prices (CAC 40, DAX 30, FTSE 100, Nikkei 225, S&P 500 and TSE 300) for the period 1970:1-2000:12. He applies Tsay's (1998) chi-squared test and find that all six stock-price indexes are all highly consistent with threshold nonlinearity. Then he applies Tsay's (1998) threshold modeling technique to partition each stock-price index into three regimes using the corresponding stock-return series as the stationary threshold variable and finds the series to be a regime reverting process. This nonlinear regime-reverting process implies a violation of the efficient market hypothesis. In contrast, Narayan (2006) investigates the behavior of US stock prices using an unrestricted two-regime threshold model for the period 1964:06 to 2003:04. He finds that the stock prices are nonlinear process and characterized by a unit root process, consistent with the efficient market hypothesis.

Lean and Symth (2007) suggest that, in terms of future research, there is growing evidence that univariate unit root tests lack the power to find mean reversion in stock prices. Perhaps a more promising approach might be to examine whether Asian stock prices are nonlinear with a unit root. Thus, this paper contributes to the existing literature on the random walk hypothesis, by providing additional evidence on the Malaysian stock market efficiency, using the threshold autoregressive (TAR) model developed by Caner and Hansen (2001). Caner and Hansen methodology is applicable if a nonlinear process has unit root. The main advantage of the TAR model is that it allows us to discriminate nonstationarity from nonlinearity in data simultaneously. Furthermore, their methodology allows testing for a partial unit root process in two regimes<sup>1</sup>. Our main finding is that the Malaysian stock price is a nonlinear process and is characterized by unit root. The latter finding is consistent with the efficient market hypothesis.

The rest of the paper is organized as follows: Section 2 outlines the empirical methodology. Section 3 presents the data and empirical results. Finally, Section 4 provides conclusion.

## 2. Empirical Methodology

Following the work of Caner and Hansen (2001), we adopt a two-regime TAR ( $k$ ) model with an autoregressive unit root as follow:

$$\Delta y_t = \theta_1' x_{t-1} I_{\{Z_{t-1} < \lambda\}} + \theta_2' x_{t-1} I_{\{Z_{t-1} \geq \lambda\}} + e_t \quad (1)$$

Where  $y$  is the logarithm of the stock price index for  $t = 1, \dots, T$ ,  $x_{t-1} = (y_{t-1}, r_t', \Delta y_{t-1}, \dots, \Delta y_{t-k})'$ ;  $I_{\{\cdot\}}$  is the indicator function;  $e_t$  is an independently and identically error term;  $Z_t = y_t - y_{t-m}$  for

---

<sup>1</sup> Many studies (see, Alba and Park, 2005; Basci and Caner, 2005 and Ho, 2005) have applied this methodology to test the unit root and threshold effect to exchange rates and Purchasing Power Parity (PPP).

$m$  represents the delay order and some  $1 \leq m \leq k$ .  $r_t$  is a vector of deterministic components including an intercept and a possible linear time trend. The threshold value  $\lambda$  is unknown and takes the values in the compact interval  $\lambda \in \Lambda = [\lambda_1, \lambda_2]$ , where  $\lambda_1$  and  $\lambda_2$  are picked according to  $P(Z_t \leq \lambda_1) = \pi_1 > 0$  and  $P(Z_t \leq \lambda_2) = \pi_2 < 1$ . It is convenient to show the components of  $\theta_1$  and  $\theta_2$  as follow:

$$\theta_1 = \begin{pmatrix} \rho_1 \\ \beta_1 \\ \alpha_1 \end{pmatrix} \quad \text{and} \quad \theta_2 = \begin{pmatrix} \rho_2 \\ \beta_2 \\ \alpha_2 \end{pmatrix} \quad (2)$$

where  $\rho_1$  and  $\rho_2$  are slope coefficients on  $y_{t-1}$ ,  $\beta_1$  and  $\beta_2$  are scalar intercepts, and  $\alpha_1$  and  $\alpha_2$  are  $K \times 1$  vectors containing the slope coefficients on dynamics regressors  $(\Delta y_{t-1}, \dots, \Delta y_{t-k})$  in the two regimes. In order to calibrate equation (1), the concentrated least squares (LS) approach is usually utilized. For each  $\lambda \in \Lambda$ , equation (1) is estimated ordinary least square (OLS) so that

$$\Delta y_t = \hat{\theta}_1(\lambda)' x_{t-1} I_{\{Z_{t-1} < \lambda\}} + \hat{\theta}_2(\lambda)' x_{t-1} I_{\{Z_{t-1} \geq \lambda\}} + \hat{\varepsilon}_t \quad (3)$$

Let  $\hat{\sigma}^2(\lambda) = T^{-1} \sum_1^T \hat{\varepsilon}_t(\lambda)^2$  be the OLS estimate of  $\sigma^2$  for fixed  $\lambda$ . The LS estimate of threshold parameter ( $\lambda$ ) is found by minimizing the residual variance,  $\hat{\sigma}^2(\lambda)$ :

$$\hat{\lambda} = \arg \min_{\lambda \in \Lambda} \hat{\sigma}^2(\lambda) \quad (4)$$

Estimating the TAR model in equation (1), the two central issues are whether or not there is a threshold effect and whether the process  $y_t$  (stock price index) is stationary or not. In this paper standard Wald test statistics,  $W_T = W_T(\hat{\lambda}) = \sup_{\lambda \in \Lambda} W_T(\lambda)$ , proposed by Caner and Hansen (2001), is

used to test the null hypothesis of no threshold effect (i.e., the process is linear)  $H_0: \theta_1 = \theta_2$ , against the alternative of threshold effect (i.e., the process is nonlinear). If the null hypothesis cannot be rejected, there is no threshold effect, in which case the two vectors of coefficients are identical between the two regimes ( $\theta_1 = \theta_2$ ). Caner and Hansen find that  $W_T$  has a non-standard asymptotic null distribution with critical values that cannot be tabulated. Hence they propose a bootstrap method to compute asymptotic critical values and  $p$ -values.

The stationarity of the process  $y_t$  depends on the parameters  $\rho_1$  and  $\rho_2$ . For regime 1, we can reject the null hypothesis of unit roots in favor of the alternative hypothesis of level stationarity if  $\rho_1$  is significantly different from zero. We can do the same for regime 2 if  $\rho_2$  is significantly different from zero. If the null hypothesis:  $H_0: \rho_1 = \rho_2 = 0$  holds, the process  $y_t$  has a unit root and model (1) can be expressed in terms of the stationary difference  $\Delta y_t$ . The obvious alternative to  $H_0$  is  $H_1: \rho_1 < 0$  and  $\rho_2 < 0$ , in which case the process  $y_t$  is stationary in both regimes. We also have to consider the intermediate partial unit root case  $H_2: \rho_1 < 0$  and  $\rho_2 = 0$  or  $\rho_1 = 0$  and  $\rho_2 < 0$ , in which case the process  $y_t$  have a unit root in one regime and is stationary in other showing mean reversion behavior.

The null hypothesis is tested against the unrestricted alternative  $\rho_1 \neq 0$  or  $\rho_2 \neq 0$  using the Wald statistics, and expressed as,  $R_{2T} = t_1^2 + t_2^2$ , where  $t_1$  and  $t_2$  are the  $t$ -ratios for  $\hat{\rho}_1$  and  $\hat{\rho}_2$  respectively

from the OLS estimation. However, Caner and Hansen (2001) note that this two-sided Wald statistics may have less power than a one-sided version of the test. As a result, they recommend the following one-sided Wald statistics:

$$R_{1T} = t_1^2 I_{\{\hat{\rho}_1 < 0\}} + t_2^2 I_{\{\hat{\rho}_2 < 0\}} \quad (5)$$

which tests  $H_0$  against the one-sided alternative  $\rho_1 < 0$  or  $\rho_2 < 0$ . A statistically significant  $R_{1T}$  justifies rejecting unit roots in favor of stationarity. However, it does not allow us to discriminate between the stationary case  $H_1$  and the partial unit root case  $H_2$ . This requires further examining the individual  $t$  statistics  $t_1$  and  $t_2$ . Only one of  $-t_1$  or  $-t_2$  being significant would be consistent with the partial unit root case.

### 3. Data and Empirical Results

The data studied in this paper are the logged values of the KL Composite index (KLCI)<sup>2</sup>, which is the main index for Bursa Malaysia (stock exchange). Monthly data over the period from 1980:1 to 2008:8 are utilized for analysis and taken from Bloomberg database. Specifically, we retrieve the closing prices of the last trading days of all months, which give the time series  $y_t$  defined in the preceding section.

Before beginning the tests we consider conventional Augmented Dickey Fuller (ADF) test for unit root against linear stationary alternative. The results are not reported here to conserve space but are available from the authors upon request. We find the calculated  $t$ -statistics to be  $-1.8976$  (with an intercept) and  $-2.8588$  (with an intercept and a trend), respectively. Given the 10% level critical value of  $-2.5712$  (for model with no trend) and  $-3.1344$  (for model with trend), we are unable to reject the unit root null hypothesis. This finding is not surprising since ADF test have almost no power when alternative is nonlinear process. This implies that KLCI has a unit root<sup>3</sup>.

To examine the stationarity in the possible presence of nonlinearities, we apply the Caner and Hansen procedure described above. The first issue we must address is the presence of the threshold effects. As stated previously, the appropriate test this purpose is the standard Wald statistic  $W_T$ . In Table 1, we report the results of the Wald test, bootstrap critical values at three conventional levels 10%, 5%, and 1%, and bootstrap  $p$ -values (using 10000 replications) for threshold variables of the form  $Z_t = y_t - y_{t-m}$  for different delay parameters  $m$  ranging from 1 to 12. The significant bootstrap  $p$ -values corresponding to the Wald tests  $W_T$  (except for  $m = 4$ , which is not statistically significant) indicate that we can reject the null hypothesis of linearity in favor of the alternative that there is a threshold effect in the monthly KLCI series. According to

---

<sup>2</sup> The Stock Exchange of Malaysia was officially formed in 1964 under the name Stock Exchange of Malaysia and Singapore (SEMS). In 1973, with the termination of currency interchangeability between Malaysia and Singapore, the SEMS was separated into The Kuala Lumpur Stock Exchange Bhd (KLSEB). KLSEB became a demutualised exchange and was re-named Bursa Malaysia in 2004 with total market capitalization of MYR700 billion (US\$189 billion). As of 31 December 2007, the Malaysia Exchange had 986 listed companies with a combined market capitalization of \$325 billion.

<sup>3</sup> Phillips and Perron (1988) and Kwiatkowski *et al.* (KPSS, 1992) unit root tests also conducted, and we found the identical results. All results are available from the author upon request.

these results, the linear AR model can be rejected in favour of the TAR model. In order to avoid the criticism that the results of Table 1 is conditional on  $m$ , which is generally unknown, Caner and Hansen (2001) recommend making  $m$  endogenous, which is achieved by selecting an  $m$  value that minimizes the residual variance of the least squares estimates. This is also the value that maximizes  $W_T$  since  $W_T$  is a monotonic function of the residual variance (Alba and Park, 2005). According to Table 1, the Wald statistics is maximized ( $W_T = 46.7$ , corresponding  $p$ -value = 0.002) when  $m = 5$ . Hence we take  $\hat{m} = 5$  as the preferred model.

**Table 1. Threshold Test**

$m$	$W_T$	Bootstrap critical values			Bootstrap $p$ -values
		10%	5%	1%	
1	35.7	31.3	34.5	41.1	0.029
2	31.2	30.9	33.8	40.9	0.092
3	32.3	30.8	34.0	40.9	0.089
4	22.0	30.7	33.9	40.7	0.514
5	46.7	30.7	33.9	39.7	0.002
6	45.0	30.7	33.7	39.0	0.002
7	39.0	30.7	33.8	40.0	0.014
8	36.8	30.6	33.8	40.0	0.024
9	35.9	30.7	33.4	39.8	0.028
10	41.5	30.6	33.5	39.9	0.007
11	38.9	30.6	33.3	40.0	0.012
12	38.7	30.5	33.3	40.4	0.015

We now examine the unit root properties of the KLCI. We first calculate the one-sided and two-sided threshold unit root test statistics  $R_{1T}$  and  $R_{2T}$  along with the bootstrap critical values and  $p$ -values for each delay parameters  $m$ , ranging from 1 to 12. The results are reported in Table 2. The Wald statistic  $W_T$  obtained from  $R_{1T}$  is statistically insignificant at the 10% level for all  $m$ . For the preferred model  $m = 5$ , the  $W_T$  test statistic of 2.80 is less than the 10% critical value (9.2). We find similar results from the two-sided Wald tests  $R_{2T}$  presented in the right panel of Table 2. For all  $m$ , Wald statistics  $W_T$  are less than the bootstrap critical values at the 10% level of significance. These results suggest that the null hypothesis of the presence of a unit root in the monthly KLCI cannot be rejected at the 10% level.

**Table 2. One and Two sided Unit root Tests**

$m$	$R_{1T}$					$R_{2T}$				
	$W_T$	Bootstrap critical values			$p$ -values	$W_T$	Bootstrap critical values			$p$ -values
		10%	5%	1%			10%	5%	1%	
1	3.15	9.1	11.3	16.2	0.571	3.15	9.5	11.6	17.1	0.603
2	2.98	9.1	11.3	16.5	0.594	2.99	9.5	11.8	17.1	0.627
3	1.81	9.1	11.4	16.0	0.751	1.82	9.6	11.8	16.4	0.788
4	1.71	9.3	11.3	16.4	0.754	1.73	9.6	11.8	16.7	0.791
5	2.80	9.2	11.4	16.5	0.606	2.80	9.6	11.9	17.1	0.643
6	1.73	9.3	11.5	16.8	0.762	1.75	9.7	11.9	17.1	0.800
7	1.73	9.2	11.5	16.8	0.761	1.76	9.6	11.9	17.0	0.798
8	3.94	9.3	11.5	16.5	0.472	3.94	9.7	12.1	16.9	0.508
9	7.03	9.4	11.7	16.8	0.205	7.03	9.7	12.2	17.1	0.229
10	6.66	9.5	11.8	17.2	0.234	6.67	9.9	12.2	17.8	0.256
11	4.17	9.6	11.8	17.0	0.458	4.20	9.9	12.2	17.1	0.490
12	3.88	9.4	11.8	17.4	0.495	3.88	9.8	12.1	17.6	0.527

To investigate stationarity of the regimes individually, we examine the individual  $t$  statistics (partial unit root),  $t_1$  and  $t_2$ . We report the  $t$  statistics along with the bootstrap critical values and bootstrap  $p$ -values in Table 3. For our preferred model  $m = 5$ , the  $t_1$  statistic (0.79) is smaller than the bootstrap critical value (2.87) at the 5% level of significance. Moreover, the  $t_2$  statistic is insignificant at the same level of significance since it is (1.47) smaller than the bootstrap critical value (2.81). So, according to the  $t$  statistics results, we conclude that both regimes are characterized by unit root individually. Hence, we are again unable to reject the unit root null hypothesis in both regimes of the monthly KLCI series. The tests results from  $R_{1T}$ ,  $R_{2T}$ ,  $t_1$ , and  $t_2$ , support the fact that the KLCI is characterized by unit root process, consistent with the efficient market hypothesis.

**Table 3. Partial Unit root Tests**

$m$	$t_1$					$t_2$				
	$t$ -stat	Bootstrap critical values			$p$ -values	$t$ -stat	Bootstrap critical values			$p$ -values
		10%	5%	1%			10%	5%	1%	
1	0.07	2.44	2.82	3.59	0.798	1.77	2.45	2.83	3.56	0.264
2	0.06	2.45	2.86	3.60	0.797	1.72	2.46	2.84	3.57	0.278
3	0.71	2.48	2.86	3.57	0.618	1.14	2.46	2.83	3.58	0.476
4	0.31	2.50	2.89	3.55	0.734	1.27	2.42	2.81	3.58	0.429
5	0.79	2.48	2.87	3.60	0.589	1.47	2.45	2.81	3.53	0.356
6	0.35	2.48	2.89	3.66	0.729	1.27	2.48	2.86	3.55	0.429
7	1.13	2.49	2.90	3.66	0.485	0.67	2.45	2.79	3.53	0.630
8	1.95	2.52	2.91	3.61	0.219	0.35	2.47	2.84	3.51	0.726
9	2.64	2.51	2.94	3.68	0.082	0.28	2.45	2.84	3.56	0.755
10	2.54	2.55	2.99	3.72	0.099	0.39	2.45	2.83	3.56	0.710
11	1.99	2.57	2.96	3.68	0.211	0.45	2.45	2.83	3.57	0.705
12	1.94	2.55	2.96	3.72	0.232	0.34	2.46	2.81	3.55	0.729

For our preferred specification of  $m = 5$ , we report LS estimates of TAR model in Table 4. The point estimate of the threshold  $\hat{\lambda}$  is 0.138. This value implies that the TAR splits the regression into two regimes depending on whether the threshold variable  $Z_{t-1} = y_{t-1} - y_{t-6}$  lies above or below 0.138. The first regime occurs when  $Z_t < 0.138$ , which happens when the KLCI has fallen, remained constant, or has risen by less than 13.8% over a 5-month period. First regime contains approximately 73% of the observations. The second regime is when  $Z_t \geq 0.138$ , which occurs when the KLCI has risen by more than 13.8% over a 5-month period. Approximately 27% of the observations belong to the second regime. Looking at the point estimates, it appears that the coefficients on  $\Delta y_{t-1}$ ,  $\Delta y_{t-3}$ , and  $\Delta y_{t-9}$  in regime 1, and  $\Delta y_{t-3}$ ,  $\Delta y_{t-7}$ ,  $\Delta y_{t-8}$ ,  $\Delta y_{t-9}$ , and  $\Delta y_{t-12}$  in regime 2, are deriving the threshold model, with other coefficient either less important invariant across regimes. Fig. 1 shows the estimated division of our data into two threshold regimes.

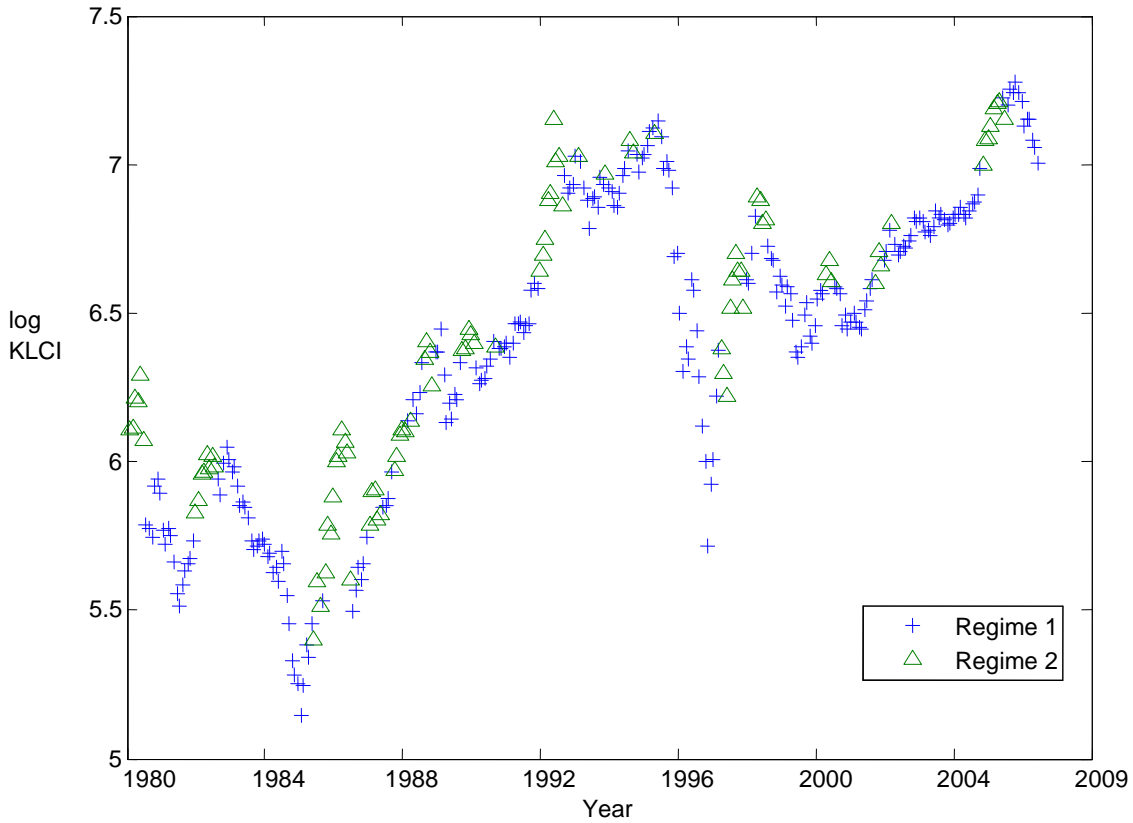
**Table 4. Least Squares Estimates for the TAR Model**

Regressors	$Z_{t-1} < \hat{\lambda} = 0.138$		$Z_{t-1} \geq \hat{\lambda} = 0.138$	
	Estimate	S.E	Estimate	S.E
$y_{t-1}$	-0.008	0.011	-0.026	0.018
Intercept	0.052	0.070	0.220	0.117
$\Delta y_{t-1}$	0.164*	0.067	-0.175	0.130
$\Delta y_{t-2}$	0.057	0.066	0.141	0.135
$\Delta y_{t-3}$	-0.134*	0.067	-0.449*	0.133
$\Delta y_{t-4}$	-0.073	0.068	-0.057	0.140
$\Delta y_{t-5}$	0.059	0.072	-0.148	0.123
$\Delta y_{t-6}$	-0.113	0.067	-0.094	0.099
$\Delta y_{t-7}$	0.065	0.070	0.190*	0.087
$\Delta y_{t-8}$	0.039	0.071	-0.226*	0.089
$\Delta y_{t-9}$	0.152*	0.072	-0.183*	0.088
$\Delta y_{t-10}$	0.104	0.069	0.158	0.088
$\Delta y_{t-11}$	-0.004	0.069	-0.100	0.086
$\Delta y_{t-12}$	0.072	0.066	-0.311*	0.092

\* Indicates significance at 5% level or higher. Regime 1 and 2 contain 241 and 90 observations, respectively.



**Fig. 1 : Kuala Lumpur Composite Index (KLCI), Classified by threshold Regime**



#### 4. Conclusions

In this paper we have investigated whether the Malaysia's Kuala Lumpur stock market is efficient or not using monthly stock price (KLCI) data for the 1980:1 to 2008:8 period. In order to achieve this, we have used two-regime threshold autoregressive (TAR) model suggested by Caner and Hansen (2001). Our findings indicate that the Kuala Lumpur stock market exhibits nonlinear behaviours with unit root. While the former finding is consistent with the evidence reported by Shively (2003) and Narayan (2005, 2006), and justifies our use of a TAR model, the latter finding is consistent with the efficient market hypothesis. This implies that returns on the Kuala Lumpur stock market cannot be predicted using its own history of stock prices.

## References

- Abhyankar, A., Copeland, L. S. and Wong, W. (1995) “Nonlinear dynamics in real-time equity market indices: evidence from the United Kingdom” *Economic Journal* **105**, 864-880.
- Abhyankar, A., Copeland, L. S. and Wong, W. (1997) “Uncovering nonlinear structure in real-time stock market indexes: the S&P 500, the DAX, the Nikkei 225, and the FTSE-100” *Journal of Business and Economics Statistics* **15**, 1-14.
- Alba, J. D., and Park, D. (2005) “An empirical investigation of purchasing power parity (PPP) for Turkey”, *Journal of policy Modeling*, **27**, 989-1000.
- Atchison, M. D. and White, M. A. (1996) “Disappearing evidence of chaos in security returns: a Simulation”, *Quarterly Journal of Business and Economics*, **35**, 21–37.
- Basci, E and Caner, M. (2005) “Are real exchange rates non-linear or non-stationary? Evidence from a new threshold unit root test”, *Studies in Nonlinear Dynamics and Econometrics*, **9**, 1-19.
- Caner, M. and Hansen, B. (2001) “Threshold autoregression with a unit root”, *Econometrica*, **69**, 1555–1596.
- Chaudhuri, K. and Wu, Y. (2003) “Random walk versus breaking trend in stock prices: evidence from emerging markets”, *Journal of Banking and Finance*, **27**, 575–92.
- Dickey, D. A. and Fuller, W. A. (1981) “Likelihood ratio statistics for autoregressive time series with a unit root”, *Econometrica*, **49**, 1057–72.
- Fama, E. F. and French, K. R. (1988a) “Dividend yields and expected stock returns” *Journal of Financial Economics* **22**, 3-25.
- Fama, E. F. and French, K. R. (1988b) “Permanent and temporary components of stock prices” *Journal of Political Economy* **96**, 246-273.
- Grieb, T. A. and Reyes, M. G. (1999) “Random walk tests for Latin American equity indexes and individual firms”, *Journal of Financial Research*, **22**, 371–83.
- Ho, T. (2005) “Investigating the threshold effects of inflation on PPP, *Economic Modelling*, **22**, 926-948.
- Huber, P. (1997) “Stock market returns in thin markets: evidence from the Vienna stock exchange”, *Applied Financial Economics*, **7**, 493-498.
- Im, K.S., Lee, J., and Tieslau, M. (2005) “Panel LM unit root tests with level shifts”, *Oxford Bulletin of Economics & Statistics*, **67**, 393–419.

- Kanas, A. and Genius, M. (2005) “Regime (non)stationarity in the US/UK real exchange rate”, *Economics Letters*, **87**, 407–413.
- Kohers, T., Pandey, V. and Kohers, G. (1997) “Using nonlinear dynamics to test for market efficiency among the major US stock exchanges”, *Quarterly Review of Economics and Finance*, **37**, 523–545.
- Lean, H.H and Smyth, R. (2007) “Do Asian Stock Markets Follow a Random Walk? Evidence from LM Unit Root Tests with One and Two Structural Breaks” *Review of Pacific Basin Financial Markets and Policies*, **10**, 15-31.
- Lee, J. and M. C. Strazicich (2003) “Minimum LM Unit Root Tests with Two Structural Breaks” *The Review of Economics and Statistics* **85**, 1082-1089.
- Lo, A.W. and A.C.MacKinlay (1988) “ Stock market prices do not follow random walks: evidence from a simple specification test” *Review of Financial Studies* **1**, 41-66.
- Liu, C. Y., Song, S. H. and Romilley, P. (1997) “Are Chinese stock markets efficient? A cointegration and causality analysis”, *Applied Economic Letters*, **4**, 511–5.
- Lumsdaine, R. and D. Papell (1997) “Multiple Trend Breaks and the Unit-Root Hypothesis”, *Review of Economics and Statistics*, **79**, 212–218.
- Narayan, P. K. (2005) “Are the Australian and New Zealand stock prices nonlinear with a unit root?” *Applied Economics*, **37**, 2161-2166.
- Narayan, P. K. (2006) “The behavior of US stock prices: evidence from a threshold autoregressive model, *Mathematics and Computers in Simulation* **71**, 103-108.
- Narayan, P. K. (2008) “Do shocks to G7 stock prices have a permanent effect? Evidence from panel unit root tests with structural change”, *Mathematics and Computers in Simulation*, **77**, 369-373.
- Narayan, P. K. and R. Smyth (2004) “Is South Korea’s stock market efficient?” *Applied Economics Letters* **11**, 707-710.
- Ozdemir, Z.A. (2008) “Efficient market hypothesis: evidence from a small open-economy”, *Applied Economics*, **40**, 633–641.
- Perron, P. (1989) “The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis”, *Econometrica*, **57**, 1361-1401.
- Poterba, J. M. and Summers, L. H. (1988) “Mean reversion in stock prices: evidence and implications”, *Journal of Financial Economics*, **22**, 27–59.

- Sarantis, N. (2001) “Nonlinearities, cyclical behavior and predictability in stock markets: international evidence”, *International Journal of Forecasting*, **17**, 459–482.
- Schaller, H. and van Norden, S. (1997) “Regime switching in stock market returns”, *Applied Financial Economics*, **7**, 177–191.
- Shively, P. A. (2003) “The nonlinear dynamics of stock prices”, *The Quarterly Review of Economics and Finance*, **43**, 505–517.
- Qi, M. (1999) “Nonlinear predictability of stock returns using financial and economic variables”, *Journal of Business and Economic Statistics*, **17**, 419–429.
- Qian, Xi-Yuan., Song, Fu-Tie., and Zhou, Wei-Xing. (2008) “Nonlinear behavior of the Chinese SSE index with a unit root: Evidence from threshold unit root tests”, *Physica A*, **387**, 503-510.
- Tsay,R. (1998) “Testing and modeling multivariate threshold models”, *Journal of the American Statistical Association*, **93**, 1188–1202.
- Urrutia, J. L. (1995) “ Test of random walk and market efficiency for Latin American emerging equity markets” *Journal of Financial Research*, **18**, 299-309.
- Zivot, E. and D.W. K. Andrews. (1992) “Further Evidence on the Great Crash, the Oil-Price Shock and the Unit Root Hypothesis”, *Journal of Business and Economic Statistics*, **10**, 251–70.