RANDOM WALK OR STATIONARITY WITH-STRUCTURAL-BREAK IN MALAYSIAN STOCK PRICES: AN EMPIRICAL NOTE

Mansor H. Ibrahim*

ABSTRACT

This note re-evaluates the random walk behaviour of the Malaysian stock prices using the Zivot and Andrews' (1992) procedure that allows for a possible break in the series. As the conventional unit root tests tend to misinterpret the trend stationarity series with a structural break as a random walk process, allowance for the breakpoint in the specification of the test seems sensible. In the model, the breakpoint is taken to be endogeneously determined by the data. The finding is that the random walk behaviour in the Malaysian stock price index, and thus the hypothesis of market efficiency, is further supported in this alternative specification. In addition, it is found that the break in the stochastic behaviour of the stock prices, in 1981 and 1984, is related to macroeconomic factors that may be linked to external shocks.

1. INTRODUCTION

One of the most widely researched areas in financial market analyses is the random walk hypothesis. The findings of the random walk behaviour in stock prices are taken to be an evidence for market efficiency. Driven by competitive forces of supply and demand, stock prices fully digest or incorporate all information available to the market, so no past information is useful for predicting their future movements. Or, alternatively, the unbiased estimates of future market prices are the current market prices.

Recent developments in the analyses of random walk behaviour based on the unit root tests have led to extensions of the conventional tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. Notably, as Perron (1989, 1990) recently argues, the standard unit root tests tend to misinterpret a trend stationary process with a structural break as a random walk process. In other words, if a known one-time change in the time series behaviour of stock prices is incorporated in the model, the prices are more likely to be trend stationary, contradicting the implication of the

---

**Assistant Professor, Kulliyyah of Economics and Management, International Islamic University Malaysia.* *The helpful suggestions of an anonymous referee are highly appreciated. However, we are responsible for the remaining errors.*

random walk hypothesis. Accordingly, the findings of unit root stock prices using ADF and PP may be spurious.

This study attempts to re-evaluate the random walk behaviour of the Kuala Lumpur Stock Exchange (KLSE) using a test that takes into consideration the possible "spurious" problem cited above. We employ the framework suggested by Zivot and Andrews (1992) which incorporates a structural break to evaluate the stochastic behaviour of the Malaysian stock prices. The framework has an advantage over the one originally suggested by Perron (1990) as it avoids the highly criticised specification of a known breakpoint (Christiano, 1992). In their specification, the breakpoint is made dependent on the data, estimated simultaneously with the model's parameters. In line with Tombini and Newbold's (1992) intervention analysis, we may be able to identify a particular major economic event that contributes to the break in the stochastic behaviour of the stock prices.

In the analysis, the Zivot and Andrews' (1992) approach is implemented in conjunction with the conventional ADF and PP tests. The main line of inquiry is on the robustness of the results across alternative unit root tests.[1]

The next section presents the methodology and model specification employed in the analysis. Section 3 discusses the data used. The estimation results of the unit root tests are presented and evaluated in the same section. Finally, section 4 contains the concluding remarks.

2. METHODOLOGY

Here, we present the framework used to test whether the univariate processes of the KLSE stock market prices (expressed in natural logarithmic terms) contain unit roots. As mentioned in the introduction, three alternative tests are utilised. They are the augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, and the Zivot-Andrews (ZA) test. The description of each test is as follows.

---

[1] *The evidence from existing studies seem to be conflicting. Annuar and Shamsher (1993, chapter 7), using standard unit root tests, found that the KLSE stock prices follow a random walk. Accordingly, they concluded that the market is at least weakly efficient. However, Saw and Tan (1989) and Neoh (1990) concluded to the contrary. See Ungku Norulkamar (1994) for current review of the evidence.*

The ADF test for unit roots is based on the following regression :

$$y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{m} \lambda_i \Delta y_{t-i} + e_i \qquad (1)$$

where y is the price series to be evaluated, t is time, and Δ is the first difference operator. The m additional terms in the first differences are included to whiten the noise process. Based on regression (1), the null hypothesis of the unit root stock price is rejected if it is found that α is significantly less than 1. The test may be conducted without or with the time trend (t). In the former, the critical statistics at 1%, 5%, and 10% levels based on MacKinnon (1991) are -3.464, -2.876, and -2.574 respectively. In the latter case, the respective critical values are -4.006, -3.433, and -3.140.

The PP test involves the estimation of the following equation :

$$y_t = \mu^* + \beta^* (t - T/2) + \alpha^* y_{t-1} + e_i \qquad (2)$$

where T is the total number of observations. Again, the null hypothesis of unit root is rejected if α^* is significantly less than 1. The critical values of the ADF test with the time trend may be used for the purpose of hypothesis testing.

In the light of Perron's (1989, 1990) critical contention that time series variables may be trend stationary if a breakpoint in the series is allowed, we re-evaluate the results of the ADF and PP tests using Zivot and Andrews' (1992) procedure. The framework endogenizes the breakpoint and, accordingly, avoids the problem of "pre-testing" that may arise from the specification of a known breakpoint as first suggested by Perron (1989, 1990). Particularly, the specification of the regression equation is given by :

$$y_t = \mu^\# + \beta^\# t + y^\# DU_t + \delta^\# DT_t + \alpha^\# y_{t-1} + \sum_{i=1}^{m} {}^\#_i \Delta y_{t-i} + e_i \qquad (3)$$

Thus, the equation further augments the ADF regression by the inclusion of DU and DT, the structural break variables. Let T_B be a possible breakpoint. Then, DU_t is a dummy variable having a value of 1 for $t > T_B$. It represents the intercept effect of the structural break. DT_t is set equal to $t - T_B$ for $t > T_B$ to capture the slope effect of the structural change.[2]

Following Zelhorst and de Haan (1995), two procedures are utilized to determine the breakpoint, T_B. Namely, the breakpoint is chosen such that (1) the F-statistic for testing the hypothesis $y^{\#} = \delta^{\#} = 0$ is maximised and (2) the one-sided t-statistic for testing $\alpha^{\#} = 1$ is minimised. The null hypothesis of the regression is that the series contain unit roots, $\alpha^{\#} = 1$. Its corresponding t-statistic is compared to the critical value provided by Zivot and Andrews, (1992), which at 1% level, is -5.57. If it is less than the critical value, then the unit root stock prices are rejected.

In the estimation of regressions (1) and (3), the lag length m is chosen using Akaike's Information Criteria (AIC). This seems sensible as Hall (1994) recently noted that data dependent method of determining m can increase the size and power of the ADF test. The maximum lag length considered in the empirical estimation is 24. Diagnostics analyses of the error terms of all regressions are performed to examine whether the error terms suffer from the problems of autocorrelation and heteroskedasticity using Durbin h, Box-Pierce-Ljung Q, and ARCH tests.

3. DATA AND RESULTS

To evaluate the hypothesis of unit root stock prices, the monthly closing prices of the Kuala Lumpur Stock Exchange Composite Index (KLSE CI) from 1977 – 1993 are used. There is a total of 204 observations. Only the Composite Index series is evaluated since we are interested in the time series behaviour of the stock market as a unit, although the framework is readily applicable to other sectoral indices. The composite index prices over the period 1977 – 1991 are from Kok Lim Lian (1993). The remaining observations are taken from *Investors' Digest* (various issue).

As noted in the previous section, we allow for a structural break in the time series behaviour of the stock prices as the period under consideration consists of two distinct subperiods. The early period from 1977 to 1986 is marked by several major economic disturbances. The oil price crisis of 1979 – 1980 created high inflationary pressure leading to a peak of inflation rate of 9.7% in 1981.

---

[2] *The Zivot and Andrew's (1992) procedure has a drawback in that, once a breakpoint is identified, it may not be able to relate the breakpoint to any specific macroeconomic disturbances.*

The recession of 1981 – 1982 ensued as a result of contractionary policies to contain inflation. Although the economy recovered slightly after that, the international terms of trade declined sharply in 1985 and 1986 by 4.5% and 15.5%, respectively. It was also the first time in the nation's history that Malaysia experienced a negative growth rate in 1985. The later period (1987 – 1993), on the other hand, is signified by a stable economic environment, with only one major disturbance, the stock market crash of 1987.[3]

Table 1 presents the results of the unit root tests. Regressions (1) and (2) correspond to the estimation of the conventional ADF test without and with a time trend respectively. Regression (3) reports the regression results of the PP test. Lastly, regressions (4) and (5) present the results of the ZA test. Respectively, the t-statistic and F-statistic criteria are used to determine the breakpoint. To conserve space, the coefficients of the first difference terms are not reported. Overall, the results provide further evidence for the random walk hypothesis in the KLSE stock market price. The evidence tends to substantiate the view that the KLSE is at least weakly efficient.

Table 1
Regression Results of the Unit Root Tests
(KLSE Composite Index, 1977 – 1993)

	Regressions				
Variables	(1)	(2)	(3)	(4)	(5)
Constant	0.1077** (1.7215)	0.3330* (2.8350)	0.2382** (2.2145)	0.5451* (3.9352)	0.3518* (2.8177)
Trend (t or t - T/2)	—	0.0004** (2.2745)	0.0003 (1.5956)	0.0015** (2.2369)	0.0032** (2.4582)
Lagged Price Series	0.9832* (91.233)	0.9363* (40.812)	0.9608* (51.64)	0.8903* (30.174)	0.9205* (32.441)
DU	—	—	—	-0.0859** (-2.9534)	-0.1004* (-3.3130)

[3]All macroeconomics events are special in their own rights. Yet, the ones that may have substantial impact, causing structural break on economic variables have to be major events. While the oil price crisis is a standard consideration (see Tombini and Newbold, 1992), the study considers the terms of trade shocks and the crash of 1987 to be other major disturbances that might structurally alter the behaviour of the stock market.

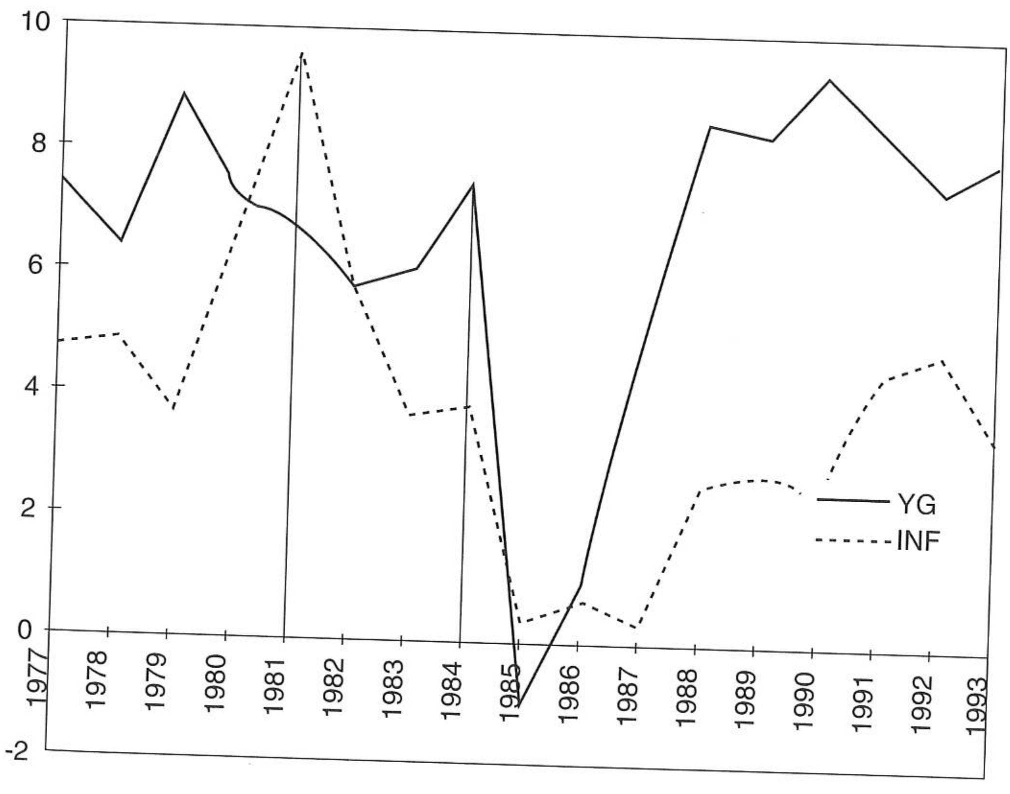
	Regressions				
Variables	(1)	(2)	(3)	(4)	(5)
DT	—	—	—	-0.0003 (-0.4489)	-0.0024** (-2.003)
m	1	11	—	11	11
T_B	—	—	—	January, 1984	June, 1981
$t_{(\alpha=1)}$	-1.561	-2.774	-2.107	-3.7181	-2.8011
Adjusted R^2	0.9767	0.9688	0.9772	0.9702	0.9703
Durbin h	-0.1664	0.1690	2.0990**	0.1320	0.3870
Q(12)	12.02	2.37	15.55	3.26	3.26
Q(24)	20.67	7.28	26.91	9.02	7.56
ARCH(1)	0.9947	1.102	2.01	0.6720	0.4997
ARCH(2)	0.9154	1.096	2.06	0.6582	0.5518
ARCH(4)	1.4972	1.776	2.69	1.9453	1.5598
ARCH(8)	2.8178	2.544	3.96	3.4895	2.7662
ARCH(12)	3.9879	3.759	5.17	5.0462	3.5955

Notes : The numbers in parentheses are t-statistics. The row denoted $t_{(\alpha=1)}$ is the statistics to test the null hypothesis for unit root. They need to be compared to the critical values reported by MacKinnon (1991) for regressions 1 – 3 and by Zivot and Andrews, (1992) for regression 4-5 – see text, section 2. Q(.) and ARCH(.) are distributed as chi-square distribution with the degrees of freedom given by the numbers in parentheses. *, **, *** denote significant at 1%, 5%, and 10% respectively.

Allowing for a possible breakpoint, it is found that the structural break in the time series behaviour of the Composite Index took place in the early 1980s. The t-statistic based test for choosing the breakpoint (regression 4) suggests the structural break in January 1984. The F-statistic criterion (regression 5), on the other hand, indicates that the break occurred earlier in June 1981. Interestingly, no structural break is found for the crash of 1987. This suggests that the event has only transient effect on the stock market movement.

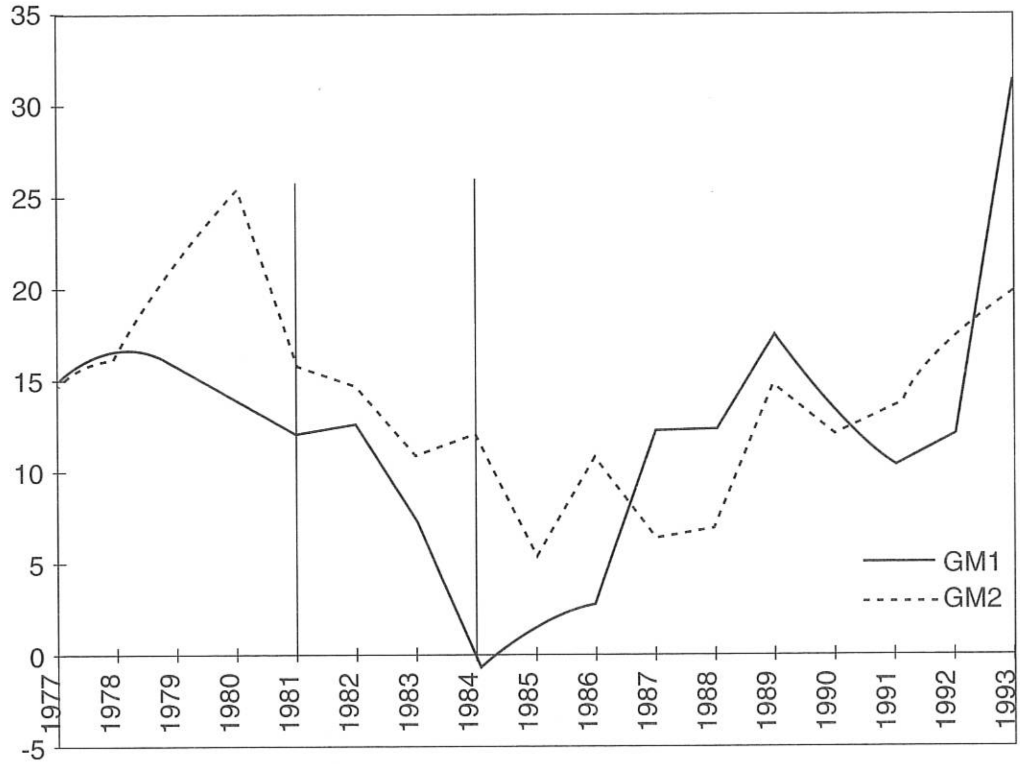
In the attempt to investigate the estimated breakpoints, there was difficulty in linking them to the exact cause of the structural break. This is the drawback of the framework as has been noted earlier (footnote 2). However, we may obtain some insights on the possible causes of the break by examining some macroeconomic indicators of the country.[4] For this purpose, we plot the annual growth rates of the real gross domestic product, the inflation rate, and the annual growth rates of M1 and M2 from 1977 – 1993 in figures 1(a) – (b).

Figure 1(a) : Economic Growth and Inflation



[4]*The authors appreciate the helpful suggestion from a referee on this point.*

Figure 1(b) : The Growth Rates of Money Supply, M1 and M2



The years of the break are also indicated by vertical lines. Note that before the break of 1981, the real GDP growth rates are relatively high, exceeding 6% annually. The oil price shock of 1979 created high inflationary pressure in the economy, indicated by an upward increase in the inflation rate. This led to monetary tightening to slow down the growth rates of money supply, M1 and M2. These events, taken together, resulted in contraction of output in 1981/1982.

Another round of contraction in output growth, with negative growth rate in 1985, took place shortly after. Inflation is kept at very low levels due to the recession. During 1981 – 1984, the monetary policy seems to be contractionary as indicated by the decline in the growth rates of M1 and M2. Lastly, it needs to be noted that the two subperiods of 1981/1982 and 1985/1986 were also periods of global economic slowdown.

Though the lead and lag relationship between stock price and macroeconomic variables may not be established here and requires further investigation, it seems possible that the break in the stock price is due to anticipation of an upcoming slowdown of the economy, driven by inflationary pressure and the resulting contraction in the growth rates of money. Both of these factors may be linked to the external factors such as the oil price shocks.

Based on regressions (4) and (5), there exists a level reduction in the stock prices by about 8% – 10%, as indicated by the significant coefficients of DU. In addition, regression (5) further suggests that the trend growth of the Composite Index is adversely affected by the break, leading to a reduction of 0.2% monthly.

Turning to the main theme of the note, the row denoted $t_{(\alpha = 1)}$ reports the t-statistics for testing the null hypothesis of the random walk in the stock price series. The statistical evidence suggests the existence of unit root in all regressions. Consistent with some previous works, the conventional ADF and PP specification (regressions 1–3) indicate that the price series follows a random walk. The t-statistics are all greater than the critical values at even 10% level. The conclusion remains unchanged even if we allow for the possible structural break (regressions 4 and 5). The computed t-statistics for both regressions are insignificant as compared to the critical values given by Zivot and Andrews (1992).

To examine the validity of the results, several diagnostics analyses of the residuals were performed. If the residuals are serially correlated and/or heteroskedastic, the conclusion above is misleading. The associated test statistics are reported in the last rows of Table 1.

The Durbin h statistic indicates, save one, no problem of serial correlation. The exception is regression (3) where the test statistics (2.099) is significant at a 5% level, suggesting a positive first-order serial correlation. To evaluate the issue further, the Box-Pierce-Ljung portmanteau test for autocorrelation of the residuals is also conducted. Essentially, the test, denoted Q(k), is based on the summation of the autocorrelation coefficients of lag 1 till lag k. The statistics is distributed as a chi-square distribution with k degrees of freedom. As can be noted from the table, both Q(12) and Q(24) are insignificant at even 10% level for all regressions. Thus, the weight of the evidence tends to indicate that the error terms do not suffer from autocorrelation problem.

In addition, the error terms were examined for the existence of ARCH effect. The ARCH(p) test is based on the regression of the squared residuals on its own p lags.

The test statistic is equal to TR^2, where T is the number of effective observations and R^2 is the coefficient of determination from the auxiliary regression. It is distributed as a chi-square distribution with p degrees of freedom. As indicated by the ARCH(p) statistics reported in Table 1 where p = 1, 2, 4, 8, and 12, the error terms do not suffer from the ARCH effect. All the statistics are insignificant at conventional levels. Accordingly, the assumption that they are homoskedastic seems to be appropriate. More importantly, these diagnostics tests suggest that the conclusion of the unit root stock prices remains valid.

4. CONCLUSION

In this note, we evaluate the random walk hypothesis as applied to the Malaysian stock market, the KLSE. In the light of Perron's (1989, 1990) criticism of the conventional unit root tests, we incorporate the possible break in the price series using Zivot and Andrews' (1992) procedure. The main finding is that the Malaysian stock market price seems to contain unit root. The existing view that the KLSE is weakly efficient is robust to the alternative specification that we employ. In addition, our investigation of Malaysia's economic performance seems to suggest that the adverse break takes place in anticipation of an economic slowdown.

REFERENCES

1. Annuar Md. Nasir and Shamher Mohamed (1993), *The Efficiency of the Kuala Lumpur Stock Exchange : A Collection of Empirical Findings,* Malaysia : Penerbitan Universiti Pertanian.

2. Christiano, L.J. (1992), "Searching for A Break in GNP," *Journal of Business and Economic Statistics,* 10, pp. 237-50.

3. Hall, A.R. (1994), "Testing for a Unit Root in Time Series with Pretest Data-Based Model Selection," *Journal of Business and Economic Statistics,* 12, pp. 461-70.

4. Lian, K.L. (1993), "Construction of Stock Indices in Malaysia," *Capital Market Review,* 1 (1), pp. 22-45.

5. MacKinnon, J. G (1991), "Critical Values of Cointegration Tests," in R.F. Engle and C.W.J. Granger (eds.) *Long-run Economic Relationships : Readings in Cointegration,* Chapter 13, New York : Oxford University Press.

6. Neoh, S.K. (1990), "An Empirical Test of Dow Theory on the Malaysian Stock Market," *Securities Industry Review,* 16(1), pp. 1-20.

7. Perron, P. (1990), "Testing for a Unit Root in a Time Series with a Changing Mean," *Journal of Business and Economic Statistics,* 8, pp. 153-62.

8. Perron, P. (1989), "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis," *Econometrica,* 57, pp. 1361-401.

9. Saw, S.H. and Tan, K.C. (1989), "Test of Random walk Hypothesis in the Malaysian Stock Market," *Securities Industry Review,* 15(1), pp. 45-50.

10. Tombini, A.A. and Newbold, P. (1992), "The Time-Series Behaviour of Brazilian Real Gross Domestic Product, 1947-87 : An Analysis of Interventions," *World Development,* 20(2), pp. 283-88.

11. Ungku Norulkamar Ungku Ahmad (1994), "Note on Technical Analysis and the Efficiency of the Malaysian Stock market," *Capital market Review,* 2(1), pp. 97-102.

12. Zelhorst, D. and De Haan, J. (1994), "Testing for a Break in Output : New International Evidence," *Oxford Economic papers,* 47, pp. 357-62.

13. Zivot, E. and Andrews, D.W.K. (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.