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Is MYR/USD a Random Walk? New Evidence from the BDS Test

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ABSTRAK

Kajian ini menyiasat secara empirikal hipotesis pergerakan rawak ke atas data harian pulangan kadar pertukaran MYR/USD. Peningkatan kuasa-guna komputer ditambah dengan kemajuan dalam dinamik tak linear dan kios, telah membantu penyelidik untuk memeriksa semula kebarangkalian jumpaan yang lebih kompleks bentuk pergantungan ke atas siri rawak. Kajian ini telah menggunakan alat statistikal seperti Brock-Dechert-Scheinkman untuk menguji sama ada siri pulangan kadar pertukaran MYR/USD mempunyai sifat-sifat taburan bebas dan kesamaan. Keputusan kajian menolak hipotesis dan menunjukkan bahawa siri MYR/USD adalah tidak rawak, saling bergantungan dan ketidaksamaan. Ini menunjukkan bahawa siri ini tertakluk kepada paten aliran pusingan turun-naik. Implikasi kajian ini menunjukkan bahawa kedapatan keberkesanan pasaran yang lemah terhadap penentuan struktur siri pulangan kadar pertukaran wang asing MYR/USD.

ABSTRACT

This study empirically investigates the daily MYR/USD exchange rate return series in the light of the random walk hypothesis. Recent breakthroughs pertaining to non-linear dynamics and chaos, coupled with the rapid acceleration in computer power, have made it possible to more robustly test for the random walk in financial and economic data. This study uses a new non-linear statistical test, namely the Brock-Dechert-Scheinkman (BDS) test to examine whether the MYR/USD exchange rate return series are random walk with the property of being independent and identically distributed. The results overwhelmingly reject the hypothesis that the MYR/USD data examined in this study are random, independent and identically distributed since some cycles or patterns show up more frequently than would be expected in a true random series. These results may have implications for the weak form market efficiency, if the underlying structure can be profitably exploitable, which remains an avenue for further research.

INTRODUCTION

Numerous efforts have been made to understand the behaviour of exchange rates. The study of the foreign exchange market has become even more important in the post-Bretton Woods era. Since the inception of the floating exchange rate regime in 1973, most currency exchange markets have experienced continuous and sometimes dramatic fluctuations and volatility. The Malaysian ringgit, which is the focus of this paper, has been no exception, especially since late 1997 when a currency crisis swept the economies of South East Asia.

In the early treatments of the efficient markets hypothesis, the statement that the current price of a security 'fully reflects' available information is assumed to imply that successive price changes are independent. Furthermore, it is usually assumed that successive changes are identically distributed. Together, the two

hypotheses constitute the random walk model (Fama 1965).

A time series, X_t, is said to follow a random walk if the change in X_t, from one period to the next is purely random, that is, if we have:

$$X_t = X_{t-1} + \mu_t \quad (1)$$

where μ_t is completely random, displaying no pattern over time. A purely random process is what statisticians call 'independently and identically distributed', such as a Gaussian with zero mean and constant variance.

Over the years, there has been an explosion of empirical research on the random walk behaviour of exchange rates. The consensus of published empirical research was that a random walk described prices fairly well, though some anomalies have been reported (Cornell 1977; Mussa 1979; Frankel 1981; Meese and Rogoff 1983; Newbold *et al.* 1998). The motivation for this line of inquiry was at least twofold. First, assumptions in statistical tests and many asset pricing models often include observations which are independent and identically distributed (i.i.d). Thus, for valid inferences to be drawn from a statistical test, this statistical assumption of i.i.d. must be met. Second, most of the earlier empirical studies hypothesized random walk behaviour to test the efficiency of foreign exchange markets. A random walk series implies that the market is weak-form efficient. Since new information is deemed to come in a random fashion in an efficient market, changes in prices that occur as a consequence of that information will seem random. Thus, investors in weak-form efficient market cannot expect to find any patterns in the historical sequence of exchange rates that will provide insight into future rate movements and allow them to earn abnormal rate of return. However, if the hypothesis of a random walk is rejected, it would be a strong statement to conclude that market is inefficient[1].

The characterization of an exchange rate return series as random in nature has been questioned in recent times by the application of new non-linear statistical tests. Interest in these non-linear techniques is based on the assumption that highly complex behaviour that appears to be random is actually generated by an underlying non-linear process. The evidence that non-linearity abounds in financial time series has further sparked the interest of many researchers and contributed to the growth in this area (Hsieh 1989, 1991; Scheinkman and LeBaron 1989; De Grauwe *et al.* 1993; Abhyankar *et al.* 1995; Steurer 1995; Brooks 1996; Barkoulas and Travlos 1998; Opong *et al.* 1999). With these breakthroughs in non-linear dynamics and chaos, coupled with the rapid acceleration in computer power, it is possible to test for the random walk hypothesis more robustly. Thus, this has prompted researchers to re-examine the possibility of uncovering a more complex form of dependencies in the underlying financial time series that often appear completely random to standard linear statistical tests, such as serial correlation tests, non-parametric runs test, variance ratio test and unit root tests.

A survey of the literature disclosed that a large number of studies have applied these new non-linear statistical tools to test whether exchange rates are random walk (Hsieh 1989; De Grauwe *et al.* 1993; Steurer 1995; Brooks 1996; Mahajan and Wagner 1999). However, it was observed that while major currencies of Japanese yen, US dollar, British pound, and German deutschmark have received substantial attention from researchers, no study has been conducted on the Malaysian ringgit. Thus, a major objective of this study is to fill the gap in the current literature so as to provide more reliable evidence on the univariate time-series properties of the Malaysian exchange rate. To the knowledge of the writers, this is the first attempt utilizing recent advances in non-linear dynamics to examine the random walk behaviour of the Malaysian exchange rate.

This paper is organized as follows: Section 2 provides a review of the relevant literature. This is followed by a brief overview of the historical development of the Malaysian foreign exchange market. Section 4 describes the data and the BDS test. The results are then summarized in Section 5 and are used to draw conclusions and implications in the final section.

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[1] In this case, it is necessary to first uncover the structure of dependencies detected in this non-random series. If investors could have profitably operated a trading rule (net of all transactions costs) which exploits those detected dependencies, then it would have been at odds with the weak-form efficient market hypothesis.

REVIEW ON RELATED LITERATURE

The characterization of exchange rate return series as random in nature has been questioned in recent times by the application of new non-linear statistical tools. The failure to uncover randomness in the market can be attributed to the fact that most of the empirical statistical tests are based on linear models. Fama (1965), in his earlier work admitted that linear modelling techniques have limitations, as they are not sophisticated enough to capture the complicated 'patterns' that the chartist observed in stock prices. Steurer (1995) expressed a similar opinion, that there is an order to the apparent randomness of the market. This order is so complex that the random walk concept was proven by the standard linear statistical tests. Another researcher, Brooks (1996) agreed that series of financial returns often appeared completely random using standard linear and spectral tests. However, he strongly believed that through a different approach, using more powerful techniques, it may be possible to uncover a more complex form of dependence in those series.

Statistical tests such as serial correlation tests, non-parametric runs test, variance ratio test and unit root tests are designed to uncover linear dependence in the data. However, the lack of linear dependence does not imply that the series are random. Non-linear dependence may exist in a series and this is supported by the growing empirical evidence that non-linearity abounds in financial time series. Following weak-form efficient market hypothesis, even non-linear combinations of previous prices are not useful predictors of future prices (Brooks 1996; Brooks and Hinich 1999; McMillan and Speight 2001). These linear statistical tests cannot detect non-linear departure from the random walk hypothesis (Hsieh 1989). Thus, this has prompted researchers to re-examine the possibility of uncovering a more complex form of dependencies in the earlier observed series that often appeared random to standard linear statistical tests.

Recent breakthroughs pertaining to non-linear dynamics and chaos, coupled with the rapid acceleration in computer power, have made it possible to more robustly test for the random walk hypothesis. Most of the empirical studies in the literature have extensively applied the Brock-Dechert-Scheinkman test (Brock *et al.* 1987, 1996)[2] to investigate whether financial and economic time series are random walk with the property of being independent and identically distributed (Hsieh 1989; Scheinkman and LeBaron 1989; De Grauwe *et al.* 1993; Steurer 1995; Brooks 1996; Mahajan and Wagner 1999; Opong *et al.* 1999). The BDS test uses the correlation function (also known as correlation integral) as the test statistic. The asymptotic distribution of the correlation function is known under the null hypothesis of whiteness (independent and identically distributed observations). As a result, the BDS test can be used as a formal statistical test of whiteness against general dependence, which includes both non-white linear and non-white non-linear dependence. The power of the BDS test in detecting departures from i.i.d. behaviour has been proven in a number of Monte Carlo simulations (Brock *et al.* 1991; Hsieh 1991).

The results from empirical studies on exchange rates using the BDS test have generally rejected the null hypothesis of being independent and identically distributed (Hsieh 1989; De Grauwe *et al.* 1993; Steurer 1995; Brooks 1996). However, the evidence from a recent study by Mahajan and Wagner (1999) using the BDS test revealed that the null hypothesis of random walk cannot be rejected for all the exchange rate data under investigation. One notable feature of all these earlier studies is that major currencies like the Japanese yen, U.S. dollar, British pound, and German deutschmark received substantial attention, while none has been given to currencies of developing countries, including Malaysia.

THE MALAYSIAN FOREIGN EXCHANGE MARKET

This section provides a brief account of the exchange rate regimes in Malaysia for the period 1957-2001. Throughout those 44 years, Malaysia implemented a diverse range of exchange rate regimes, starting initially with pegging the ringgit to the pound sterling. This was followed by a

[2] The growing popularity of the BDS test has witnessed its incorporation into commercial statistical package of E-Views version 4.0.

floating regime, first against the U.S. dollar and later in terms of a composite basket of currencies. Since 1st September 1998, the Malaysian ringgit has been pegged to the U.S. dollar.

In those earlier days after independence in 1957, when the value of the Malaysian currency was determined in terms of pound sterling, its stability was closely related to the pound sterling in the foreign exchange market. At that time, foreign exchange was only used to fulfill the needs of exporters. The rate of the Malaysian ringgit was managed by the Malaya Board of Commissioners of Currency and British Borneo (the Currency Board) and fixed at 2s. 4d. sterling. Independence of the foreign exchange market in Malaysia was attained on 12 June 1967 when the Central Bank of Malaysia assumed sole power to issue currency from the Malaya Board of Commissioners of Currency.

With the floating and devaluation of the pound sterling in early 1970, Malaysia adopted the U.S dollar as the intervention currency in June 1972. Owing to uncertainty in the international foreign exchange markets, the ringgit was allowed to float upwards from 21st June 1973. Through that floating arrangement, the Central Bank of Malaysia was no longer bound to buy one unit of U.S. dollar with the set floor rate of RM2.4805.

That floating regime against the U.S dollar was in place for only two years before the Malaysian Government adopted a new exchange rate regime on September 27th, 1975. Henceforth, the rate of exchange of the ringgit was determined in terms of a composite basket, comprising the currencies of Malaysia's major trading partners. Under this floating exchange rate regime, Malaysia did not set targets for ringgit exchange rate levels. Central Bank interventions were only to ensure the stability of the ringgit, so that the exchange rate reflected the underlying economic fundamentals.

On July 2nd, 1997, the announcement of the Bank of Thailand to abandon its defence of the baht caused the collapse of its national currency. What appeared to be a local financial crisis in Thailand quickly escalated into an Asian financial crisis, spreading to other Asian countries including Indonesia, Korea, Malaysia and the Philippines. The Malaysian ringgit came under intense selling pressure and the Central Banks was forced to intervene heavily to defend the value of the ringgit. At the same time, the Malaysian government undertook some corrective measures such as tightening monetary policy, emphasising fiscal prudence and strengthening the financial system, all aimed to restore confidence and stability in the markets. However, all these efforts were ineffective in curbing the downward pressure on the Malaysian ringgit.

The ringgit continued to experience extreme volatility and reached a historical intra-day low of USD1 = RM4.8800 on January 7th, 1998. The ringgit remained volatile under intense speculative pressure and it traded within the range of USD1 = RM4.0900 to RM4.2650 during July and August that year. In order to prevent further pressure on the ringgit, the Malaysian government implemented selective exchange control policies on September 1st, 1998. This exchange control served to reduce the internationalization of ringgit through the elimination of speculative activities in the foreign exchange markets, both external and at home. As part of these measures, the ringgit was pegged to the U.S. dollar at RM3.8000. At the time of writing, the ringgit's peg to the dollar has held firm though there have been pressures to re-peg the ringgit at a higher rate following the decline of regional currencies against the U.S. dollar.

RESEARCH DESIGN AND METHODOLOGY

The Data

The daily spot exchange rates for Malaysian ringgit (MYR/USD) are obtained from the Federal Reserve Statistical Release[3] over the period January 2nd, 1990 to 31st August 1998. The sample period after this is excluded from the current study because Malaysia adopted a fixed ringgit regime from September 1st, 1998. At the time of writing, the Malaysian ringgit peg at 3.80 to the U.S. dollar has held firm[4].

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[3] These daily data are obtained from the Federal Reserve Board's official website at http://www.federalreserve.gov/releases/H10/hist on 18/4/2001. The H.10 release contains daily rates of exchange of major currencies against the U.S. dollar.

[4] We thank anonymous referee for highlighting us of the sample period selection. After this period the pegging of ringgit to the US dollar is irrelevant to our study.

The raw exchange rate data are transformed into the differenced-log return series (r_t). All subsequent analyses are performed on these transformed Malaysian exchange rate return series, which can be interpreted as a series of continuously compounded percentage daily returns (Brock *et al.* 1991). Formally, it can be written as:

$$r_t = 100\ (\ln\ (S_t) - \ln\ (S_{t-1})) \qquad (2)$$

where S_t is the exchange rate at time t, and S_{t-1} the rate on the previous trading day.

This transformation has become standard in the finance literature (Hsieh 1989; De Grauwe *et al.* 1993; Steurer 1995; Brooks 1996; Mahajan and Wagner 1999). Thus, this transformation is done to conform to the literature and to allow comparison with other studies in this domain. Another possible justification for using returns rather than raw data is that the raw data is likely to be non-stationary. Stationarity is a pre-requisite for the BDS test. Hsieh (1991) pointed out that non-stationarity in the data series can cause a rejection of the null hypothesis of i.i.d. on the basis of the BDS test.

The Brock-Dechert-Scheinkman Test (BDS Test)

Brock, Dechert and Scheinkman (Brock *et al.* 1987) developed a statistical test and the BDS statistic. The original BDS paper took the concept of the correlation integral[5] and transformed it into a formal test statistic which is asymptotically distributed as a normal variable under the null hypothesis of i.i.d. against an unspecified alternative. A revision of this original paper was done in Brock *et al.* (1996).

The BDS test is based on the correlation integral as the test statistic. Given a sample of independent and identically distributed observations, $\{x_t$: t = 1, 2, ..., $n\}$, Brock *et al.* (1987, 1996) showed that:

$$W_{m,n}(\varepsilon) = \sqrt{n}\,\frac{T_{m,n}(\varepsilon)}{V_{m,n}(\varepsilon)} \qquad (3)$$

has a limiting standard normal distribution, where $W_{m,n}(\varepsilon)$ is the BDS statistic[6], n is the sample size, m is the embedding dimension, and the metric bound, ε, is the maximum difference between pairs of observations counted in computing the correlation integral. $T_{m,n}(\varepsilon)$ measures the difference between the dispersion of the observed data series in a number of spaces with the dispersion that an i.i.d. process would generate in these same spaces, that is $C_{m,n}(\varepsilon) - C_{1,n}(\varepsilon)^m$. $T_{m,n}(\varepsilon)$ has an asymptotic normal distribution with zero mean and variance $V^2_m(\varepsilon)$[7].

This BDS test has an intuitive explanation. The correlation integral $C_{m,n}(\varepsilon)$ is an estimate of the probability that the distance between any two m-histories, $x_t^m = (x_t, x_{t+1}, ..., x_{t+m-1})$ and $x_s^m = (x_s, x_{s+1}, ..., x_{s+m-1})$ of the series $\{x_t\}$is less than ε, that is, $C_{m,n}(\varepsilon) \rightarrow \text{prob}\{|x_{t+i} - x_{s+i}| < \varepsilon$, for all i = 0, 1, ... m-1$\}$, as n → ∞

If the series $\{x_t\}$are independent, then, for $|t\text{-}s|>m$, $C_{m,n}(\varepsilon) \rightarrow \prod_{i=0}^{m-1} \text{prob}\{|x_{t+i} - x_{s+i}| < \varepsilon\}$, as n → ∞. Furthermore, if the series $\{x_t\}$ are also identically distributed, then $C_{m,n}(\varepsilon) \rightarrow C_1(\varepsilon)^m$, as n → ∞.

The BDS statistic therefore tests the null hypothesis that $C_{m,n}(\varepsilon) = C_{1,n}(\varepsilon)^m$, which is the null hypothesis of i.i.d[8].

The need to choose the values of ε and m can be a complication in using the BDS test. For a given m, ε cannot be too small because $C_{m,n}(\varepsilon)$ will capture too few points. On the other hand, ε cannot be too large because $C_{m,n}(\varepsilon)$ will capture too many points. For this purpose, we adopt the approach used by advocates of this test. In particular, we set ε as a proportion of standard deviation of the data, σ. Hsieh and LeBaron (1988a, b) have performed a number of Monte Carlo simulation tests regarding the size of the BDS statistic under the null of i.i.d. and the alternative hypotheses. The Monte Carlo evidence showed that the 'best' choice of ε is between 0.50 and 1.50 times the standard deviation.

On the other hand, at our chosen setting of ε, we produce the BDS test statistic, $W_{m,n}(\varepsilon)$ for

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5 In Grassberger and Procaccia (1983), the correlation integral was introduced as a measure of the frequency with which temporal patterns are repeated in the data. For example, the correlation integral C(ε) measures the fraction of pairs of points of a time series $\{x_t\}$ that are within a distance of ε from each other.

6 See Brock *et al.* (1987, 1996) for the derivation of the BDS test statistic.

7 Vm(ε) can be estimated consistently by $V_{m,n}(\varepsilon)$. For details, refer Brock *et al.* (1987, 1996).

8 The null of i.i.d. implies that $C_{m,n}(\varepsilon) = C_{1,n}(\varepsilon)$m but the converse is not true.

all settings of embedding dimension from 2 to 10, in line with the common practice of most researchers (Hsieh 1989; De Grauwe *et al.* 1993; Brooks 1996; Mahajan and Wagner 1999; Opong *et al.* 1999). However, it is important to take note that the small samples properties of BDS degrade as one increases the embedding dimension. Thus, in this study, the results with embedding dimensions of 2 to 5 are given the most serious consideration[9].

Asymptotically, the computed BDS statistics, $W_{m,n}(\varepsilon) \sim N(0,1)$ under the null of i.i.d. against an unspecified alternative. Thus, this would suggest a two-sided test. However, this is a very tricky issue. Brooks (1996) and Opong *et al.* (1999) clearly stated that the BDS test is a two-sided test so that the rejection of the null of i.i.d. occurs when the estimated value of the $W_{m,n}(\varepsilon)$ is more extreme (in either tail) than the corresponding statistic from the normal tables. However, Barnett *et al.* (1995, 1997) run it as a one-tailed test. In this study, the BDS test is taken as a two-tailed test.

RESULTS AND ANALYSIS

Descriptive Statistics

Before proceeding to the formal BDS test, we provide some descriptive statistics of the Malaysian exchange rate return series in order to get a better view of some of the important statistical features of this series of returns.

Table 1 reveals that the Malaysian exchange rate return series exhibit some degree of negative or left-skewness. On the other hand, the distribution of this return series is highly leptokurtic, in which the tails of its distribution taper down to zero more gradually than do the tails of a normal distribution. Not surprisingly, given the non-zero skewness levels and excess kurtosis demonstrated within this series of returns, the Jarque-Bera (JB) test strongly rejects the null of normality. These results conform to the consensus in the literature that the distributions of exchange rate return series are non-normal (Hsieh 1989; Steurer 1995; Brooks 1996).

One area that deserves our attention is the stationarity of the exchange rate return series, which is a pre-requisite for the BDS test. The results from the Augmented Dickey Fuller (ADF) test in Table 2 show that the null hypothesis of a unit root can be rejected for the Malaysian exchange rate return series even at the 1% level of significance. Similar conclusions are made based on the results of Phillips-Perron (PP) test summarized in the same table. Thus, the results indicate that the transformed return series of the Malaysian exchange rate do not contain a unit root and thus are stationary, as displayed in *Fig. 1*. Those statistics confirm the appropriateness of the differenced logarithmic transformation in rendering the exchange rate

TABLE 1
Summary statistics of differenced-log returns for MYR/USD (r_t)

	MYR/USD
Sample Period	2/1/1990-31/8/1998
No. of observations	2179
Mean	0.020103
Median	0.000000
Maximum	7.195700
Minimum	-9.156700
Std deviation	0.694546
Skewness	-0.083968
Kurtosis	43.14067
JB normality test statistic	146292.7
p-value	(0.000000)*

* Denotes a very small value.

[9] In a personal communication, LeBaron recommends the use of embedding dimension from 2 to 5 at sample sizes comparable to ours.

TABLE 2
Unit root test results for MYR/USD

	Level	First Difference
	Trend	No Trend
Augmented Dickey Fuller (ADF)	0.421134 (6)	-21.00660 (5)**
Phillips-Perron (PP)	0.587583 (7)	-45.21833 (7)**

Note: The null hypothesis is that the series contains a unit root. The critical values for rejection are -3.97 for models with a linear time trend and -3.43 for models without a linear time trend at a significant level of 1% (**). Values in brackets indicate the chosen lag lengths.

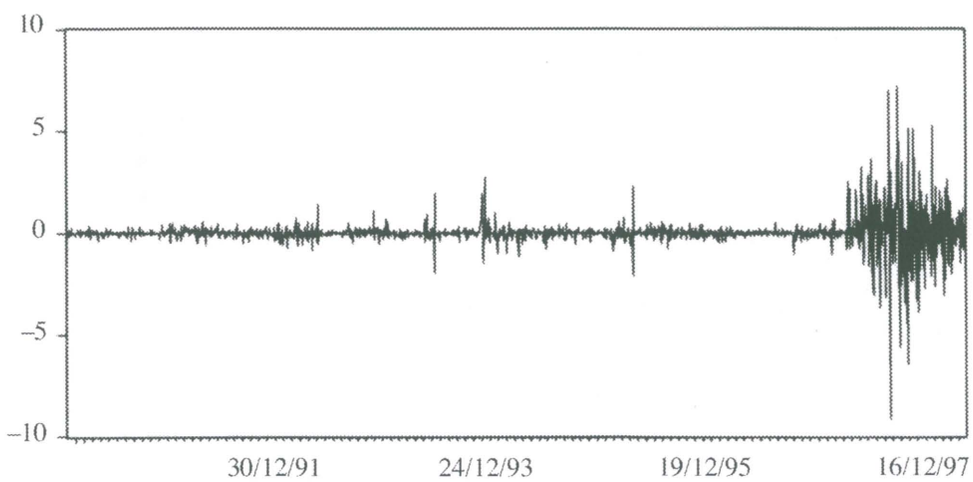

Fig. 1: Differenced-log returns of MYR/USD (rt), 2/1/1990 to 31/8/1998 (2179 observations)

return series stationary.

BDS Test

Subsequently, we apply the BDS test on the Malaysian exchange rate return series in order to test whether these return series are random walk with the property of being independent and identically distributed. Table 3 reports the results of the BDS test. The BDS statistics, $W_{m,n}(\varepsilon)$, are calculated for all combinations of m and ε where m = 2, 3,.....10 and $\varepsilon = 0.50\sigma$, 0.75σ, 1.00σ, 1.25σ and 1.50σ, with a total of 45 combinations. Although we report the results with embedding dimensions varying from 2 to 10, the results with embedding dimensions of 2 to 5 should be given the most serious consideration. This is because the small sample properties of BDS degrade as one increases the dimension. Specifically, as one gets beyond m=5, the small sample properties are not robust in terms of normal approximations at sample sizes comparable to ours.

It is obvious from Table 3 that all the BDS statistics are in the extreme positive tail of the standard normal distribution. Specifically, all of the values are significant even at the 1% level of significance, especially at the suggested dimensions of 2 to 5. According to Brock *et al.* (1991), the large BDS statistics can arise in two ways. It can either be that the finite sample distribution under the null of i.i.d. is poorly approximated by the asymptotic normal distribution, or the BDS statistics are large when the null hypothesis of i.i.d. is violated. From the various Monte Carlo simulations, Brock *et al.* (1991) ruled out the first possibility, thus suggesting that our large BDS statistics in Table 3 provide strong evidence of departure from the i.i.d. null.

The rejection of the i.i.d. random behaviour implies that there is indeed some dependence in the underlying generating process of Malaysian

TABLE 3
BDS test results for differenced-log returns of MYR/USD (r_t)

	ε				
M	0.50	0.75	1.00	1.25	1.50
2	7.25	10.37	13.97	15.66	15.79
3	9.03	12.16	16.22	18.53	18.48
4	10.62	13.52	17.75	20.37	20.41
5	12.34	14.77	18.92	21.55	21.59
6	14.43	16.22	20.10	22.60	22.48
7	17.00	17.92	21.41	23.66	23.32
8	20.19	19.90	22.91	24.87	24.28
9	24.14	22.22	24.62	26.21	25.34
10	29.05	24.90	26.58	27.74	26.55

Note: Asymptotically, the computed BDS statistics, $Wm,n((\varepsilon\sim)\ N\ (0,1)$ under the null of i.i.d. The BDS test is taken as a two-tailed test. All the BDS statistics are significant at the 1% level of significance.

exchange rate return series. This is because some cycles or patterns show up more frequently than would be expected in a true random series. However, the results from the BDS test do not provide any insight into the cause of rejection, which may be due to non-white linear and non-white non-linear dependence. Additional diagnostics tests are needed and this remains an avenue for further research.

CONCLUSIONS

This study has empirically examined the behaviour of the Malaysian exchange rate return series in the light of the random walk hypothesis. With a new and powerful non-linear statistical tool, namely the BDS test, it is possible to test for the random walk hypothesis more robustly in series of financial returns that often appear completely random to standard linear statistical tests, such as serial correlation tests, non-parametric runs test, variance ratio test and unit root tests. The outcomes of our econometric investigation reject the hypothesis that the MYR/USD relationships examined in this study are random, independent and identically distributed. This is because some cycles or patterns show up more frequently than would be expected in a true random series. These results may have implications for the weak form market efficiency, if the underlying structure can be identified and profitably exploited. Specifically, it is necessary first to uncover the structure of dependencies in the underlying process, either in the form of linear or non-linear, and then proceed to assess whether investors could have profitably operated a trading rule which exploited these dependencies. This remains an avenue for further research.

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