

Assessing the Level of Efficiency of The Stock Exchange of Mauritius

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Abstract

This paper assesses the level of efficiency of SEM by using a sample the daily market returns for the period 1999 to 2004. The main tests conducted are Run test, Augmented Dicker Fuller test, KPSS test and Auto-correlation test. The results for all tests provide evidence that returns on the market do not follow a random walk. Also, stock prices appear to be serially correlated such that future predictions on the market are possible. Finally, the study concludes with some implications and recommendations for different stakeholders in view to attain a higher degree of efficiency.

Keywords: Efficiency, Stock Market, Mauritius, Autocorrelation, Random Walk, SEM Ltd

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1.0 INTRODUCTION

The financial sector in Mauritius has experienced a boom over the last decades and as such a wide variety of financial instruments has been developed and made available to investors. The Stock Exchange of Mauritius (SEM) has positioned itself as one of the very most important financial institutions in the Mauritian financial sector by providing Mauritian as

well as foreigners with the opportunity to invest in local companies. Also, the SEM has provided these investors an exit route to their investments by trading their shares on the secondary market, thereby solving the liquidity problem. However, one issue pertains to the price obtained if shares were to be sold immediately. Basically, the relevant issue is whether the price obtained on the market reflects the intrinsic or fair value. In this regard, the level of price efficiency observed on the SEM is of great importance to an investor.

This study attempts to identify whether the SEM is price efficient or not based on some tests of efficiency like the Run test, Augmented Dickey Fuller test, and Auto-correlation tests as well as addressing some pertinent issues that may enhance efficiency level on the stock exchange.

2.0 OVERVIEW OF THE STOCK EXCHANGE OF MAURITIUS

The Stock Exchange of Mauritius was set up in 1989 and has since then successfully expanded its operation with around 40 listed companies on the official market. There are two equity markets on SEM, namely the official market and the OTC market. Basically, the OTC market's listing rules are more flexible relative to firms listed on the official market. However, since August 2006, a new market, known as the Development and Enterprise Market, has been created to account for firms quoted on the OTC market, Small and Medium-sized Enterprises (SME's) and newly set-up companies. In this respect, the OTC market will gradually phased out. Moreover, the SEM has a debt market where there are currently around 10 companies that are quoted for their debentures The Stock Exchange has also classified companies into seven sectors - namely Banks and Insurance, Industry, Investments, Sugar, Commerce, Leisure & Hotels and Transport. The SEMDEX, SEM-7 and SEMTRI, are the three main indices representing market trends.

Major developments on the SEM, amongst others, include the abolition of exchange controls to allow foreign investors to invest on the SEM in 1994, the successful implementation of the Central Depository System (CDS) to facilitate dealings in equity and debt securities with an efficient clearing system, the launching of an automated trading mechanism in 2001, known as SEMATS, which is aimed at enhancing transparency, liquidity, and fairness for the benefit of investors and more recently, the affiliation to securities markets within the *Fédération Internationale des Bourses de Valeurs (FIBV)*.

As at end 2005, the market capitalization stands at around U\$2.6 billion¹ compared to U\$ 93 million in 1989. Also, the annual turnover is around U\$150 million as at 2005 compared to U\$ 925 thousands. Undoubtedly, in terms of market size and liquidity, the SEM has improved significantly since its inception.

3.0 LITERATURE REVIEW

3.1 Introduction

EMH is one of the most researched areas of finance with its origins being traced back to French mathematician Louis Bachelier's doctoral thesis "*The Theory of Speculation*" in

¹ SEM FACTBOOK 2006

1900. His observations led to the development of the Random Walk Theory. The main concern is that all precedent information about a share is believed to be already reflected in its price such that recent or new information will activate an adjustment. Since information occurs randomly, the Random Walk Theory concludes that price adjusts randomly². Also, Clarke et al. (2001) argued that EMH and the Random Walk Theory could be used alternatively. Moreover, Fama (1970) found that an efficient market is one in which prices fully reflect available information. He further stated that this efficiency could be measured by how much the market price differs from its intrinsic value, that is, the value justified by the facts. Therefore, EMH implies that prices reflect all available information and can adjust rapidly to new information³.

There are three types of market efficiency namely the weak-form, the semi-strong form and the strong form efficiency. The level of efficiency depends on the degree of information reflected on the prices. For instance, weak form efficiency will be a situation where prices reflect all past available information, semi-strong form efficiency will be where all publicly available information is adjusted on the market and strong form efficiency will be a situation where prices reflect all available information, including insider information.

Based on these definitions, Malkiel (1999) described the weak-form efficiency as a situation where the stock price changes were independent, the semi-strong form efficiency as a market where prices quickly reflected new value changing information and the strong form efficiency as a market where professional managers were unable to accurately forecast future prices of individual stocks.

3.2 Efficient Market Hypothesis- Empirical Evidences

There are indeed numerous studies on the Efficient Market Hypothesis. However, there seem to be some mixed support for EMH with some researchers focusing on the assumptions of EMH while others identifying a series of anomalies in the market.

In support for the EMH, Russel (2003) believed that very few active managers make money on stock exchange while Wilks (2003) added that active managers only beat the market because they take excessive risks. Moreover, Fama (1998) refused to abandon the EMH theory by arguing that anomalies found in the market are just an illusion and are economically or statistically insignificant. He qualified the market imperfections found as the result of the changes made in the method of estimating abnormal returns.

On the other hand, various studies have criticised the assumptions of EMH. For instance, Bogle (2003) argued that the EMH does not account for transaction costs and as such, market efficiency did not matter since investors, as a group, would fall short of the market return by the amount of costs they incurred. There is no doubt that transaction costs play an important role in investment strategies.

Moreover, Ball (1994) postulated that cost for information is not zero but positive, contrary to the assumption of EMH. Besides, the assumption that investors are rational is questioned by Shleifer and Summers (1990) where there are noise traders that act on imperfect information causing the prices to deviate from their intrinsic values. In addition, Russel and Torbey (2002) argued that individuals are often prone to make mistakes and tend to rely on the

² McLaney(1997)

³ Fama (1991) and Uszczapowski (1995)

opinion of others. In fact, human beings do not process information with machine-like speed, efficiency or rationality where as EMH assumes that information is processed correctly and immediately.

Apart from these arguments, some studies are based on anomalies present in the stock market. For instance, Rozeff and Kinney (1976) suggested that the month of January experiences higher return than other months on the New York Stock Exchange. This stock market anomaly was dubbed henceforth as the “January Effects”⁴. Another anomaly related to stock returns on a given day of the week is known as the day of the week effect. French (1980) claimed that there was a tendency for returns to be negative on Mondays where as they are positive on the other days of the week similar to the findings of Tandon (1994).

There also exists a size effect on the stock markets. For instance, Banz (1981) stipulated that holding stocks of low capitalization firms yielded excess returns, though it is argued that these excess returns may be only a compensation for exposure to the risks associated with small firms. Similarly, some authors argued for the presence of the price earnings ratio effect on some stock markets. For example, in contradiction of the EMH theory, Basu (1977) has demonstrated that investors holding low price earnings ratio portfolio earned higher returns than an investor holding an entire sample of stocks.

Furthermore, Ou and Penman (1989) postulated that the market has a tendency to under-utilise information given in financial statements. Thus, these proofs indicate clearly that information is not impounded in prices immediately as predicted by EMH. Harris and Gurel (1996) provided evidence that there was an increase in share price if a stock was announced to be included in the S&P 500 index. However, EMH argues that price should change only with new information about the firm and that as such, inclusion in the index should not trigger a positive change in the price. Thus, from above, these anomalies clearly confirm that information alone is not moving prices. Russel & Torbey (2002) concluded that information was just one of the variables affecting security valuation.

Finally, Grossman et al. (1980) remarked that if everyone knows that the market is efficient, the no one will engage in costly research to exploit market imperfections. However, if nobody does research, markets will be inefficient. Thus, there is no way to have an efficient market where all investors believe that the market is efficient.

3.3 Overview of factors leading to improved market efficiency

From the above literature, greater dispersion of information in the market can increase market efficiency⁵. However, Russel & Torbey (2002) concluded that information was just one of the variables affecting security valuation. Therefore, in relation to the Stock Exchange of Mauritius, the factors improving market efficiency can be classified into demand and supply influences. On the demand side, one can suggest factors like the development of an investment culture or the improvement of financial literacy in the investment area. On the Supply side, focus is mainly on increasing operational efficiency with measures such as improvement in the microstructure of the market, increase in the minimum floating of shares, creation of a regional stock exchange, etc.

⁴ This effect was present for many other countries as well. (Gultekin and Gultekin 1983).

⁵ Fama (1970)

4.0 RESEARCH METHODOLOGY

The main objective of this study is to assess the efficiency of SEM and to identify factors that may contribute to towards increasing the level of efficiency on the stock market. Daily market returns (represented by daily SEMDEX figures) were used for the analysis. The sample had 1499 observations starting from 04 January 1999 till 31 December 2004 and logarithmic returns⁶ were computed accordingly.

4.1 Tests for randomness

To test whether returns on the SEM are actually a random series, the Run test is used. Essentially, the following hypotheses are examined.

H₀: Return on SEM follows a random walk; that is, SEM is efficient.

H₁: Return on SEM does not follow a random walk

The run tests does not assume any distribution and considers the number of runs which is computed as a sequence of price change of the same sign, for example, ++, --, 00. When the expected number of run is significantly different from the observed number of runs, the test reject the null hypothesis that the daily returns are random. The Urrutia (1995) formula is also used to compute the expected number of runs as follows:

Expected Number of Runs = $2(n+1) / 3$; where n is the number of observations (n= 1499) – equation (1)

4.2 Econometric Methodology

A First-Order Auto-regression model is used to test whether the returns on the SEM are stationary or not that is, whether they follow a random walk or not. The following model (a Random Walk with a drift process) is used:

$$P_t = a P_{t-1} + C + v_t \text{ - equation (2)}$$

Where P_t = price index at time t (given by SEMDEX figures)

a = coefficient of P_{t-1}

P_{t-1} = price index at time t-1

C = an arbitrary drift parameter

v_t = a white noise error term with mean and variance equal to zero

If the value of a is equal to 1, the series are non-stationary and as such, follow a random walk. However, if the coefficient value is less 1, then the series are said to be stationary, implying that they do not follow a random walk. In this respect, the Augmented Dicker Fuller test is used to test whether the series are stationary or not. The hypotheses are tested as follows:

H₀: Series are non-stationary and follows a random walk

H₁: Series are stationary and does not follow a random walk

⁶ According to Poshokwale, S. (1996), Logarithmic returns are analytically more tractable when linking together sub-period of returns over long period intervals and empirically, they are more likely to follow normal distributions.

Additionally, to complement the above test, the KPSS⁷ stationary test is conducted with the null hypothesis that the series are stationary. KPSS test has the advantage of being more robust for testing stationarity directly with the alternative being assumed that the series are non-stationary.

4.3 Auto-Correlation Test

Finally, the auto-correlation test is used to detect either dependence or independence of random variables in a series. The auto-correlation test has been computed at 250 lags representing approximately the number of trading days over a year. Also, the test has also been conducted for 22 lags approximating to a one-month trading. If the autocorrelation coefficients are not significant, this will indicate that the series follow a random walk with no serial correlation.

5.0 ANALYSIS AND FINDINGS

5.1 Graphical Analysis

As a first step, a graphical analysis is conducted to see whether there is any discernible pattern of the SEMDEX returns. Figure 1, as shown below, shows the daily stock returns from 04 January 1999 till 31 December 2004 (that is 1499 observations).

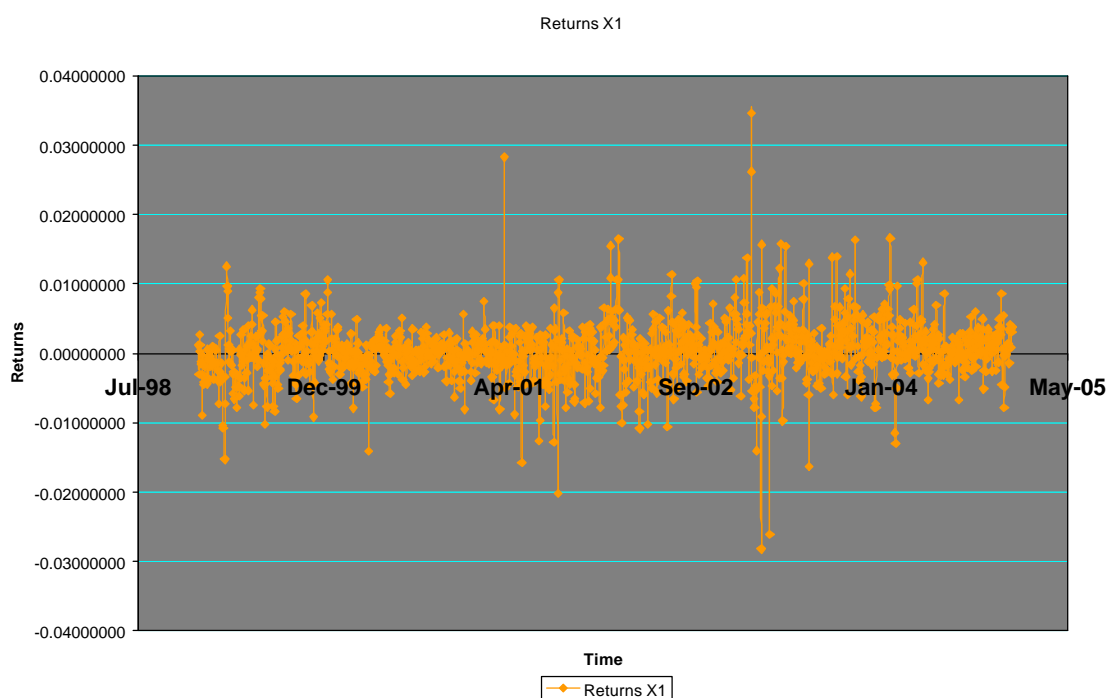


Figure 1: Visual plot of return

From above, there are a few wide fluctuations in the series with a concentration of most of the values ranging from 0.01 to -0.01. Also, except for those few observations, the series seem a priori stationary. However, to confirm this statement, formal statistical tests will be conducted later on.

⁷ For KPSS test, EViews provides with the option of using the Newey-West (1994) data-based automatic bandwidth or lag length parameter methods.

5.2 Descriptive Statistics

A descriptive analysis has been carried out to have more information about the behaviour of the stock prices. The results are summarised in the following tables.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
RETURN	1499	-.02821	.03460	.0002822	.00414161	.000
Valid N (listwise)	1499					

Table 1: Properties of the distribution

Descriptive Statistics

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
RETURN	1499	.447	.063	9.587	.126
Valid N (listwise)	1499				

Table 2: Skewness and Kurtosis of distribution

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RETURN	.085	1499	.000	.902	1499	.000

a. Lilliefors Significance Correction

Table 3: Normality Tests

Essentially, three broad measures are considered. These are the standard deviation that provides a means of assessing volatility in the market, the kurtosis and skewness statistics, and the normality tests to evaluate the distribution's characteristic of the series.

Table 1 show that out of the 1499 observations, the minimum is -0.02821 and the maximum is 0.03460 with a mean of 0.0002822. The standard deviation statistic, which is considered as a good indicator of volatility, is very low, indicating that the market has a very low volatility in returns. This may be because large price fluctuations are not very frequent or the exchange is not very active.

On the other hand, values for skewness and kurtosis value are zero and three respectively when the distribution is perfectly normally distributed. Table 2 shows the skewness and kurtosis statistics. It is observed that the series are positively skewed with a value of 0.447 and a kurtosis of 9.587. The positive value of the skewness statistics suggests that there is a probability of larger increases in returns than decreases. The high value of kurtosis shows a leptokurtic distribution. Thus, the stock return series deviates from the prior condition of random walk model that is returns are normally distributed.

In addition to the above, a more powerful test of normality which is the Kolmogorov-Smirnov test is used to compare the cumulative distribution functions for the variable with a normal distribution. Essentially, the Kolmogorov-Smirnov test is used to decide if a sample comes from a population with a specific distribution. The Kolmogorov-Smirnov test generally compares the empirical distribution function with a normal cumulative distribution function and calculates the maximum distance between those two. An attractive feature of this test is the advantage of making no assumption about the distribution of data.

The Kolmogorov-Smirnov test is generally defined by:

H0: The data follow a normal distribution

H1: The data do not follow the normal distribution

Alternatively, one can also use the Shapiro-Wilk test with the same hypotheses as the Kolmogorov-Smirnov test. Published in 1965 by Samuel Shapiro and Martin Wilk, the Shapiro-Wilk test tests the null hypothesis that a sample x_1, \dots, x_n came from a normally distributed population. The Shapiro-Wilk statistic must be greater than zero and less than or equal to one, with small values of W leading to rejection of the null hypothesis of normality.

Using the Kolmogorov-Smirnov and the Shapiro-Wilk Test, it is observed from Table 3 below that test statistic is significant at 1% level such that the returns are not normally distributed.

Finally, to support the above findings, the Jarque-Bera (JB) test with the null hypothesis that data is assumed to be normally distributed is computed for the above series. The JB statistics is 5747.993 with a prob. value of 0.0000. Similar to the above findings, the null hypothesis is clearly rejected such that the returns are not normally distributed.

5.3 Test for randomness- Run Test

Stock returns should follow a random walk if they exhibit the characteristics of a normal distribution. Thus the following hypotheses are tested:

H₀: Return on SEM follows a random walk; that is, SEM is efficient.

H₁: Return on SEM does not follow a random walk

The Run Test is a non-parametric method used to test the randomness of the variable or the serial dependence in the returns. From Table 4 shown below, the Z statistic shows a value of -

	RETURN
Test Value ^a	.0002381
Cases < Test Value	749
Cases >= Test Value	750
Total Cases	1499
Number of Runs	581
Z	-8.759
Asymp. Sig. (2-tailed)	.000

a. Median

8.759 and is significant at 1% level. Thus, the observed series is not random.

Table 4: Run Test

In addition, using the Urrutia (1995) formula, the expected number of runs was 1000. Therefore, the observed number of runs (581) is less than the expected number of runs (1000). A lower expected number of runs in fact indicate that the market may be either over or under-reacting to information and so providing an opportunity to make excess returns⁸.

5.4 Augmented Dicker Fuller Test and KPSS test

Using a sample of SEMDEX returns for the period 1999 to 2004 (i.e 1499 observations), the Augmented Dicker Fuller test is conducted based on following regression, $P_t = a P_{t-1} + C + v_t$ equation (2) and the results are as follows:

Dependent variable is SEMDEX returns 1498 observations used for estimation from 2 to 1499			
	Test Statistic		
DF	4.5249		
ADF (1)	3.1157		
95% critical value for the augmented Dickey-Fuller statistic = -2.8639			

Table 5: Augmented Dicker Fuller Tests⁹

Table 5 shows that the null hypothesis of unit root (that is the series are random) is rejected. (The ADF statistic 3.1157 is greater than the absolute critical value 2.8639.) As such, the ADF test reveals that the data is stationary and that as such, the series does not follow a random walk.

To support the above results, the KPSS test is conducted with the results shown below.

Null Hypothesis: SEMDEX returns are stationary			
Bandwidth: (Newey-West (1994))			
			LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic			0.076989
Asymptotic critical values*:	1% level		0.216000
	5% level		0.146000
	10% level		0.119000
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)			

Table 6: KPSS Tests

From table 6, the null hypothesis of stationary for the series is not rejected since the test statistic is less than the critical values at 1% significance level. Therefore, this result reinforces the hypothesis that the SEM returns does not follow a random walk.

⁸ Poshakwale (1996)

⁹ Prior to the ADF tests, Akaike information criterion (AIC) has been used for 12 lags to decide the ADF order. See appendix for more information.

5.5 Auto-Correlation Test

Considering the auto-correlation test for the whole sample with 250 days, which represent approximately one year of trading, it can be observed that all the coefficients are significantly different from zero at 1% level based on Box-Pierce Statistics¹⁰. This clearly suggests the presence of serial dependence between the values and that as such, the series are not random with the possibility of some future predictions. Similarly, the autocorrelation tests for 22 lags, which approximate to a one-month trading activity, are conducted with the results implying interdependence in the returns. Moreover, the serial dependence of the values may suggest slow adjustment to new information from investors or the presence of insider information or the lack of liquidity on the market with infrequent trading or movement of prices.

5.6 Policy Recommendations

The results seem to indicate the SEM is an inefficient market with the possibilities to earn excess returns. As such, weaknesses of the SEM need to be identified and appropriate policies need to be adopted in view of enhancing its level of efficiency. The measures advocated are directed towards increasing liquidity and the level of information on the market. These are as follows:

5.6.1 Increasing the number of Market Players

With a view of establishing itself as a major market on the African continent, the SEM needs to increase the number of market participants. It is quite obvious that the local capital market is not accessible to the population at large and therefore, the traditional route for investment or savings is mainly channelled through banks. The stock exchange needs to undertake explanatory campaigns to target the population at large and encourage small investors to join its investment community. Undoubtedly, this may resolve the problem of infrequent trading on the exchange and enhance the level of efficiency.

5.6.2 Increasing the number of Listed Companies

The Stock Exchange needs to attract firms from different economic sectors by giving appropriate incentives such as reductions in listing costs and/or more flexible procedures for listing. For example, firms in the offshore sector may be targeted. Increasing the number of firms will no doubt allow the market to move more independently and not be influenced by movements in few big firms. Also, the investors will be offered greater opportunities in terms of portfolio rebalancing.

5.6.3 Disclosure Requirements

The key to enhance efficiency often resides in the availability of information. If information is available at the right time to investors, then markets should be efficient. To this effect, more stringent procedures and penalties that adhere to international standards should be adopted in terms of the level of information disclosed by the listed companies. Essentially, the figures on the accounts should be fair and accurate and there should be a standard treatment for off-balance sheet items.

5.6.4 Developing New Investment Products

The introduction of new investment products on the exchange will undoubtedly be beneficial for local and foreign investors. Essentially, derivatives such as options, futures or swaps will provide investors tailor-made product that suit their different needs, namely in terms of

¹⁰ For convenience purposes, the detailed results are not shown.

managing risk exposures, speculation etc. The creation of such new products will attract new investors in the market, thereby having a positive impact on liquidity.

6.0 CONCLUSION

This study has assessed the level of efficiency of SEM and identified some measures that can be adopted to correct some weaknesses of the SEM. A graphical analysis revealed that the SEMDEX returns were stationary and that it did not follow a random walk. Also, a descriptive analysis showed that the market was not strongly volatile and the returns were positively skewed. Moreover, the run test showed that the observed series was not random and indicated that the market may be either over or under-reacting to information and so providing an opportunity to make excess returns. Furthermore, the Augmented-Dickey Fuller test confirmed that the series were stationary and that as such, did not follow a random walk. Finally, the autocorrelation tests reveal that daily stock returns were serially correlated with a possibility to earn excess returns on the market. The latter also seemed predictable and reacted very slowly to new information.

From the above findings, the SEM in general is not an efficient market and that as such, certain policies need to be adopted to enhance the level of efficiency, namely in terms of increasing market participants, improving the disclosure requirements, increasing the number of listed companies and developing new investment products.

7.0 APPENDIX

	The Dickey-Fuller regressions include an intercept but not a trend	Akaike Information Criterion
	Test Statistics	Test Statistics
DF	4.5449	-2957.4
ADF(1)	3.1157	-3022.2
ADF(2)	2.8140	-2953.6
ADF(3)	2.5756	-2951.7
ADF(4)	2.5793	-2952.6
ADF(5)	2.6172	-2953.5
ADF(6)	2.5030	-2953.8
ADF(7)	2.3957	-2954.1
ADF(8)	2.2746	-2954.3
ADF(9)	2.3925	-2954.1
ADF(10)	2.4491	-2954.8
ADF(11)	2.4090	-2955.7
ADF(12)	2.2978	-2955.9
Dickey-Fuller statistic at 95% critical level	-2.8639	

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