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How Efficient is Dhaka Stock Exchange in Terms of Weak Form of Market Efficiency?

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Abstract
Weak form of market efficiency is quite a buzzword among the academicians of financial arena. Part of the statistics dominated methodology of this study had used inputs of the previous studies – studies back in days of 1960's. By using monthly market return series data, the researchers had tried to check whether DSE - Dhaka Stock Exchange had been efficient in the weak form or not. Evidence of weak form of efficiency had been also tested across time slabs, across share category and across industries. Both parametric and non-parametric tests were used to find out evidence of random walk behavior. To add variations in the study daily return series and unsmoothed return series were used. The researchers had not found any evidence of weak form of market efficiency for Dhaka Stock Exchange on the whole, even though there was a sign of improvement in terms of weak form of market efficiency across time. The returns of stocks and market portfolio were found to be auto-correlated and market generally overreacted to information. The effectiveness of two-market anomaly based trading strategy (momentum and weekend effect) was tested based on ex-post return series but these strategies failed to garner sustainable abnormal profit. But still the researchers cannot refute the possibility of a trading rule or a few trading rules extracting abnormal return in an inefficient market like Bangladesh. There was no real sign of weak form of market efficiency across share categories and across industries. Inefficiency in the weak form was an expected result, but whether the sign of improvement (in terms of weak form of market efficiency for the recent time slab) is sustainable in the long run or not is a big question.
Keywords: Market efficiency, market anomalies, trading rule

Introduction

Bachelier, L. (1900) was the first academician to observe and explain the random walk behavior of stock price in his seminal paper "Théorie de la Spéculation" – where he described the relationship between stock price movement and dissemination of price sensitive information. As per Bachelier- Osborne model, it is postulated that price changes across the transactions are independent from each other and it was also inferred that the distribution of the price changes would form a normal distribution. It was also assumed under the Bachelier-Osborne model that the price changes will have a finite variance and thus the daily, monthly and the weekly price changes will form normal or Gaussian distribution.

Fischer Black (1986) had conducted extensive research on the impact of noise on market efficiency. It was revealed that at times noise brings about extra efficiency into the market, since both the trade volume and number of participants are expected to increase with the noise-based trades. Eugene Fama was the first academician to prescribe three sub-sets of market efficiency. According to Fama, the stationary principle of stock price can be loosened if a strong evidence of independence can be traced out.

Little research had been performed on the evidence of various layers of market efficiency centering the stock markets of the emerging economies. The researchers had tried to check out the extent of weak form of efficiency in case of Dhaka Stock Exchange across time slabs, across share categories, across sectors. One of the prime focuses of the study was to delineate any sign of improvement in terms of the weak form of market efficiency in case of DSE over time.

Literature review

Stock market efficiency refers to the speed and the quality of adjustment – the way new information gets aligned with the stock price is known as stock market efficiency. There are three layers of stock market efficiency – weak form of market efficiency, semi-strong form of market efficiency and strong form of market efficiency.

In a weak form of efficient market only new information can affect the share price as the impact of the old information and old news have already been adjusted in the stock price. So, in an inefficient market, technical analysis will become a very viable tool to earn abnormal profit and vice-versa. By semi strong form market efficiency generally we refer to the speed and accuracy by which new information gets aligned with the stock price. So, if a stock market is efficient as per semi strong form efficiency we can deduce that all the price sensitive information will be disseminated in an unbiased manner to all the participants of the stock market. A market which is not efficient in the semi strong form, there will be an opportunity of earning abnormal profit by tracking the price sensitive information at an earlier basis. In a strong form of efficient market, by conducting insider trading abnormal profit making will not be possible; rather all the market participants can earn only the risk-adjusted profit. On the other hand if the market is not efficient as per the strong form of market efficiency, then we can earn abnormal profit by tracking the inside information. So, in a completely efficient market there will be very little opportunity to earn abnormal profit through conducting technical analysis, tracking the price sensitive information earlier and tacking the inside information.

Kendal (1953) had concluded that the weekly price changes of UK firms are normal and that was a sign of market efficiency. Moore (1962) had quite unlikely found out sings of market efficiency while using daily price data instead of using the monthly price information in USA market. Lo and Mackinlay (1988) had conducted rigorous research on the efficiency level of USA market and it was evident that the market is not efficient for the overall time slot, it is not even efficient for time subsets as well as for the different hypothetically constructed portfolio. Fama and French (1988) had found evidence of efficiency in the USA market but they had concluded that this inefficiency might be a result of sampling biases. Hudson, Dempsey and Keasey (1994) had found evidence of limited existence of inefficiency but this type of inefficiency fails to explain the abnormal profit making opportunity of the market.

Asma Mobarek and Keavin Keasey (2000) had conducted research in order to track down the weak form of efficiency in case of DSE, there was no sign of efficiency in the stock market as the daily data set proven out to be inefficient in terms of run test, autocorrelation test and ARIMA test result; even for individual firm and even for the segmented time slots the market was proven out to be inefficient. For the data set, ARIMA (2,0,1) was the best predictor model. Ahmed (2002) had found evidence of serial correlation and he had to conclude that the market is not efficient as per the weak form of efficiency. As per the Ljung-Box statistic (LBQ) results it was evident that for the earlier time slot, DSE turned out to be efficient but for the later time slot the extent of efficiency did erode to a greater extent. The researcher had also found evidence that it took approximately one month for the public information to get adjusted with the stock price – a sign of very little stock market efficiency in the semi strong form. Chowdhury, Sadique and Rahman (2001) had conducted rigorous study over the calendar based strategies - specially weekend strategy in case of DSE – Dhaka stock exchange. It was revealed from the analysis that DSE did not have any sort of seasonality issue as both the last trading day and the first trading day of the week had failed to generate any sort of abnormal profitability. Hossain (2004) had conducted study over the market inefficiency level in case of DSE through implementing momentum strategy. It was revealed in the study that by holding bank shares for two trading days, an investor could earn abnormal profit from the market. Even though the aforementioned strategies have been formed up randomly, this does give an indication that there exists abnormal profitability opportunities in DSE. According to Hassan, Islam and Basher (2000) DSE stock market return is negatively correlated, which is a sign that violates the efficiency status. Kader and Rahman (2004) had been able to set up a profitable trading strategy by setting up k-percentage filter rule and the profitability statistics did hold in the longer run.

Methodology

By conducting this research the researchers tried to track the level of efficiency in terms of weak form in Dhaka stock exchange. There were three broad arenas of research – test of weak form of efficiency for the overall market, test of weak form of efficiency across different share category prescribed by the stock market regulators (categories - A, B, and Z) and finally test of weak form of efficiency across various sectors of the DSE (like bank, NBFI, ceramics, food etc). Both parametric tests like (Auto correlation, and ARIMA model) and non-parametric test (run test) were used to check whether the any particular return series (return series for the index or the return series relevant for firms) follows the random walk model or not. Randomness of the return is the true reflection of the weak form of efficiency and irrelevance of any chartist model. The null hypothesis was that the overall market or the stock price of any enlisted and regularly traded firm is efficient in terms the weak form of efficiency.

Since stock market indices are theoretically the closest proxy of the overall market the researchers have decided to go for DSE all share index to track the issue of weak form of efficiency in case of Dhaka stock exchange. Researchers have decided to go for the month end index value and since the researchers have a longer-range time frame in the mind (from 1987 to 2010), the researchers do not think thin or infrequent trading can pose any significant bias to the research result. To check whether Dhaka stock exchange is heeding towards the attainment of weak from of efficiency gradually, the researchers have decided to divide the long time period into two segments to test the significance of the improvement associated with the regulatory reforms, increase in market capitalization, and inclusion of quality stocks in the attire. The two chosen segments are: 1. From the year 1987 to 1996 (up to the month of June) and 2. from year 1997 (excluding January to June) to year 2010 (upto the month of July). The highly volatile period (from July 1996 to June 1997) was kept out of the account, as it was the outlier. Later on, the time slab of 13 years (from 1997 to 2010) was broken into two segments to check out the possibility of any improvements in terms of the weak form of market efficiency. The two chosen segments are: 1. From the year 1997's July to 2003 (December) and 2. From year 2004 (from January) to year 2010 (upto the month of July). In the later parts of the study the researchers used daily return series.

The researchers checked out whether the formation of any trading rule could give any investor abnormal return or not. To be more precise, the researchers tracked the effectiveness of momentum-based strategy (holding the wining portfolio and selling short the losing portfolio). Based on a sample size of 65 regularly traded firms in Dhaka Stock exchange, the researchers checked out the effectiveness of momentum based strategy. Moreover to achieve the third research objective separate test for randomness was conducted for various classes (like A, B, and Z category) of stocks not for the overall market. Based on some randomly chosen firms, the researchers tested whether there was any significant variation in terms of weak form of market efficiency across various industries.

Since in all the analysis the input variable is going to be return series (either the market return or the stock return), at first the researchers must explain the definition of return. First of all since the data represents monthly return only month beginning index or stock price and month ending index or stock price will matter and for this study the interim price or index value will be irreverent. For conducting research with the stock market index, return is the historical monthly appreciation or depreciation of the index value (the difference between current index value and the base index value where base value means the index of the just previous month) divided by the base index value. In case of calculating monthly return for listed stocks the formula will be very straight cut; it will be monthly capital gain or loss divided by the base price (price that existed at the last trading day of the previous month). Cash dividend adjustment, stock dividend adjustments will be incorporated in the calculation of return. For simplicity, the right share issue related affairs would not be embedded in the calculation of the return series; although to get the true monthly stock return such adjustments were essential. For daily return calculation, return would simply refer to the capital gain or capital loss. At times natural log of the market return and stock based return was used as the input variable since logarithmic returns are more prone to be distributed normally which is a precondition of almost any statistical technique (Kumar, 2005).

Natural log of market return = $Ln(I_t / I_{t-1})$

Here, Ln represents natural log, I_t is the index value at t (t - at times will be day or it can be month and at times even a year), I_{t-1} is the index value at period t-1 (t-1 – this can at time represent the previous day or previous month or even a previous year).

Natural log of the individual share return = $Ln[(P_t * S.D.A. + C) / P_{t-1})]$

Here Ln represents natural log, P_t is the stock price at t (t - at times will be day or it can be month and at times even a year), S.D.A is the adjustments that should be made for the stock dividend adjustment, C is the amount of cash dividend and finally P_{t-1} is the stock price at period t-1 (t-1 – this can be at time represent the previous day or previous month or even a previous year).

Run test - Run test checks the evidence of independence in the data set. The cutting point that is used to dichotomize the data set (return series in the case) could be specified as a particular number, or the value of a statistic (like mean, median or mode). In this analysis the researchers used mean as the cutoff point. Cases with values that will be less than the cut point (which is mean in this case) were assigned to one group, and cases with values that were greater than or equal to the cut point (which is mean in this case) were assigned to another group (Nykiel, 2007).

For each of the data points (monthly or daily - market or stock return), the difference $D_i = X_i -$ cut point was calculated (Golafshani, 2003). If $D_i \geq 0$, the difference was considered positive, otherwise negative. The number of times the sign changed, that is $D_i \geq 0$ and $D_{i+1} < 0$ or $D_i < 0$ and $D_{i+1} \geq 0$ as well as the number of positive (n_p) and negative (n_a) signs was determined. The number of runs (R) was the number of sign changes plus one. The run test converts the total number of runs into a Z statistic. If the Z value is lower than 1.96, then we should accept the null hypothesis at 5% level of significance and we should also conclude that the market or the stock price of any firm is efficient in terms of the weak form of efficiency and vice versa (Golafshani, 2003). The Z value was calculated as the difference between the actual and expected number of runs divided by the standard deviation, so $Z = (R- \mu_r)/ \sigma_r$, here μ_r goes for the expected number of runs and σ_r is the standard deviation. Once again, $\mu_r = [2n_pn_a / (n_p + n_a)] +1$ and σ_r is calculated as follows: $\sigma_r = \sqrt{[\{2n_pn_a * (2n_pn_a - n_a - n_p)\} / \{(n_p + n_a)^2 * (n_p + n_a-1)\}]}$

Auto-correlation test - Auto-correlation test is a reliable measure for testing of either dependence or independence of random variables in a series. It is the similarity between observations as a function of the time separation between them (Klenke, 2010). In case of the analysis, autocorrelation is the tendency of market returns to depend on the values of the lag period values. For the random nature (impliedly the achievement of weak form of efficiency) of the overall stock market or any firm's stock, the autocorrelation coefficient of respective return series needs to be zero or closer to zero.

Hypothesis test was developed to determine whether a particular autocorrelation coefficient was significantly different from zero (Creswell, 1994). Once again the null hypothesis was that a particular autocorrelation coefficient is equal to zero or the overall market or any stock price follows the random walk behavior. The analysis covers monthly index based return (both smoothed and non-smoothed) for DSE all share index and the smoothed and unsmoothed monthly return series of randomly chosen firm. If the series is of non-stationary nature then the return series will appear to grow or decline over time and the autocorrelation coefficients of different lags will eventually fail to die out rapidly (Klenke, 2010). If the return series exhibit seasonality then the autocorrelation coefficients at the seasonal lag (4th lag in case of quarterly data, 12th lag in case of monthly data) or multiple of seasonal lags will demonstrate statistically significant coefficients (in other words significantly different from zero). If the return series is of a stationary nature then the basic statistical properties such as the mean and variance remain will constant over time and the autocorrelation coefficients will decline to zero quite rapidly, generally after the second or third time lag (Creswell, 1994). The autocorrelation coefficient for the kth lag will be calculated by the following formula:

$$r = \frac{\sum_{t=k+1}^{n} (Y_t - \overline{Y})(Y_{t-K} - \overline{Y})}{\sum_{t=1}^{n} (Y_t - \overline{Y})^2}$$

Here r_k = autocorrelation coefficient for the kth lag

$\overline{Y}$ = mean of the data set

Y_t = Observation in time period t

Y_{t-k}= Observation at time period t-k

To conclude whether any autocorrelation coefficient is statistically different from zero or not the researchers compared the t-statistics of respective lags with the upper and lower limit value (Patton, 2002). If the t-statistics fell within the region then the null hypothesis was accepted that is the autocorrelation coefficients at different time lags were not significantly different from zero and vice versa (Silverman, 2005).

$t = (r_k - \rho_k) / SE (r_k)$

Here r_k = autocorrelation coefficient for the kth lag

ρ_k = Population autocorrelation coefficient (assumed to be zero)

SE (r_k) = Standard error of autocorrelation function. It will be calculated as $\sqrt{(1+2*\Sigma r^2_k)/n}$.

Upper limit = + t- table value (1.96) * SE (r_k) (level of significance = 5%)

Lower limit = - t- table value (-1.96) * SE (r_k) (level of significance = 5%)

Since number of observations will always be higher than 29 at a 5% confidence level t –table value is +/- 1.96

Instead of testing the autocorrelation coefficients separately, the researchers alternatively used the very common portmanteau test known as Box-Ljung test (Patton, 2002). It tests whether any of a group of autocorrelations of a time series (return series in our case) is different from zero.

If Q statistics exceeds the critical value of a chi-square distribution with s degrees of freedom, then at least one value of r is statistically different from zero at the specified significance level (in our case the confidence level will be set at 5%) (Silverman, 2005). At 12 and 24 degrees of freedom, the table value for a chi-square distribution at 5% level of significance is 21.02 and 36.415. The Null Hypothesis will be that none of the autocorrelation coefficients up to lag s are significantly different from zero (Cooper & Schindler, 2011).

ARIMA test - ARIMA (a dynamic time series model) was used to check whether the return series depends on the past values of the return series and past disturbance elements. The model is generally referred to as an ARIMA (p, d, q) model where p, d, and q are integers greater than or equal to zero and refer to the order of the autoregressive, integrated, and moving average parts of the model respectively.

Autoregressive orders (p) specify which previous values from the series are used to predict current values (Cooper & Schindler, 2011). Difference (d) Specifies the order of differencing applied to the series before estimating models. Moving average orders specify how deviations from the series mean for previous values are used to predict current values. ARIMA models form an important part of the Box-Jenkins approach to time-series modeling (Silverman, 2005). If the market is efficient in the weak form then the coefficients will not differ significantly from zero and the best fit will be found in ARIMA (0, 1, 0) model. In conducting the ARIMA for testing the random walk behavior of the return series the researchers will follow the following gradual and generic steps:

Step 1: Model identification: At first by observing autocorrelation coefficient scenario carefully the researchers decided whether the time series is of stationary nature or not. Non-stationary series had an ACF that remains significant for half a dozen or more lags, rather than quickly declining to 0 (Maxwell, 2005). Every case the researchers had decided to go for the first order of differencing which is $\Delta Y_t = Y_t - Y_{t-1}$. Once a stationary series is obtained, the researchers identified the appropriate form of the model that should have been used. Here the researchers tried to match various theoretical set of autocorrelation and partial autocorrelation associated with the respective ARIMA model. For example, if autocorrelation died out exponentially to zero and partial autocorrelation cut off, the model will require autoregressive terms. The number of spikes will indicate the order of the auto regression (Maxwell, 2005). If the autocorrelations cut off and partial autocorrelation die out the model will require moving average terms. The number of spikes indicates the order of the moving average if both the autocorrelations and partial autocorrelation die out; both the autoregressive and moving average terms need to be indicated (Ragin, 1994).

Step 2: Model estimation: Then the researchers tried to estimate the parameters of the model. Parameters that are statistically different from zero needs to be retained in the model; on the other hand parameters that are not statistically different from zero needs to be dropped from the model (Cohen, et al., 2000). The confidence level was set at 95%.

Step 3: Model checking: An overall model adequacy was checked is provided by a Chi-square test based on the Box-Ljung statistics (Ragin, 1994). The Q statistic will be calculated by the following formula:

$$Q = n(n+2) \sum_{K=1}^{m} r^2_k / (n-k)$$

Here, r_k = residual autocorrelation coefficient for the k^{th} lag
n = Number of residuals
m = Number of time lags to be tested
k = the time lag
If the p value associated with the statistics is small (less than 5%), the model is assumed to be considered inadequate and vice versa.
Trading strategy – momentum: The methodology in this research is almost in line with Jegadeesh and Titman's (1993) original approach to study the momentum effect. Assumptions and procedures are as follows:

Two hypothetical scenarios will be tested – for observing the effectiveness of momentum effect driven strategy - 30 month return series (monthly return) of 65 sample firms was tested. There was a one-month lag between the ranking period and holding period. After observing the ranking, for the next holding period the winner portfolio will be hold and the losing portfolio will be short sold (in case of checking the effectiveness of the momentum effect driven strategy). The top capital gain based return generator 10 firms out of the sample of 65 constituted the winner portfolio and the top 10 capital loss based losing shares constituted the losing portfolio. In case of the winner and loser portfolio, stocks had equal weights. After that holding period return from the winning portfolio and losing portfolio was computed. In short, return from the momentum strategy is the return of the winning portfolio less the return of the losing portfolio. If the return pattern of the ranking period repeats then the winning portfolio shares will have more price hikes and the losing portfolio shares could have been returned by an even less funding (it is actually the very basic motive behind momentum strategy). In this case, the return from momentum effect driven strategy (the short sale of the losing portfolio and purchase of the winners at the beginning of the holding period) can be expected to be substantially higher than the broad based index – DSE all share in the research, since the index is constituted of both the winners and losers. Moreover, since we have shorted losing portfolio, the negative returns on that portfolio are actually the short seller's gain. After each holding period there will be a new ranking and eventually new winning and losing portfolio. The researchers will check whether on a 30 month basis this market anomaly based strategy could had outperformed the broad based market index (the performance of an investor who has hold a market value weighted numbers for all traded, listed securities of DSE). The winning and losing portfolios were equally weighted and the net investment was assumed to be zero. Further the researchers assumed no reinvestment of profits meaning that all over the term, the chartist's net investment would be zero.

Trading strategy – day of the week effect: The methodology for tracking the evidence of any weekend effect in DSE was very simple. The researchers calculated the daily capital gain and loss based return of the DSE all share index for all the trading days in DSE – Sunday, Monday, Tuesday, Wednesday and Friday. Because of the extra time and extra risk associated with the opening week's price, academicians expected that Monday's return will be substantial (in our case Sunday) but actually there is an almost universal tendency of stocks to exhibit relatively large returns on Friday (in our case Thursdays) compared to those on Mondays (in our case it will be Sunday). Based on the comparison of average daily return of the trading days over a 10 year time frame, the researchers tried to check the evidence of such market anomaly in case DSE. The researchers had to select any week where trading had occurred in all the five days of the week.

Sampling framework - In conducting the research, sampling was an issue since the researchers wanted to track the level of weak form of market efficiency across industry and across category. For the first case the researchers chose 65 firms and for the second case the researchers chose 30 firms. At first the whole population of the listed firms was subdivided into different stratum like category A, B, Z etc. or in case of industry wise analysis stratum like banks, cement, ceramics etc. (Saunders, et al., 2003). From the strata to choose the appropriate firm simple random sampling was the preferred sampling mechanism since all the firms got almost the same probability of getting selected for the sample.

Analysis

The analysis will be segregated into four major research areas of interest – test of weak form of market efficiency (covering the whole market set with an special focus on the possible evidence of improvement in terms of weak form of efficiency over time), the effectiveness of any market anomaly based trading strategy (if Dhaka stock exchange turns out inefficient in terms of weak form of market efficiency) in generating sustainable abnormal return with different time frame, test of weak form of market efficiency in case of individual stocks across time with a special focus on the industry belongingness, test of weak form of market efficiency of individual stocks across time with a special focus on the market regulator prescribed share category belongingness. The researchers want to start the analysis with the test of weak form of market efficiency covering the whole market set with the special focus on the possibility of improvement in terms of weak form of efficiency over time.

The run test result suggests, Dhaka stock exchange is not efficient in terms of weak form of efficiency, since the monthly return series of 282 months (from January 1987 to June 2) was proved not be random in nature and the market did not follow the random walk behavior. The negative Z value indicates that the number of observed runs were fewer than the expected number of runs at a 95% confidence level. A lower than expected number of runs indicates market's overreaction to information. The tendency of market's overreaction to information is a consistent phenomenon across time, across other holding period of the portfolio focusing only the market index. When the analysis was conducted for two segmented time slabs, the earlier period (from January 1987 to June 1996) seemed to be more efficient in terms of weak form of market efficiency than the case with the later period (from July 1997 to July 2010) even though, in absolute terms only in the earlier time slab the market followed the random walk behavior. When further study was conducted, the market was found to be more efficient in terms of weak form of market efficiency during the earlier time frame (July 1997 to December 2003) than the case with the latest time slot (from January 2004 to July 2010), even though during both the time set the market return did fluctuated randomly. When daily market return series were used to check the level of weak form of market efficiency, in the earlier time slabs (from June 1997 to December 2003) the market was found to be overreacting to information far more than the case with the latest time slabs (from (March 2005 to July 2010), even though the market did not follow the random walk behavior in any time of the two time segments. When the normal definitions of monthly and daily market return (no adjustment using the natural log) were used for different time slabs, the previous conclusions did not fluctuate significantly.

In terms of Box-Ljung Statistic, the market was found to be inefficient (in the weak form) since the LBQ of 40.74 (for the 24 time lags), was significantly higher than the reference Chi-square value of 36.42 (at 5 % level of significance and 24 degrees of freedom. So the conclusion was that at least one of the autocorrelation coefficients up to 24 lags was significantly different from zero and the market return series was of nonrandom nature. When the researchers had calculated the t- statistics for each of the 24 time lags (the null hypothesis was that the autocorrelation coefficients at different time lags were not significantly different from zero) and compared the calculated value with the upper and lower limit, only the autocorrelation coefficient of the 8th lagged period was found be statistically not different from zero. Market returns of all other 23 time lags could have created impact over the return of the most current month since there were correlation between the actual value of market return series and lagged value of market return series. It was evident that there were significant (positive sign) auto-correlation coefficients at 1st, 2nd, 3rd, 4th, 7th, 12th, 13th ,19th ,20th ,21th , 23rd and 24th and significant (negative sign) auto-correlation coefficient at 5th, 6th, 8th, 9th ,10th ,11th ,14th ,15th ,16th ,17th ,18th ,22nd lag. So technical analysis in an inefficient market like DSE can be very useful and generate pivotal returns. The presence of non-zero auto-correlation coefficients in the market returns series clearly suggests that there is a serial dependence between the values. The return series was of non-stationary nature since the autocorrelation coefficients of different lags eventually failed to die out rapidly and ACF remained significant for half a dozen or more lags. Moreover the return series of the market showed sign of seasonality since the autocorrelation coefficients at the seasonal lag (12th lag in case of monthly data) or multiple of seasonal lags (24th lag) demonstrated statistically significant coefficients (in other words autocorrelation coefficients were significantly different from zero). The graphical correlogram of different time lags and partial autocorrelation function failed to match exactly with any established theoretical model, but with a limited version of time lags these two graphs resembles AR (1) model with no real sign of errors at previous time periods getting incorporated in the current observations. When the researchers has conducted the study on the nature of autocorrelation function relevant for different previously stated time slabs (from January 1987 to June1996, from July 1997 to July 2010, from June 1997 to December 2003, and finally from January 2004 to July 2010) the researchers really did not find any sign of improvement in terms of weak form of efficiency, since the market failed to follow the random walk behavior in all the time slots. Every time the LBQ statistics was supporting the random walk behavior of the market at different time lags (since LBQs were lower than the reference Chi-square value in every case), but detailed tests for checking the significance of the autocorrelation coefficients at different time lags revealed that all the data set figures (monthly market return series) were highly correlated with their lagged values – at some cases even the two year old return showed significant correlation with the current return. When unsmoothed market return series was used for different time slabs the situation worsened, since at that case even the LBQ statistics for the latest time slab (January 2004 to July 2010) was telling that at least one of the autocorrelation coefficients upto 24 lags was significantly different from zero and the market return series was of nonrandom nature even though for other time slabs the generalized autocorrelation coefficient related decision was in favor of the prevalence of random walk behavior. In case of daily return series across time slabs, (earlier one - from June 1997 to December 2003 and later one - March 2005 to July 2010) Dhaka Stock Exchange lacked efficiency (efficiency in weak form) severely, since both the LBQ and separate test for significance for correlogram refuted any existence of weak form of efficiency since the daily market return series were not random in its nature, in fact each return series were highly correlated within itself.

The overall market monthly return series did not get aligned with the ARIMA (0,1,0) model. If the market were efficient in terms of weak form, then the best fit could had been found at ARIMA (0,1,0) model (an ARIMA of 0,1,0 orders means no existence of AR or MA terms and the first order differencing assumes that the original series has a constant average trend). When the overall model adequacy was checked by a Chi-square test based - Box-Ljung statistics, the p value (the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true) associated with the statistics was very small (less than 5%), so the null hypothesis of random walk behavior for the market had to be rejected. Eventually the best fit was found in an ARIMA (1,0,0) model. So for this monthly return based time series, autocorrelation coefficients died out exponentially to zero and number of spikes was actually one. For this particular return series, the differencing of linear trends meaning $\Delta Y_t = Y_t - Y_{t-1.}$, (ARIMA deals only with the stationary time series and by means of differencing trends of different orders of a non-stationary series needs to be removed) was questionable since the best fit ARIMA supported for no differencing. With a p = 1, q = 0 and d = 0, the best fit ARIMA model for this return series eventually reduces to a pure autoregressive model of order 1, where only returns of the last month should be used predict current values and past disturbance elements have no real business. The null hypothesis associated with the ARIMA (0,1,0) model (the return series is random and thus the market follows random walk behavior) had to be rejected across time slabs, across holding period, since the p-value associated with the Box-Ljung statistics, had always been lower than 5%. In none of the cases the estimated constants of the model were significantly different from zero. There was a real sign of improvement in terms of weak form of market efficiency for the latest time frame (January 2004 to July 2010), since at this case the null hypothesis got rejected at a relatively higher p-value of 3.8%. ARIMA (0,0,0) seemed to be the best-fit time series model for the monthly return series across time slabs where returns were either smoothed or unsmoothed. An ARIMA (0,0,0) model with constant (constant had been a SPSS default) is an ARIMA model with no differencing and no AR or MA terms, considers only a constant term. This is just the "mean" model under another name, and the time series plot of the residuals will therefore be just a plot of deviations from the mean. In case of the daily return series the best bit time series model revealed the impact of past disturbance elements on current return series since deviations from the series mean for previous values (upto 4th order) can be used to predict current values.

In terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the industries had shown remarkable level of efficiency (in terms of weak form of market efficiency), since the return series of sample firms (65 sample firms) belonging to 14 industries were more or less proved to be random in nature. There were no real differences between industries in terms of weak form of market efficiency. The researchers could have easily concluded that the sample firm's stock price (firms belonging to different industries) followed the random walk behavior and current price of those firms reflected all the relevant past information. But when the return series (the 119 months return starting from July 2000 and ending June 2010) of 65 sample firms (across 14 sectors) were checked against the null hypothesis (the return series fit the ARIMA – 0, 1, 0 order, so return series is of random nature), all the 65 hypothesis were rejected and the 65 default estimated constants were resembling 0 – not statistically different from zero. When separate test for significance of the autocorrelation coefficient for the first twelve lags were conducted for the return series of all the 65 companies, there were no company with no significant autocorrelation coefficient in all the 12 time lags. At some cases, for all the time lags, returns were found out to be highly correlated with the previous month's return and all the null hypothesis of zero autocorrelation at respective time lags needed to be rejected. Out of the 65 firms, for 43 firms (66%) the best fit time series model was ARIMA (0,0,0) which is a is an ARIMA model with no differencing, no AR or MA terms, only a constant term. ARIMA (0,0,0) was the best fit model for the ceramic and service & real estate sector industry since all the sample firms of those two industries fitted with this time series model. Return series of firms belonging to the financial service industry (bank, mutual fund and NBFI) and pharmaceutical & chemical industry were also found to fit properly with the ARIMA (0,0,0) model (with a 86% match). When the time slot of 119 months were segregated into two spans The researchers have got quite an optimistic result since there was evidence of weak form of efficiency in terms of ARIMA (0,1,0) model. Once again, during the earlier time slot (July 2000 – July 2005) in terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the industries had shown remarkable level of efficiency (in terms of weak form of market efficiency), since the return series of sample firms (65 sample firms) belonging to 14 industries were more or less proved to be random in nature. Firms belonging to banking and pharmaceutical industries were the most efficient, since return series of 67% and 43% of the banks and pharmaceutical companies that were chosen randomly were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was accepted for those firms). Firms belonging to NBFI, service & real estate and tannery industries were the least efficient, since return series of no firms belonging to those industries were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was rejected for those firms). During the later time slot (July 2005 – June 2010) in terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the industries had shown remarkable level of efficiency (in terms of weak form of market efficiency), since the return series of sample firms (65 sample firms) belonging to 14 industries were more or less proved to be random in nature. Firms belonging to tannery, ceramics and cement industries were the most efficient, since return series of 67% of the tannery, ceramics and cement companies that were chosen randomly were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was accepted for those firms). Firms belonging to banks, fuel & power, service & real estate and insurance industries were the least efficient, since return series of no firms belonging to those industries were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior was - rejected for those firms). Since financial service industry (40% of the trading in DSE centers around banking firms and these stocks were considered to be the fairly liquid) lacked consistency in terms of weak form of market efficiency across time, we cannot conclude that magnitude of trade volume and extent of liquidity can explain the scenario of weak form of market efficiency in case of individual stocks (one could have easily expected that shares with higher trade volume and liquidity on an average would turn out to be more efficient).On the whole, the level of weak form of market efficiency did not vary significantly among industries. Industries had been more or less successful to keep up consistency in terms of weak form of market efficiency (investment, engineering, textile, others had equal efficient representatives for both time frame). Individual firms failed to remain consistent in terms of weak form of market efficiency, since only 3 firms (AIMS 1st mutual fund, Miracle industry and Eastern cables) out of the 16 firms which were efficient in weak form during the first time frame (July 2000 – July 2005), were able to repeat the trend.

In terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the categories (A, B and Z for the analysis) had shown remarkable level of efficiency (in terms of weak form of market efficiency), since the return series of sample firms (30 sample firms) belonging to 3 categorizes were more or less proved to be random in nature*,* even though 'A' category share showed better efficiency (weak form) with a 100% efficient representation. So the researchers could have easily concluded that the sample firm's stock price (firms belonging to different categories) followed the random walk behavior and current price of those firms reflected all the relevant past information. But when the return series (the 119 months return starting from July 2000 and ending June 2010) of 30 sample firms (across 3 categories) were checked against the null hypothesis (the return series fit the ARIMA – 0, 1, 0 order, so return series is of random nature), all the 30 hypothesis was rejected and the 30 default estimated constants were resembling 0 – not statistically different from zero. When separate test for significance of the autocorrelation coefficient for the first twelve lags were conducted for the return series of all the 30 companies, there were no company with no significant autocorrelation coefficient in all the 12 time lags. At some cases, for all the time lags, returns were found out to be highly correlated with the previous month's return and the all null hypothesis of zero autocorrelation for respective time lags needed to be rejected. Out of the 30 firms, for 17 firms (57%) the best-fit time series model was ARIMA (0,0,0). ARIMA (0,0,0) was the best-fit model for the 'A' category since 70% of the sample firms of that category fitted with this time series model. Return series of firms belonging to the 'Z' category were also found to fit properly with the ARIMA (0,0,0) model (with a 60% match). When the time slot of 119 months were segregated into two spans the researchers has got quite an optimistic result since the evidence of weak form of efficiency in terms of ARIMA (0,1,0) model was evident. Once again, during the earlier time slot (July 2000 – July 2005) in terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the categories had shown remarkable level of efficiency in terms of weak form of market efficiency ('B' category shares with a special mention over achieving 10% more efficient representative in comparison to the previous time slot), since the return series of sample firms (30 sample firms) belonging to 3 categories were more or less proved to be random in nature. Firms belonging to 'B' category were the most efficient, since return series of 20% of the 'B' category companies that were chosen randomly were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was accepted in 20% of the case). Firms belonging to 'A' and 'Z' category were the relatively less efficient, since return series of only 10% of firms belonging to those categories were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was rejected in 90% of the case). During the later time slot (July 2005 – June 2010) in terms of the run test and autocorrelation results (represented by the Z score and LBQ), all the industries had shown remarkable level of efficiency in terms of weak form of market efficiency, since the return series of sample firms (30 sample firms) belonging to 3 categories were more or less proved to be random in nature. Firms belonging 'Z' category were the most efficient, since return series of 30% of the 'Z' category companies that were chosen randomly were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior -was accepted in 30% of the case). Firms belonging to 'A' category stock were the relatively less efficient, since return series of 20% of the firms belonging to those categories were proven to be efficient (Null hypothesis – ARIMA of 0,1,0 order fits the return series and the stock price follows random walk behavior - was rejected in 80% of the case). Since 'A' category shares, as a group was never more efficient (efficient among the three categories in terms of weak form of market efficiency) in a percentage form (number of efficient firms under the stratum / number of firms under the stratum), we cannot conclude that better or worse categorization can explain the scenario of weak form of market efficiency in case of individual firms (one could have easily expected that shares with better categorization on an average would turn out to be more efficient). On the whole, the level of weak form of market efficiency did not vary significantly among share categories.

Discussion

So the final comment on the overall market's weak form efficiency will be a big 'NO' but the researchers cannot refute the academician and practitioner's view of the evidence of improvement in terms of weak form of efficiency across time in Dhaka Stock Exchange. Although, ARIMA and run test result assure me about the validity of the later comment but one should not forget the fact that the market returns of the most current terms were highly auto correlated. The inclusions of quality and numerous firm's in the attire (from 2005 till date there are 127 IPO), the sheer size of the market (it is around a twelve times big market in comparison to 2005) and the added rules and regulations contributing towards transparency are the prime reasons contributing to the marked difference in weak form of market efficiency in recent times. Since the market was found to be inefficient in the weak form, it was quite an interesting affair to check the effectiveness of any market anomaly based trading strategy, since in an efficient (weak form) market any trading strategy based on market anomaly will fail to generate sustainable abnormal return.

The effectiveness of momentum effect driven strategy was checked. In a hypothetical scenario, with a holding period of one month, a time lag of one month between the ranking and investing-opposite to investing (short sale) and under the assumptions of market perfection (far from the reality), a simple momentum effect based strategy had failed to generate excessive return. The return from the market index portfolio was used as the reference and actually there was an annualized average excess return of -10% that could be generated by any chartist who had faith in the momentum based trading.

The researchers had tried to find out the relevance of weekend effect (one calendar based anomaly) in terms of DSE. But since both Sundays and Thursdays were the two abnormal daily return generators in Dhaka Stock Exchange the weekend effect was nonexistent in this case. The ruling out of this two market anomaly based trading strategies does not necessarily mean that any chartist will fail to generate sustainable abnormal return since the researchers has not checked the effectiveness of other market anomaly based trading strategies like The January effect, year of the month effect and contrarian effect, and perhaps most importantly, the analysis was packed up with a lot of unrealistic assumption and was conducted on sampling basis.

Conclusion

The researchers had not tried to form any complex mechanical trading rules based on past price pattern to check the supremacy of a buy-and hold strategy (in case of a weak form efficient market). The researchers had not tried to form any complex mechanical trading rules based on past price pattern to check whether it was possible to earn abnormal profit even in a real world of taxes and transaction cost. Still the results of statistical tests are more than enough to conclude that Dhaka Stock Exchange is not efficient in the weak form.

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Table – 1: Autocorrelation result for the DSE all share index (1987-2010)

Lag	Autocorrelation	Std. Error	Box-Ljung Statistic		
			Value	df	Sig.[a]
1	.2010	.0589	11.41	1	.0011
2	.0207	.0589	11.53	2	.0023
3	.0607	.0589	12.53	3	.0016
4	.0373	.0589	12.92	4	.0152
5	-.0766	.0589	14.65	5	.0182
6	-.0788	.0589	16.36	6	.0102
7	.0591	.0589	17.36	7	.0195
8	-.0078	.0584	17.12	8	.0206
9	-.0289	.0584	17.62	9	.0404
10	-.0160	.0584	17.70	10	.0608
11	-.0225	.0584	17.86	11	.0857
12	.04477	.0584	18.42	12	.1037
13	.04286	.0584	18.96	13	.1255
14	-.0428	.0584	19.47	14	.1485
15	-.0357	.0584	19.84	15	.1785
16	-.0516	.0584	20.63	16	.1947
17	-.1327	.0584	25.87	17	.0779
18	-.1235	.0577	30.49	18	.0337
19	.0351	.0577	30.83	19	.0428
20	.0298	.0579	31.16	20	.0594
21	.0678	.0577	32.45	21	.0592
22	-.1308	.0579	37.77	22	.0270
23	.0738	.0578	39.35	23	.0158
24	.0678	.0579	40.74	24	.0198

a. Based on the asymptotic chi-square approximation.

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Table – 2: Autocorrelation result for the DSE all share index (1987-2010)

Lag	Autocorrelation coefficient	T statistics	Upper limit	Lower limit	Decision
1	0.270	3.386	0.11672	-0.11672	Reject
2	0.029	0.392	0.12130	-0.12130	Reject
3	0.067	0.907	0.12134	-0.12134	Reject
4	0.048	0.680	0.12174	-0.12174	Reject
5	-0.088	-1.292	0.12190	-0.12190	Reject
6	-0.087	-1.295	0.12254	-0.12254	Reject
7	0.060	0.924	0.12321	-0.12321	Reject
8	-0.016	-0.181	0.12360	-0.12360	**Accept**
9	-0.039	-0.454	0.12360	-0.12360	Reject
10	-0.027	-0.825	0.12369	-0.12369	Reject
11	-0.023	-0.935	0.12372	-0.12372	Reject
12	0.0477	0.780	0.12377	-0.12377	Reject
13	0.046	0.696	0.12399	-0.12399	Reject
14	-0.044	-0.656	0.12418	-0.12418	Reject
15	-0.046	-0.585	0.12437	-0.12437	Reject
16	-0.058	-0.870	0.12451	-0.12451	Reject
17	-0.131	-2.097	0.12479	-0.12479	Reject
18	-0.125	-1.930	0.12668	-0.12668	Reject
19	0.049	0.573	0.12830	-0.12830	Reject
20	0.036	0.484	0.12843	-0.12843	Reject
21	0.073	1.082	0.12851	-0.12851	Reject
22	-0.137	-1.998	0.12899	-0.12899	Reject
23	0.079	1.089	0.13076	-0.13076	Reject
24	0.077	1.080	0.13132	-0.13132	Reject

Table – 3: ARIMA result for the DSE all share index (1987-2010)

Model ID	MRDSEallsharems1	Model Type
		ARIMA (0,1,0)

Variable	Ljung-Box Q		
	Statistics	DF	Sig.
MRDSEallsharems1	65.550	18	.0210

MRDSEallsharems1		Estimate	SE	t	Sig.
	Constant	-.004	.723	-.005	.9986
	Difference	1			

Table - 4: Test of weak form of market efficiency across industries (July 2000 – June 2010)

Sector (Sample size)	Run test result		Autocorrelation test result		ARIMA test result	
	Number of efficient firms	Number of inefficient firms	Number of efficient firms	Number of inefficient firms	Number of efficient firms	No. of inefficient firms
Bank (3)	2	1	2	1	1	2
NBFI(2)	2	0	1	1	1	1
Investment (2)	2	0	1	1	1	1
Engineering(10)	7	3	8	2	1	9
Food & Allied(10)	7	3	6	4	2	8
Fuel & Power (3)	2	1	2	1	1	2
Textile(10)	8	2	6	4	1	9
Pharmaceutical & Chemical (7)	5	2	5	2	0	7
Service & Real estate (2)	1	1	2	0	0	2
Tannery(3)	2	1	2	1	0	3
Ceramics(3)	2	1	2	1	0	3
Cement(3)	2	1	1	2	0	3
Insurance(4)	3	1	3	1	0	4
Others (4)	3	1	1	3	0	4

Table -5: Test of weak form of market efficiency across categories (July 2000 – June 2010)

Particulars	A category (sample size 10)		B category (sample size 10)		Z category (sample size 10)	
	Number of efficient firms	Number of inefficient firms	Number of efficient firms	Number of inefficient firms	No. of efficient firms	No. of inefficient firms
Run test result	1	9	8	2	10	0
Autocorrelation test result	1	9	6	4	6	4
ARIMA test result	1	9	1	9	1	9

Table – 6: Effectiveness of momentum effect driven trading strategy

Time	Return from the momentum strategy	Index return	Excess return
Return - 2008 January	-8%	-19%	11%
Return - 2008 February	0%	1%	-1%
Return - 2008 March	-20%	3%	-22%
Return - 2008 April	-2%	2%	-4%
Return - 2008 May	27%	3%	23%
Return - 2008 June	-2%	-4%	2%
Return - 2008 July	9%	-8%	17%
Return - 2008 August	-12%	1%	-13%
Return - 2008 September	2%	5%	-2%
Return - 2008 October	-4%	-9%	5%
Return - 2008 November	-6%	-10%	5%
Return - 2008 December	0%	13%	-14%
Return - 2009 January	-2%	-5%	2%
Return - 2009 February	18%	-2%	21%
Return - 2009 March	9%	-5%	14%
Return - 2009 April	-17%	4%	-21%
Return - 2009 May	-12%	1%	-14%
Return - 2009 June	-6%	17%	-24%
Return - 2009 July	-3%	-3%	0%
Return - 2009 August	4%	1%	3%
Return - 2009 September	11%	5%	6%
Return - 2009 October	-22%	9%	-30%
Return - 2009 November	-3%	29%	-32%
Return - 2009 December	14%	3%	11%
Return - 2010 January	-1%	18%	-19%
Return - 2010 February	-6%	3%	-9%
Return - 2010 March	-10%	1%	-11%
Return - 2010 April	5%	1%	3%
Return - 2010 May	4%	8%	-4%
Return - 2010 June	13%	2%	11%
Average	-1%	2%	-3%
S.D.	11%	9%	15%
Annualized	-3%	7%	-10%

Table – 7 : Effectiveness of Weekend effect driven trading strategy

Day of the week	Daily average return
Return on Sunday	0.2795%
Return on Monday	0.0321%
Return on Tuesday	0.1569%
Return on Wednesday	0.1662%
Return on Thursday	0.4016%