TESTING WEAK-FORM MARKET EFFICIENCY OF DHAKA STOCK EXCHANGE: A TIME SERIES ANALYSIS

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ABSTRACT

This paper endeavors to determine whether Dhaka Stock Market (DSM) is efficient in weak-form of Efficient Market Hypothesis (EMH) or not. The EMH is a concept of informational efficiency, and refers to market's ability to process information into prices. An efficient capital market is one in which security prices equal their intrinsic values at all times, and where most securities are correctly priced. The weak form of the EMH says that the current prices of stocks already fully reflect all the information that is contained in the historical sequence in prices and that is why new price movements are completely random. They are produced by new prices of information and are not related or dependent on past price movements. This study is based on secondary data collected from the website of Dhaka Stock Exchange (DSE). Both parametric (autocorrelation and variance ratio test) and non-parametric tests (Run Test and Kolmogorov-Smirnov Goodness of Fit Test) have been conducted duly using Statistical Package for Social Science (SPSS). The study reveals that DSM does not follow random walk model in pricing the securities traded over there and it is supported by all the tests conducted in this study. Finally, the study concludes that DSM is inefficient in weak form of EMH.

Keywords: Efficient Market Hypothesis, Weak-Form Efficiency, Return, Random Walk

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1. INTRODUCTION

Financial markets are greatly important in a country's economy due to many reasons. They create liquidity, improve international trade, accumulate wealth of investors and help economic agents to make more accurate forecasts of future development in financial industry (Blake, 2004). It is widely accepted that large and developed financial markets are more efficient by means of their thickness in trading, competent liquidity, low transaction costs, and quick absorption of new information. Conversely, emerging and less developed markets are assumed to be relatively thinner, less liquid and actually much less responsive in the context of informational change. When financial market is considered to be inefficient, there have to be some patterns in asset movements which might become foreseen.

Fama (1970) updates the theory of randomness in stock markets and decided to divide market efficiency into three forms: weak, semi-strong and strong. All three forms testify market being efficient but in different levels of information. Less developed and emerging markets are suitable only for weak-form market efficiency investigation because of the lack of sufficient information to assess semi-strong and strong form of efficiency. Among the empirical evidences, studies are usually divided into two parts: fundamental research and technical analysis. Statistical approach uses a variety of parametric and non-parametric tests to capture serial correlations in return series. If there are significant autocorrelations in time series, present returns are likely to be dependent across their lagged values therefore leading to the rejection of random walk hypothesis. Whenever statistical dependence of returns is found, technical analyses are employed to see if returns can be predictability exploited as a profit making strategy. At present there are two stock markets in Bangladesh: Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE). DSE is the larger and main capital market in the country. Capital market may be efficient in weak-form, semi-strong form, and in strong form. This paper tries to measure the weak-form market efficiency of DSE. Although there are many previous works regarding this issue but market efficiency is always changing. That is why researchers feels interest and importance to work in this issue continuously.

1.1 Objectives of the Study

i. To determine whether DSM is efficient in weak-form of EMH or not;
ii. To determine whether DSM exhibits a trend towards increased efficiency over time or not.

1.2 Literature Review

Using Phillips-Peron unit root and Johansen's co-integration tests, Chan et al. (1997) tested for the weak-form and the cross-country market efficiency hypothesis of eighteen international stock markets. The markets included are Australia, Belgium, Canada, Denmark, Finland, France, Germany, India, Italy, Japan, Netherlands, Norway, Pakistan,

Spain, Sweden, Switzerland, the United Kingdom, and the United States. Their data covers the period from 1962 to 1992, with 384 monthly observations. They concluded that all stock markets examined are individually weak form efficient and only a small number of stock markets show evidence of co-integration with others. Al-Loughani and Chappel (1997) examined the validity of the weak-form of EMH for the UK stock market using the Lagrange multiplier serial correlation, Dickey-Fuller unit root and Brock, Dechert and Scheinkman non-linear tests. Their data include daily observations of Financial Times Stock Exchange 30-share index from the period 1983 to 1989, a period that they describe as free of changing government economic policy toward financial markets. The result of Dickey Fuller tests show that series are non-stationary in levels and are stationary in first differences, which are consistent with random walk hypothesis. Through autocorrelation tests, they reject the random walk hypothesis finding autocorrelation and conditional heteroskedasticity in the FTSE 30 returns. Therefore, according to their results the series of FTSE 30-share index does not follow a random walk during the sample period.

Harvey (1995) studied volatility and returns predictability of six Latin American, eight Asian, three European and two African emerging stock markets and found presence of strong serial correlation in the stock returns which cause them more predictable. Laurence (1986) applies both the runs and autocorrelation test on the Kuala Lumpur Stock Exchange (KLSE) and the Stock Exchange of Singapore (SES). He uses price observations of the individual stock from the period 1973-78 for both KLSE and the SES. The results of both tests suggest that both markets are not weak form efficient. Contrary to his results, Barnes (1986) finds KLSE to be weak form efficient. He conducted a similar method of testing applied to 30 companies and six sector indexes for the six years period ended 1980. He concludes that the results of both tests show that the KLSE exhibit a high degree of efficiency in the weak-form. In the Middle East, Butler and Malaikah (1992) examine weak-form efficiency for the Kuwait and Saudi Arabian stock markets by using autocorrelation test. Their data covers daily stock returns of two stock markets for the period of 1985-89. They find evidence of efficiency in Kuwait stock market, but not in the Saudi Arabian market. Similarly, Abraham et al. (2002) study weak-form efficiency in three major Gulf stock markets including Kuwait, Saudi Arabia, and Bahrain using the variance ratio and runs tests for the period of 1992-98. Their data consist of weekly index values for each of three Gulf stock markets. The results of both tests reject the random walk hypothesis in all markets. After the correction, they fail to reject the random walk hypothesis for Saudi Arabia and Bahrain markets, but not for the Kuwait market. Moustafa (2004) examines the behavior of stock prices in the United Arab Emirates (UAE) stock market using daily prices of 43 stocks included in the UAE market index for the period 2001-03. He finds that the returns of the 43 stocks do not follow normal distribution. However, the results of run tests show that the returns of 40 stocks out of the 43 are random at 5% level of significance. Although the UAE stock

market is newly developed and it is still very small, also suffering from infrequent trading, according to his results, the UAE is found to be weak-form efficient.

Mobarek and Keasey (2000) used the runs and autocorrelation tests to examine the validity of weak-form efficiency for the DSM. Their sample covers 2638 daily observations of daily price indices from the period of 1988-97. Based on the runs and the autocorrelation tests, they argue that returns of DSM do not follow random walks. Different results was found by Khaled and Islam (2005) on testing weak-form efficiency of the DSM using daily, weekly and monthly market prices from the period of 1990-2001. Unit root and variance ratio tests were used to test for the random walk hypothesis in their studies. In addition, they examine the structural changes by applying the variance ratio test separately for the period before July 1996 when the DSM boom started in July 1996 and for the period after March 1997 when crash in mid-November continued until March 1997. According to them, the hypothesis of market efficiency could not be rejected in the case of monthly data. For weekly and daily data, market efficiency is rejected for the pre-boom period, not for the post-crash. In addition, they argue that by using heteroscedasticity of variance ratio test they find evidence in favor of short-term predictability of share prices in the DSM before the 1996 boom, but not during the crash. Chaity and Sharmin (2012) conducted normality test along with Serial correlation, ARIMA of stock daily return from All Share Price Indices (ASPI) and DSE General Indices (DSEGI) respectively for the period of 1993-2011 and the data of 2002-2011. Their sample covers 4363 for ASPI and 2433 for DSEGI of daily price. The Result of the study indicates that the DSE is not Weak form of Efficient and does not follow Random Walk model. Hasan (2014) used run test, unit root tests, variance ratio test and autocorrelation test for measuring the efficiency of the DSM. He used daily return data for the three stock indices of DSE such as DSI (from 1993-2013) with a total of 4823 daily return observations, DGEN (from 2002 to 2013) with a total of 2903 daily return observations, and DSE-20 (from 2001 to 2013) with a total of 3047 daily return observations. The evidence suggests that all the return series do not follow the random walk model, and thus the DSM is inefficient in weak form. Khandoker, Siddik and Azam (2011) tested the market efficiency in the DSE. They used run test, Dickey-Fuller unit root test to process and analyze the behavior of daily return of DSM indices during the past 11 years. The sample includes daily price indices of all securities listed on the DSE in general, DSI (All Share), DSE top 20 indices, and Daily indices listed in the market. The results provide evidence that DSM does not follow the random walk model and so the DSM is not efficient even in weak-form. Bose, Uddin and Islam (2014) used both parametric and nonparametric tests for the period 1993-2002 to measure the efficiency level of DSE and CSE. They used ARIMA, autocorrelation and run test to examine the nature and extent of serial dependence. The result of their study shows that DSE and CSE are not efficient in the weak-form and strong-form of EMH.

2. DATA AND RESEARCH METHODOLOGY

2.1 Data and Hypothesis

To examine Dhaka stock market efficiency, the data used in this study are daily price index of DSE and collected from the DSE website. The observation period ranges from July 1, 2005 to June 30, 2015. The empirical analysis of this study uses daily data of closing prices for the two indexes for the indicated sample periods, which are presented in Table 1.

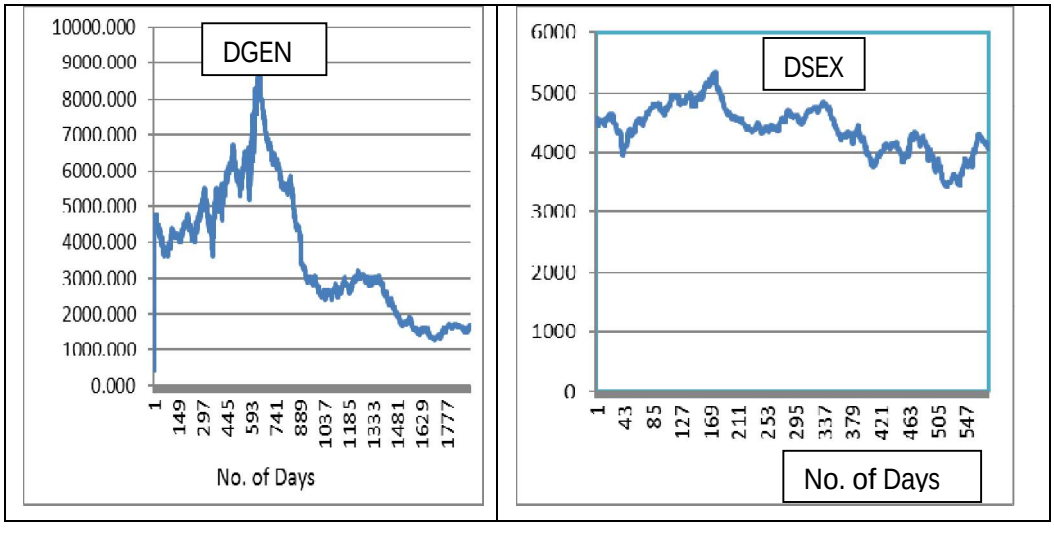
Table 1: Description of Sample Data

Index	Sample period	Observations
DSEX	27/01/2013 - 30/06/2015	579
DGEN	01/07/2005 - 31/07/2013	1921

Source: Constructed by Authors

These two market indices are chosen because they are the most authoritative statistical indices used by domestic and overseas investors in measuring the performance. DSEX and DGEN indices are a weighted average of the stock prices listed in the DSE. Researchers believe that the sample of this study provides a greater variety of information, which should reflect the dramatic changes that have taken place in DSM in the last decade. Figure-1 shows the price index movements of the DSM for the study period. DSM has experienced some large ups and downs during the study period.

Figure-1: Time Series Plots of Dhaka Stock Market Indices



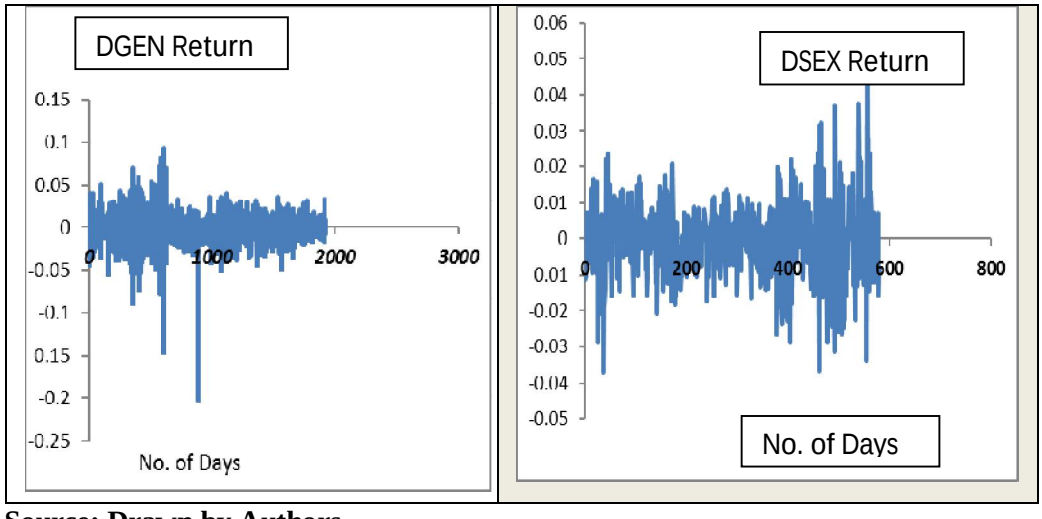
Source: Constructed by Authors

Figure-1 shows the plots of the daily returns of each of the indices. All index series returns are calculated using the following continuously compounded formula:

$$R_t = \ln.(\frac{P_t}{P_{t-1}}).....(1)$$

Where, R_t represent daily stock return, *Pt* and *Pt*-1 represent the closing prices of an index at time *t* and *t*-1, respectively and ln is natural logarithm (Brooks, 2004).

Figure-2: Time Series Plots of Daily Returns of Dhaka Stock Market Indices



Source: Drawn by Authors

Figure-2 shows the returns of markets indices to fluctuate around zero and tranquil alongside periods with large increases and decreases. The variations in returns seem to decrease over time for returns under DGEN index and to increase under DSEX.

To meet the objectives of the study following hypothesis has been set:

H_0: Dhaka stock market follows random walk model in pricing securities.

H_1: Dhaka stock market doesn't follow random walk model in pricing securities.

2.2 Statistical Tools for Testing Market Efficiency

In this study, researchers used four statistical tests, namely autocorrelation test, run test, variance ratio test, and Kolmogorov-Smirnov Goodness of Fit Test to examine weak-form market efficiency of DSE. The run test is one of the most well-known tests of the random walk hypothesis, which are based on the test of independently and identically

distributed assumptions of the random walk increments, while the autocorrelation tests are based on the test of the weakest version of the random walk model. The variance ratio tests was developed by Lo and MacKinlay (1988) that is not only more powerful compared to the previous two tests, but also more reliable test of the random walk hypothesis, which allows testing all three versions of the random walk hypothesis. Kolmogorov–Smirnov test (K–S test or KS test) is a nonparametric test of the equality of continuous, one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution (one-sample K–S test), or to compare two samples (two-sample K–S test). The K–S statistic quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution, or between the empirical distribution functions of two samples.

3. ANALYSIS AND RESULTS

3.1 Descriptive Statistics

A summary of descriptive statistics for stock returns series of DSE for the entire sample period are presented in Table-2. Mean returns of both indices are negative. DGEN's mean return is -0.000491 while DSEX's mean return is -0.000211. The minimum return is -0.2038 for DGEN while it is -0.00021 for the DSEX. The maximum return is 0.0933 for DGEN index while it is 0.0536 for the DSEX index.

Table-2: Descriptive Statistics for the Daily Index Returns

Time Series	N	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
DGEN	1921	-.000491	.0933	-.2038	.0170860	.130	1.973
DSEX	579	-.000211	.0536	-.0368	.0105525	-.908	16.176

Source: Calculated by authors.

Standard deviation of stock returns is 0.0170860 in case of DGEN index while it is 0.0105525 in case of DSEX index. As can be seen in Table-2 the skewness and kurtosis values indicate that returns of all indexes are not normally distributed. Returns of all indexes are negatively skewed or skewed to the left, indicating greater probability of large deceases in returns than rises. DSEX has the highest negative value of skewness, while DGEN has the highest positive value. The kurtosis or degree of excess, in all index returns is also large, ranging from 1.973 for DGEN to 16.176 for DSEX, thereby indicating leptokurtic distributions. High positive value of kurtosis signifies that the distributions of these variables are centered.

3.2 Results of Autocorrelations Test

The table-3 (see in appendices) represents Ljung-Box test for higher order autocorrelations for DGEN and DSEX stock price index. For the full sample Q statistics are significant at lag all lags and it means there is serial dependence in returns and therefore it is proved that stock returns do not follow random walk model. The table-4 (see in appendices) represents Ljung-Box test for higher order autocorrelations for DGEN stock price index for two different time periods. Autocorrelations of first sample period (2005-09) and second sample period (2009-13) show that all coefficients are significant and thus reject the null hypothesis of efficiency. The presence of non-zero auto-correlation coefficients in the log of the market returns series clearly suggests that there is a serial dependence between the values. The results of autocorrelation test confirm that there is significant autocorrelation of daily market returns for the whole sample period, sub-sample period without outlier.

3.3 Results of Variance Ratio (VR) Test

If the VR is 1, the data series follows a pure random walk, hence no predictions are possible and any trial to create a profitable trading system on such a price series will fail. If the VR is larger than 1, the price series shows a tendency to form trends, i.e., changes in one direction are more often followed by changes in the same direction. If the VR is below 1, the price series shows some degree of mean reversion. Changes in one direction are more often followed by changes in the opposite direction. Table–6 shows that VRs of daily market return are not 1, therefore it may be concluded that DSM is inefficient in weak-form of EMH.

Table 6: F-Test (Two-Sample) for Variances of DGEN and DSEX.

	DGEN		**DSEX**	
	Variable 1	Variable 2	Variable 1	Variable 2
Mean	-0.00039	-0.00063	3.76	7.18
Variance Ratio	0.000437	0.00014	0.000207	7.29
Observations	977	943	285	292
Df	976	942	284	291
F	3.115879		2.833113	
P(F<=f) one-tail	8.11		2.57	
F Critical one-tail	1.11222		1.214362	

Source: Calculated by authors

3.4 Results of Run Test

The results of the run tests for returns are reported in table-5. All of the estimated Z-values are significant at the 5% level for returns. The negative Z-values for returns on all indices indicate that the actual number of runs is less than expected number of runs in all the periods and for both indices. Run tests clearly show that DSM is inefficient under weak-form of EMH as the actual number of runs is less than expected number of runs.

Table-5: Results of runs test for the daily market returns.

Time Period	Market Index	Total Cases	Actual number of runs	Expected runs	Z-statistic	*p*-value
2005-09	DGEN	978	431	486.890	-3.600	0.00032
2009-13	DGEN	944	403	472.153	-4.512	6.424
2005-13	DGEN	1921	836	958.058	-5.591	2.2550
2013-15	DSEX	579	245	290.458	-3.782	0.000

Source: Calculated by authors.

3.5 Results of Kolmogorov-Smirnov Goodness of Fit Test

Table-7 shows a 0.0000 probability for the Z which clearly indicates that the frequency distribution of the daily price indices of DSM not fit by normal distribution and hence K-S test suggests that DSM does not follow random walk model.

Table 7: Kolmogorov-Smirnov test for the for the daily market returns.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Return (DGEN)	.079	1921	.000	.890	1921	.000
Return (DSEX)	.042	579	.015	.981	579	.000
VAR01 (2005-09)	.094	977	.000	.885	977	.000
VAR02 (2009-13)	.038	943	.003	.988	943	.000

Source: Calculated by authors

Finally it may be asserted that DSM does not follow random walk model in pricing securities and this is supported by all the tests conducted in this study. Therefore it is concluded that DSM is not efficient in weak-form of EMH.

4. POLICY IMPLICATION AND CONCLUSION

As the study reveals that DSM is not efficient in weak-form of EMH, hence regulators and policy makers can consider the following suggestions to make it efficient over the time.

- Market depth must be increased to increase market efficiency by supplying more securities in the capital market. In order to motivate prospective companies for listing in the capital market, more privileges can be provided to them. For example, considerable lower tax rate on income for the listed companies than that of non-listed companies.

- Market monitoring must be highly effective so that no one can make artificial speculation in trading securities and price movement become random.

- Price sensitive information must be disseminated among the investors and other stakeholders in the right time and in the right way, so that all the relevant information reflects in the market price of securities.

Efficiency of stock market plays the pivotal role for achieving the ultimate goals of capital market. As DSM is not efficient in weak-form of EMH, therefore it is unable to utilize all the prospective benefits from the operation of capital market. Policy makers and respective regulators must understand this problem and have to go for in-depth analysis to identify the problem and pay emphasis on initiating the right policies and actions to overcome the issues of present inefficiencies of DSM in particular.

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APPENDICES

Table 3: Autocorrelation for the Daily Index Returns of DGEN and DSEX

DGEN						DSEX					
Log	Autocorrelation (2005-2013)	Std. Error[a]	Box-Ljung Statistic			Log	Autocorrelation (2013-15)	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]				Value	df	Sig.[b]
1	.016	.023	0.511	1	.475	1	.076	.041	3.34	1	.068
2	-.036	.023	3.000	2	.223	2	.035	.041	4.07	2	.131
3	-.008	.023	3.109	3	.375	3	.066	.041	6.64	3	.084
4	.019	.023	3.769	4	.438	4	.108	.041	13.47	4	.009
5	.029	.023	5.360	5	.374	5	.062	.041	15.70	5	.008
6	-.009	.023	5.520	6	.479	6	-.022	.041	15.10	6	.014
7	-.004	.023	5.558	7	.592	7	-.027	.041	16.42	7	.022
8	.018	.023	6.186	8	.626	8	.006	.041	16.43	8	.037
9	.053	.023	11.579	9	.238	9	.000	.041	16.43	9	.058
10	.024	.023	12.692	10	.241	10	.073	.041	19.63	10	.033
11	-.030	.023	14.396	11	.212	11	-.015	.041	19.77	11	.049
12	.013	.023	14.714	12	.257	12	.027	.041	20.21	12	.063
13	-.053	.023	20.186	13	.091	13	.006	.041	20.23	13	.090
14	.020	.023	20.967	14	.102	14	-.021	.041	20.48	14	.116
15	.037	.023	23.650	15	.071	15	.000	.041	20.48	15	.154
16	.009	.023	23.798	16	.094	16	-.014	.041	20.59	16	.195

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

Table 4: Autocorrelation for the Daily Index Returns of DGEN

Log	Autocorrelation (2005-2009)	Std. Error[a]	Box-Ljung Statistic			Log	Autocorrelation (2009-13)	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]				Value	df	Sig.[b]
1	-.004	.032	.016	1	.901	1	.085	.033	6.783	1	.009
2	-.039	.032	1.491	2	.474	2	-.020	.032	7.168	2	.028
3	-.012	.032	1.641	3	.650	3	.008	.032	7.236	3	.065
4	.019	.032	1.984	4	.739	4	.025	.032	7.810	4	.099
5	.011	.032	2.093	5	.836	5	.088	.032	15.171	5	.010
6	-.022	.032	2.584	6	.859	6	.031	.032	16.115	6	.013
7	-.009	.032	2.670	7	.914	7	.010	.032	16.203	7	.023
8	.032	.032	3.662	8	.886	8	-.027	.032	16.921	8	.031
9	.056	.032	6.710	9	.667	9	.054	.032	19.674	9	.020
10	.035	.032	7.904	10	.638	10	-.008	.032	19.733	10	.032
11	-.038	.032	9.357	11	.589	11	-.002	.032	19.739	11	.049
12	.034	.032	10.514	12	.571	12	-.051	.032	22.261	12	.035
13	-.079	.032	16.734	13	.212	13	.036	.032	23.509	13	.036
14	.025	.032	17.379	14	.237	14	.005	.032	23.530	14	.052
15	.046	.032	19.457	15	.194	15	.009	.032	23.603	15	.072
16	.022	.032	19.929	16	.223	16	-.027	.032	24.309	16	.083