DO STOCKS FOLLOW THE RANDOM WALK IN LATVIAN STOCK MARKET

Ph.D. candidate Raivis Kakanis

University of Latvia

August 2004

YouREC Conference Paper
August 2004

Do Stocks Follow the Random Walk in Latvian Stock Market

Abstract

Author of the paper is testing whether successive daily returns of Riga Stock Exchange (RSE) quoted stocks are serially uncorrelated that is do they follow the random walk.

The author found that Latvian stock market daily stock returns exhibit statistically significant serial correlation in the period from 09-Apr-96 to 01-Apr-04 however it is very unstable in shorter time subperiods and generally is decreasing in the most recent time periods and it is the most pronounced in the first half of the research period from 09-Apr-96 to 03-Apr-00. Author also found that observed serial correlation of daily stock returns implies that linear relationship with the lagged stock return can be used to explain about 2% of the variation in the current stock return, which is probably insignificant from an economic viewpoint however there are time subperiods which are characterized by far higher serial correlation which can be used to explain even up to 20% of the variation in the current stock returns which is without any doubt economically significant.

The research also showed that big capitalization stocks do exhibit higher serial correlation compared to smaller capitalization stocks and that the return on the illiquid stocks is really unpredictable as the serial correlation of daily returns is statistically insignificant in all examined time periods.

Keywords: Random walk, Riga Stock Exchange, Stock prices

Author:
Ph.D. candidate Raivis Kakanis
University of Latvia
E-mail: raivis.kakanis@nordea.lv

Do Stocks Follow the Random Walk in Latvian Stock Market?

Introduction

There are many meanings of the term random walk. But we will use in this paper one defined by the finance professor Eugene Fama that relates to the stock market:

> "*A stock market where successive price changes in individual securities are independent is, by their definition, a random walk market. Most simply the theory of random walks implies that a series of stock price changes has no memory-the past history of the series cannot be used to predict the future in any meaningfull way. The future path of the price level of a security is no more predictable than the path of a series of cumulated random numbers*" [15, 76].

Forecasting future stock price changes by using only the past price changes may seem naïve or worthless however it can give very important insights in the way stock prices are formed in the market.

Brief Literature Review and Analysis

The first researcher who linked the random walk process to economic processes was French mathematician Louis Bachelier in his Ph.D. dissertation titled "The Theory of Speculation" (1900) [6;7]. He was the first researcher ever who used theory, including mathematical techniques to explain why stock market behaves as it does [2, 18]. He observed that contradictory opinions concerning market changes diverge so much that at the same instant buyers believe in a price increase and sellers believe in a price decrease. That forced him to conclude, "*The mathematical expectation of the speculator is zero"*. However his research remained largely unknown untill fifties of 20th century.

The first researcher after Bachelier who decided to investigate whether market professionals are able consistently to forecast stock price changes with any degree of success that can be rated higher than random success was Alfred Cowles who concluded that it is very doubtful [8;9;10;11].

These two initial researches later on were followed by many other researchers like Working (1934) [27], Kendall (1953) [20], Roberts (1959) [25], Osborne (1959) [24],

Cootner (1962) [4], Fama (1965) [14;15] and many others. Their researches mostly concentrated on the statistical approach to testing stock price independence and their main conclusion was that even if stock price changes are not completely random then the changes are very close to random changes and can not be used to predict future stock prices. This point of view was maintained until more recent researches of De Bondt and Thaler (1985) [12], Fama and French (1987) [16], Lo and MacKinlay (1988) [22], Jegadeesh (1987, 1990) [19;18] and others who shown that stock price changes are not random.

The obvious question, which can arise, is what has changed in the most recent researches comparing to the early ones? Why there are so contraverse results in the researches?

To answer this question I would like to use the citation from the professor H.Roberts who already in 1959 forecasted such contrarian opinions:
"*...it seems likely that departures from simple chance models will be found – if not for stock-market averages, then for individual stocks; if not for weekly periods, then for some other period; if not from the independence assumption, then from the assumption of a stable underlying distribution; etc."* [25, 7]. After deeper examination of vast number of the researches on the field the author realized that the researches with contrarian inferences usually use different samples of data, different time periods and different methodologies. Besides researches which pretend to defend random walk hypothesis, in fact, reach results which are not unambiguous as observed serial correlation of stocks' percentage price changes are statistically significantly different from zero [20;15]. However they treat it as economically insignificant due to the fact that it is small by its absolute magnitude.

Objective of the Research

To date there are no researches done on the Latvian stock return predictability and the author decided to investigate whether there exist significant departures from randomness in stock return changes in the Latvian stock market and in case if such departures exist to make inferences why they exist.

To make the results of the analysis more general the author compares Latvian

stock market return independence to Lithuanian and Estonian stock return independence and compares results achieved with the stock return independence in the developed stock market. As the benchmark for the developed stock market serves composite US Standard & Poors 500 capitalization weighted stock price index returns.

Methodology of the Research

There are various statistical methodologies of various complexity for the testing of stock return predictability based on their past returns however as it is noted by well known researchers in the field Campbell, Lo and MacKinlay [4, 44] the one of the most direct and intuitive tests of the random walk hypothesis for an individual time series is to check for serial correlation, correlation between two observations of the same series at different dates. This technique has been already used in the early tests of the stock return predictability by Kendall (1953) [20], Cootner (1962) [5], Fama (1965) [14; 15] and others.

The author performed statistical tests of serial correlation among successive returns on the Riga Stock Exchange (RSE) quoted stocks' portfolios for the period from 04 April, 1996 to 05 April, 2004.

Although many researchers, for instance Osborne (1959) [24], Fama (1965) [14; 15] used natural logarithms of succesive stock prices as the variables the author decided to use successive percentage stock price changes to be more accurate as in such a market as Latvian Stock Marker stock price changes oftenly are very large which makes use of stock price logarithms not accurate especially for the illiquid stock analysis.

Taking into account that stock price change is only one component of the return from stock holding investor is receiving it is necessary to include in the analysis other income from stock holding, for instance, such income as cash dividends, income resulting from receiving stock dividends, stock splits and to take into account other corporate events which can influence the return on the stock

Above mentioned indicates that it is necessarily to use some appropriate stock market index, which takes into account all these corporate events. After examining the existing RSE stock market indexes the author concluded that they have some deficiencies as they are not taking into account cash dividends and the composition of the indexes is

changing over time. Not taking into account cash dividends will bias stock returns downwards but changing composition of the index (for so small market as it is Latvian stock market) could make returns in various time periods uncomparable.

In order to avoid these difficulties the author decided to elaborate new stock market indexes both capitalization weighted and equally weighted. The mathematical base of these indexes calculations is given in the Appendix 1 and Appendix 2.

The main differencies from existing RSE indexes in the methodology of the indexes are:

1. stock included in the index composition is excluded from it only in the case the stock is excluded from the exchange;
2. insolvent companies are not just excluded from the index but it is assumed that their stock price on the exclusion date is zero (as it is unlikely for the shareholders to receive any liquidation dividends);
3. stock prices used are not daily closing prices but weighted average daily stock prices;
4. index is calculated by taking into account all shares issued not only publicly traded shares of the companies.

Author calculated 4 separate stock market indexes for each capitalization and equally weighted indexes. One of them is the index which represents most liquid and actively traded stocks, the second one is representing medium liquid stocks, third one is representing illiquid stocks and last one is representing all ever listed stocks in RSE.

The criteria for the inclusion in the most liquid stock index were following:

1. trading turnover of shares per session on average is at least 0.01% of the average of all outstanding shares during listing period
2. stock price should be set on average in at least 40% of all trading sessions when company is listed in RSE (block and reported trades excluded)
3. company has quoted for at least 2 years in RSE.

The criteria for the inclusion in the medium liquid stock index were following:

1. stocks not meeting requirements set for the inclusion in the most liquid stock index;
2. stock price should be set on average in at least 25% of all trading sessions when company is listed in RSE (block trades excluded).

The criteria for the inclusion in the illiquid stock index were following:

1. stocks not meeting requirements set nor for the inclusion in the most liquid nor medium liquid stock indexes;
2. stock price should be set on average in at least 10% of all trading sessions when company is listed in RSE (block trades excluded).

Last index is representing all RSE listed stocks and there are no any criteria for inclusion in this index.

The stock index return was calculated as follows:

$r_t = \left(\frac{I_t}{I_{t-1}} - 1 \right) \times 100\%$, Where

r_t return on the stock index during time period t

I_t stock index value at the end of the period t

I_{t-1} stock index value at the end of the period $t-1$

The serial correlation among returns on the stock indexes were calculated according to the following formula:

$$\hat{\rho}_k = \frac{\hat{\gamma}_k}{\hat{\gamma}_0} = \frac{\frac{\sum \left(Y_t - \bar{Y}\right)\left(Y_{t+k} - \bar{Y}\right)}{n}}{\frac{\sum \left(Y_t - \bar{Y}\right)^2}{n}}, \text{ where} \qquad [13, 714\text{-}715]$$

$\hat{\rho}_k$ serial correlation coefficient at lag k;

$\hat{\gamma}_k = \frac{\sum \left(Y_t - \bar{Y}\right)\left(Y_{t+k} - \bar{Y}\right)}{n}$ stock return co variation at lag k;

$\hat{\gamma}_0 = \frac{\sum (Y_t - \bar{Y})^2}{n}$ dispersion of stock return.

The standard error of the serial correlation coefficient was calculated based on the Barlett methodology:

$$\text{var}(r_k) = \frac{1}{n}\left(1 + 2\sum_{l=1}^{k-1} r_l^2\right), \text{where} \qquad [3]$$

$\text{var}(r_k)$ variance of serial correlation coefficient

n number of time periods

r_l^2 squared serial correlation coefficient

$\sum_{l=1}^{k-1} r_l^2$ sum of squared serial correlation coefficients at lags $k-1$.

and the standard error is the square root of the variance:

$$SE(r_k) = (\text{var}(r_k))^{1/2} \qquad [13, 76]$$

One of the methodologies used for estimating the significance of serial correlation is Ljung-Box (LB) statistic, which is defined as:

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^2}{n-k}\right) \sim \chi_m^2, \text{ where} \qquad [13, 717]$$

n sample size

m lag length

$\hat{\rho}_k$ serial correlation coefficient at lag k.

Results

First of all the author examined the serial correlation present among daily stock market returns for the most liquid RSE stocks. Author calculated serial correlation coefficients among daily stock index returns at lags from 1 to 30. Results are illustrated in Figure 1 below.

As we can see from the Figure 1 then daily stock returns at various lag levels are statistically significantly serially correlated as 12 of 30 serial correlation coefficients at different lags are outside the confidence limits which show the 95% probability (1.96 standard errors of serial correlation coefficient from zero) that serial correlation coefficients are statistically insignificant. Especially significant is the serial correlation coefficient at lag 1 as the probability of reaching such serial correlation coefficient randomly is practically zero. These results indicate that daily RSE stock returns are not independent from their past returns.

However is this statistical significance economically important and could this dependence be used to make forecasts of next trading session stock returns?

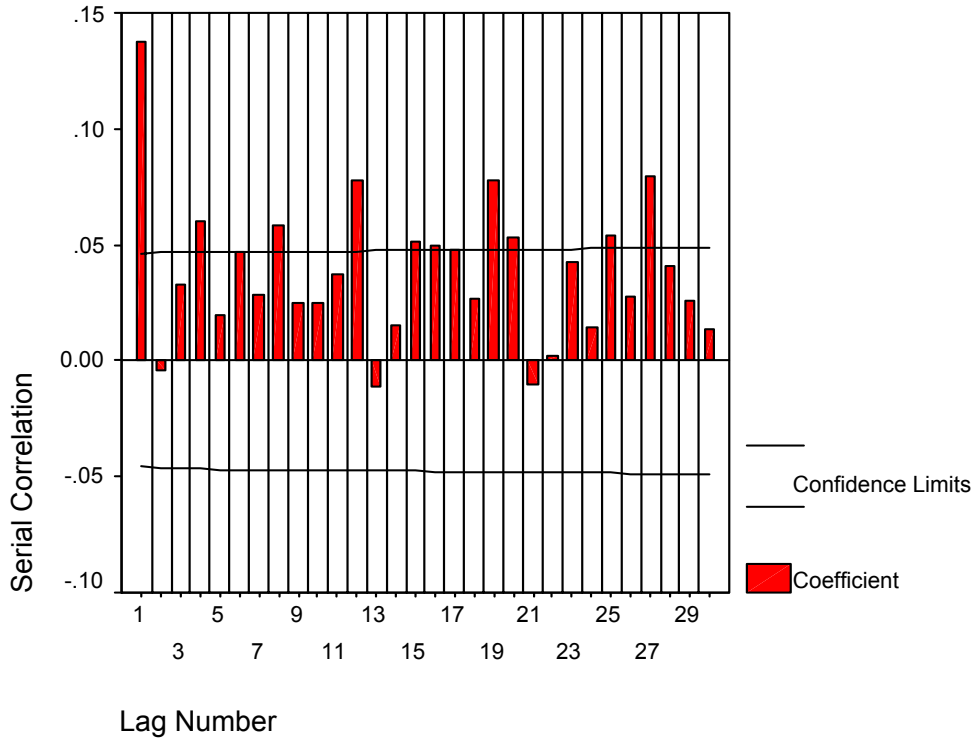

Fig. 1 Most Liquid RSE Listed Daily Stock Return Serial Correlation at Lags from 1 to 30, 09-Apr-96 to 01-Apr-04

To answer this question it is not necessary to make any trading models, it is enough to point out that the serial correlation coefficient value at lag 1 is not high in absolute terms (around 0.138) as it implies that linear relationship with the lagged stock

return can be used to explain about only 2% of the variation in the current stock return, which is probably insignificant from an economic viewpoint.

As it is already mentioned by finance professor E.Fama the random walk model may be acceptable even though it does not fit the facts exactly (there is present some serial correlation) cause the independence assumption of the random walk model is valid as long as knowledge of the past behaviour of price changes cannot be used to increase expected gains [14; 15]. And it is very doubtful that any investor can increase his expected gains by using information, which explains at best 2% of stock returns variation. This leads the author to make inference that based on analyses made so far it seems that daily RSE most liquid stock returns have not been predictable based only on their past returns in the period from 09-Apr-96 to 01-Apr-04 as the predictable part of their return have been very small.

Besides the author wants to emphasize that the statistical significance of the serial correlation coefficient is dependent on the standard error of the serial correlation coefficient. Therefore it is important to know what is the underlying stock return distribution in order to know what methodology to apply for standard error calculation. From previous empirical works, for instance, Kendall (1953) [20], Mandelbrot (1963) [23] and Fama (1965) [15], we know that stock returns follow highly leptokurtic distribution compared to the Gaussian distribution and that means that large stock price changes occur much more frequently than would be expected if the stock price changes would follow Gaussian distribution. And that is true also for the daily stock returns in Latvia as well.

Let's take a look on Figure 2 below. As we can see from the Figure 2 daily stock returns of the most liquid RSE quoted stocks are highly leptokurtic as the highest density of the returns is peaked around the mean but it is by far exceeding density expected by the normal distribution. From the other side tails of the distribution are very long and right hand tail is even exceeding 10 standard deviations from the mean.

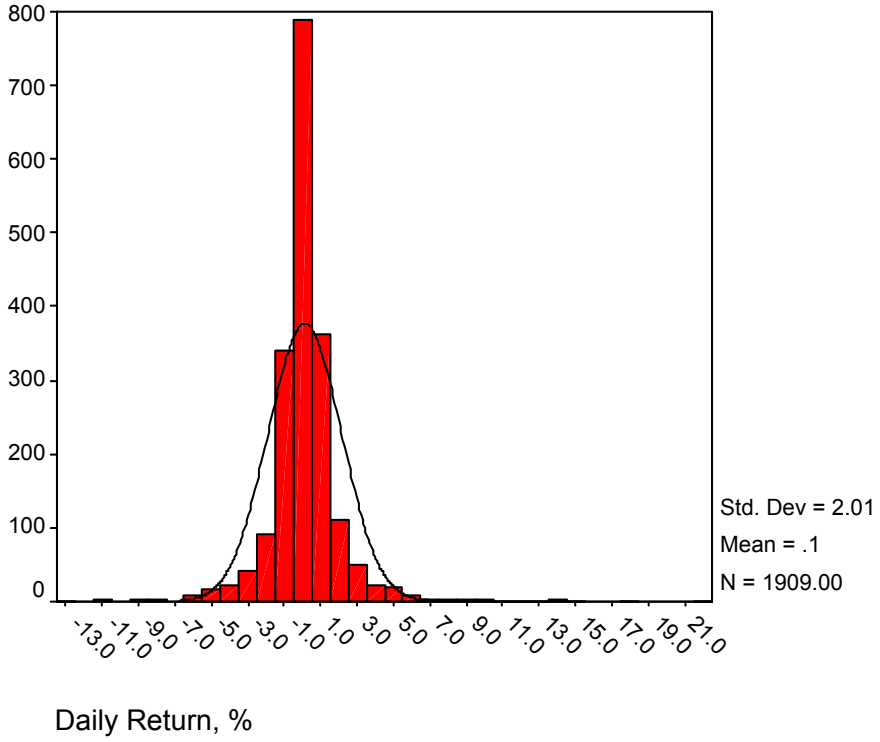

Fig. 2 Empirical Density Plot of RSE Most Liquid Stock Portfolio Daily Return Distribution against Normal Density Plot, 09-Apr-96 to 01-Apr-04

The leptokurtosis of the stock return distribution indicates that the calculation of the standard error of serial correlation coefficient according the methodology based on normal distribution understates it and that can lead to the overestimation of the significance of serial correlation. However in our case the serial correlation coefficient value of most liquid RSE stock daily returns is almost six times exceeding its standard error so we can still make inference that it is statistically significant[1].

However to make any final inferences on daily most liquid RSE stock return predictability it is necessary to investigate the presence of serial correlation in shorter time sub periods therefore the author calculated the serial correlation coefficients for

[1] according to the Chebyshev's theorem: for any distribution, the minimum proportion of observations that fall within k standard deviations of the mean is given by: $1-\left(1/k^2\right)$, where k is the number of standard deviations from the mean. According to this theorem if we want to calculate how much greater should be our statistic compared to the standard error of it in order to ensure 95% confidence limit for statistic we get 4.5 standard deviations and 10.0 standard deviations for 99% confidence limits.

different overlapping and non-overlapping time sub periods of the entire research period.

Results are given in Table 1.

We can see that serial correlation coefficient of daily most liquid capitalization weighted RSE stock portfolio returns has been unstable in different time sub periods. For instance, most liquid stock portfolio returns have serial correlation coefficient 0.138 for entire research period from 09-Apr-96 to 01-Apr-04 but it is negative in some separate time sub periods. It is interesting to observe that serial correlation is relatively strong in three first successive overlapping 2 year time periods from 09-Apr-96 to 03-Apr-00 but afterwards it is becoming less and less significant. We can see that serial correlation is also statistically insignificant in last 5 year period from 01-Apr-99 to 01-Apr-04 where it is only 0.047.

It is important to understand what causes serial correlation in stock returns and why it was statistically significant in the beginning of the research period. One of the hypothesis the author wanted to examine is the hypothesis that relatively high serial correlation in daily most liquid RSE listed capitalization weighted stock portfolio returns in time period 09-Apr-96 to 01-Apr-99 was due to 2 pronounced stock price movement trends: pronounced uptrend in period from 02-Apr-96 to 01-Apr-97 (stock index increased from 1000 to 5407) and pronounced downtrend in period from 01-Oct-97 to 01-Oct-98 (stock index decreased from 5808 to 1387)[2].

It is interesting to note that both calculated serial correlation coefficients were statistically insignificant 0.125 (SE 0.125) and 0.108 (SE 0.063) respectively. Further results showed same contrary results: stock return in the time sub period from 01-Oct-98 to 01-Oct-99 which was not characterized by any price trend (see Appendix 3: starting index value 1144 and ending index value 1147) was characterized by serial correlation 0.250 which was statistically significant (SE 0.063, LB 15.926).

[2] dynamic of the most liquid RSE listed stock index is given in the Appendix 3

Table 1

Serial Correlation at Lag Equal One Trading Session, Standard Error of Serial Correlation and Ljung- Box Statistic of Daily RSE Stock Return for Most Liquid, Medium Liquid and All RSE Stock Portfolios and for Existing RSE Stock Market Indices – RICI and DJIRSE, 09-Apr-96 to 01-Apr-04

Time period		SE*	Most Liquid RSE Stock Portfolio (capitalization weighted)		Medium Liquid RSE Stock Portfolio (capitalization weighted)		Illiquid RSE Stock Portfolio (capitalization weighted)		All RSE Listed Stock Portfolio (capitalization weighted)**		Most Liquid RSE Stock Portfolio (equally weighted)		Medium Liquid RSE Stock Portfolio (equally weighted)		Illiquid RSE Stock Portfolio (equally weighted)		All RSE Listed Stock Portfolio (equally weighted)**	
			(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Seven successive overlapping 2 years periods																		
09.Apr.96	01.Apr.98	0.050	0.151	9.14	0.126	6.29	0.139	7.76	0.182	13.19	0.339	45.95	0.144	8.28	0.061	1.49	0.191	14.56
01.Apr.97	01.Apr.99	0.045	0.148	11.04	0.122	7.54	0.038	0.75	0.076	2.90	0.266	35.91	0.105	5.56	0.049	1.23	0.184	17.06
01.Apr.98	03.Apr.00	0.044	0.222	25.04	0.162	13.35	0.051	1.34	0.097	4.77	0.190	18.42	0.089	4.01	0.021	0.23	0.074	2.81
01.Apr.99	02.Apr.01	0.044	0.127	8.27	-0.061	1.92	0.043	0.95	0.033	0.56	-0.058	1.71	-0.021	0.23	-0.001	0.00	0.013	0.08
03.Apr.00	02.Apr.02	0.044	0.043	0.94	0.306	47.66	-0.094	4.48	0.401	81.81	-0.049	1.20	0.043	2.64	-0.015	0.12	0.054	1.49
02.Apr.01	02.Apr.03	0.044	-0.006	0.02	0.466	110.61	-0.092	4.33	0.484	119.16	-0.010	0.05	-0.003	0.00	0.010	0.05	0.103	5.41
02.Apr.02	01.Apr.04	0.044	-0.022	0.25	0.180	16.49	-0.027	0.37	0.173	15.12	0.084	3.54	-0.042	0.89	0.054	1.49	0.039	0.77
Eight overlapping periods with end date 01-Apr-04																		
01.Apr.03	01.Apr.04	0.063	-0.037	0.35	0.004	0.00	-0.043	0.48	0.022	0.13	0.188	8.97	-0.007	0.01	0.039	0.38	0.025	0.16
02.Apr.02	01.Apr.04	0.044	-0.022	0.25	0.180	16.49	-0.027	0.37	0.173	15.12	0.084	3.54	-0.042	0.89	0.054	1.49	0.039	0.77
02.Apr.01	01.Apr.04	0.036	-0.012	0.11	0.438	145.51	-0.075	4.32	0.452	155.45	0.054	2.20	-0.003	0.01	0.017	0.21	0.068	3.47
03.Apr.00	01.Apr.04	0.031	0.013	0.18	0.293	86.83	-0.062	3.91	0.374	141.76	0.035	1.21	-0.017	0.31	-0.005	0.03	0.053	2.89
01.Apr.99	01.Apr.04	0.028	0.047	2.81	0.271	92.87	-0.023	0.66	0.357	161.05	0.024	0.75	-0.009	0.10	-0.003	0.01	0.046	2.73
01.Apr.98	01.Apr.04	0.026	0.117	20.64	0.239	86.80	-0.001	0.00	0.295	131.74	0.116	20.44	0.021	0.65	0.006	0.05	0.077	8.91
01.Apr.97	01.Apr.04	0.024	0.106	19.82	0.198	69.07	0.004	0.03	0.259	118.69	0.132	30.77	0.033	1.97	0.009	0.16	0.092	14.92
09.Apr.96	01.Apr.04	0.023	0.138	36.33	0.189	68.26	0.044	3.76	0.249	118.60	0.219	91.71	0.056	6.09	0.020	0.78	0.134	34.38
Two non-overlapping 4 years periods																		
09.Apr.96	03.Apr.00	0.033	0.187	31.45	0.140	17.71	0.097	8.41	0.170	26.14	0.308	85.81	0.127	14.56	0.044	1.76	0.191	33.04
03.Apr.00	01.Apr.04	0.031	0.013	0.18	0.293	86.83	-0.062	3.91	0.374	141.76	0.035	1.21	-0.017	0.31	-0.005	0.03	0.053	2.89

SE* standard error of serial correlation coefficient, equal for all indexes (calculated according to Barlett (1946) methodology)

** All RSE listed stock portfolio includes completely all RSE ever listed stocks (in.al. also very illiquid stocks)

(1) serial correlation coefficient

(2) Box-Ljung Statistic

In the same time stock return in the time sub period from 03-Mar-03 to 01-Mar-04 which was characterized by strong stock price uptrend (see Appendix 3: starting index value 2378 and ending index value 6027) was characterized by statistically insignificant serial correlation 0.027 (SE 0.063, LB 0.180).

These findings are not supporting previous hypothesis of the author that serial correlation is higher in times when there are pronounced market trends and that is another step closer to the random walk of the RSE most liquid stock returns.

However the results of other researchers are indicating that the results should be exactly as they are showed above and that serial correlation of returns should be higher in relatively calm market times and opposite in volatile market periods and that is so called "feedback trading strategy of the investors" [26, 423]. However the more detailed tests of this issue author will leave for another research and that will not be in the scope of this paper.

Next the author formed capitalization weighted medium liquid, illiquid and all RSE ever listed stock portfolios and calculated serial correlation of daily returns for each of these portfolios. Calculated results for the same time periods as for the most liquid RSE stock returns are given in Table 1.

As we can see from Table 1 serial correlation of medium liquid RSE stock returns is higher compared to most liquid RSE stock returns in research period from 09-Apr-01 to 01-Apr-04: 0.189 against 0.138 which means that past returns explain about 3.5% of current medium liquid stock return fluctuations. However illiquid stocks' return seems to do not have any highly statistically significant serial correlation of returns at all except some minor significance in some early and middle time sub periods and besides illiquid stock return serial correlation is even negative in most of examined time sub periods.

Looking at the serial correlation of the return of all RSE listed stock portfolio return we see that is has relatively very high serial correlation in most of examined time sub periods however at this stage of the research it is not possible to distinguish whether that is due to serial correlation of very illiquid stocks' return or that is due to the serial correlation of medium liquid stocks' return which by itself is the highest of all stocks examined.

We can see that for the medium liquid and all RSE stock portfolio contrary to most liquid and illiquid stock returns there are no trend of decreasing serial correlation in the

recent years and that it is even higher in the recent years except last year. Astonishing serial correlation is observed in the time period from 02-Apr-01 to 02-Apr-03 for both medium liquid and all RSE stock portfolios 0.466 and 0.484 respectively. That is very substantial serial correlation, which already explains more than 20% of the variation of the current stock returns. What is causing so high serial correlation?

One of the explanations which is found in other empirical researches is that infrequent or thin as well as nonsynchronous stock trading can cause increased spurious serial correlation in the stock returns [17;21] as different security prices are set in different times but are treated as if they were sampled simultaneously.

This effect by author's opinion can not be the reason for observed serial correlation of most liquid stock prices as they are traded frequently and stock prices used in the calculation are not day closing prices but are the weighted average daily prices which, by author's opinion, describe the daily market prices of stocks much better than the day closing prices in such small relatively illiquid market as it is Latvian stock market. Of course, one can argue that as stock prices are not point estimates it can cause spurious serial correlation in stock returns as it was showed by Working [28, 916] however it is not really that case Working has shown.

Also it is known that small capitalization stocks are less liquid than larger stocks, therefore new market information is impounded first into large – capitalization stock prices and then into smaller stock prices with a lag. This lag induces a positive serial correlation, which is more pronounced in equally weighted stock index [22, 56].

According to the researches of other authors [17;21;22] we can make hypotheses that all 4 equally weighted RSE stock portfolios should exhibit higher serial correlation compared to the respective capitalization weighted portfolios due to at least two reasons: there is dominant return of big capitalization stocks in the capitalization weighted stock index and these bigger stocks are relatively very frequently traded.

Calculated serial correlation for all equally weighted RSE stock portfolios are given in Table 1.

The hypothesis is true for the most liquid RSE stock portfolio returns as on average equally weighted stock portfolios exhibit higher serial correlation of returns however the hypothesis is not supported by results of medium liquid stocks as well as from illiquid

stocks and all RSE stocks' portfolio.

It is also interesting to observe that equally weighted illiquid stock returns do not exhibit any statistically significant serial correlation in any of examined time sub periods. That shows us that illiquid RSE stock returns are truly unpredictable both economically and statistically but this conclusion is in conflict with existing empirical findings that returns of illiquid stocks should be more predictable.

Also worth of noting is the fact that return of both equally weighted medium liquid and all stocks' portfolios have no more statistically significant serial correlation in the second half of the research period from 03-Apr-00 to 01-Apr-04 what indicates that exactly big stocks were responsible for high serial correlation of returns for medium liquid capitalization weighted and all RSE capitalization weighted stock portfolios. Also it is known that medium liquid RSE stock portfolio comprises couple of largest capitalization stocks.

Above-mentioned leads us to conclude that infrequent trading and size factor could not be responsible for the existing serial correlation of daily RSE listed stock returns.

Some researchers proved that nonsyncronous securities trading can not explain empirically observed serial correlation and there seems to be other factors to be playing major role in generating the serial correlation [1, 117;22, 61] however that will not be in the scope of the current paper.

Next the author decided to compare serial correlation of daily stock returns observed in Latvian stock market with the serial correlation of daily returns in Lithuanian, Estonian stock markets and to compare these results to some developed stock market, such as US. However it was not possible to acquire such extensive raw data for making all calculations in the way it was done for the Latvian stock market therefore the author decided to use existing stock market indexes of all countries and to calculate serial correlation of the stock market index returns. Of course this results should be treated as very indicative as we will be analysing index returns but all indexes do not have the same calculation methodologies behind.

Calculated serial correlation of index returns is given in the Table 2.

It is surprisingly but it looks like serial correlation of daily stock returns is even higher in neighbouring countries where it reaches 0.226 and 0.436 for Estonia and

Lithuania respectively for the period from 09-Apr-96 to 01-Apr-04. Calculated serial correlation of the US Standard&Poors 500 index return do not exhibit any predictability based on past index return in all examined periods.

There is similar trend for the serial correlation to decrease in the most recent time periods for the Lithuanian stock market but that is not true for the Estonian stock market.

The author do not want to draw any inferences based on these results however it looks like Latvian stock market daily returns are more unpredictable compared to the stock returns in two neighbouring countries Lithuania and Estonia however there is much more serious and detailed analysis required to maintain such hypothesis.

Table 2

Serial Correlation at Lag Equal One Trading Session, Standard Error of Serial Correlation and Box-Ljung Statistic of Daily Latvian, Estonian, Lithuanian and USA S&P 500 Stock Market Indices in period from 09-Apr-96 to 01-Apr-04 and 4 consecutive sub periods [29;30;31;32]

Time period		Estonian Stock Index TALSE*			Lithuanian Stock Index LITIN - G			Latvian Stock Index DJIRSE			USA S&P 500		
		(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
09.Apr.96	01.Apr.98	0.237	0.046	26.25	0.508	0.070	53.69	0.138	0.050	7.60	0.012	0.044	0.08
01.Apr.98	03.Apr.00	0.234	0.044	27.96	0.166	0.045	13.56	0.220	0.044	24.59	-0.005	0.044	0.01
03.Apr.00	02.Apr.02	0.063	0.044	2.03	0.077	0.044	3.05	0.154	0.044	12.06	-0.020	0.045	0.00
02.Apr.02	01.Apr.04	0.293	0.044	43.97	0.106	0.044	5.75	-0.015	0.044	0.12	-0.057	0.044	1.64
09.Apr.96	01.Apr.04	0.226	0.022	101.15	0.436	0.024	324.72	0.154	0.023	45.50	-0.015	0.022	0.47

(1) serial correlation coefficient
(2) standard error of serial correlation coefficient (calculated according to Barlett (1946) methodology)
(3) Box-Ljung Statistic
* The start date of the first subperiod is 04-Jun-96 instead of 09-Apr-96

Conclusions

After examination of serial correlation of Latvian stock market daily returns the author made following conclusions:

Latvian stock market daily stock returns exhibit statistically significant serial correlation in the period from 09-Apr-96 to 01-Apr-04 however it is very unstable in shorter time sub periods and generally is decreasing in the most recent time periods and is the most pronounced in the first half of the research period from 09-Apr-96 to 03-Apr-00.

Larger capitalization stock returns do exhibit higher serial correlation than smaller capitalization stock returns as the serial correlation of returns on equally weighted stock portfolios is higher compared to that on capitalization weighted stock portfolios. Besides larger capitalization stock return is characterized by relatively high serial correlation also in more recent time sub periods.

The serial correlation of the most liquid RSE stock portfolio return is high in times when market volatility is rather low and it is low when market volatility is high. This finding indicates the presence of so called "investors feedback trading strategy" however the degree of its presence and its statistical importance should be evaluated separately.

Observed serial correlation of daily stock returns implies that linear relationship with the lagged stock return can be used to explain about 2% of the variation in the current stock return, which is probably insignificant from an economic viewpoint however there are time sub periods which are characterized by far higher serial correlation which can be used to explain even up to 20% of the variation in the current stock returns which is without any doubt economically significant.

Equally weighted illiquid stock returns do not exhibit any statistically significant serial correlation in any of examined time sub periods. That shows us that illiquid RSE stock returns are truly unpredictable both economically and statistically but this conclusion is in conflict with existing empirical findings that returns of illiquid stocks should be more predictable.

There should be done further research on the predictability of Latvian stock returns by using stock returns of longer time periods than one day as well it should be investigated whether return on some particular big capitalization companies stocks is not exhibiting strong serial correlation.

Bibliography

1. Atchison M.D., Butler K.C., Simonds R.R. "Nonsynchronous Security Trading and Market Index Autocorrelation." Journal of Finance, Volume 42, Issue 1 (Mar., 1987), 111-118
2. Bernstein P.L. "Capital Ideas: The Improbable Origins of Modern Wall Street" New York: The Free Press 1992
3. Barlett M.S. "On the Theoretical Specification of Sampling Properties of Autocorrelated Time Series," Journal of the Royal Statistical Society, Series B, vol. 27, 1946, pp.27-41.
4. Campbell Y.Y., Lo W.A., MacKinlay C.A. 1997. "The Econometrics of Financial Markets." Princeton University Press, pp 611
5. Cootner P.H. "Stock Prices: Random vs. Systematic Changes." Industrial Management III, (Spring, 1962), 24-45
6. Cootner P.H. "The Random Character of Stock Market Prices." Cambridge: M.I.T. Press, 1964
7. Courtault J.M., Kabanov Y., Bru B., Crepel P., Lebon I., Marchand A.L. "Louis Bachelier on the Centenary of *Theorie De La speculation.*" Mathematical Finance, Vol. 10, No. 3 (July 2000), 341-353
8. Cowles A. "Can Stock Market Forecasters Forecast?" Econometrica, Vol. 1, Issue 3 (Jul., 1933), 309-324
9. Cowles A., Jones E. H. "A Posteriori Probabilities in Stock Market Action." Econometrica, Vol. 5, Issue 3 (July 1937), 280-294
10. Cowles A. "Stock Market Forecasting." Cowles Commission Papers, New Series, No. 6, Reprinted from Econometrica 12, 1944, 206-214
11. Cowles A. "A Revision of Previous Conclusions Regarding Stock Price Behaviour." Econometrica, Vol. 28, Issue 4 (October 1960), 909-915
12. De Bondt F. M., Thaler R. "Does The Stock Market Overreact?" Journal of Finance, Volume 40, Issue 3, Papers and Proceedings of the Forty-Third Annual

Meeting American Finance Association, Dallas, Texas, December 28-30 1984 (Jul., 1985), 793-805

13. Gujarati N.D 1995. "Basic Econometrics." McGraw-Hill, Third Edition, pp. 838
14. Fama E.F. "Random Walks in Stock Market Prices." Financial Analysts Journal, September/October 1965 (reprinted January-February 1995
15. Fama E.F. "The Behavior of Stock-Market Prices." Journal of Business, Volume 38, Issue 1 (Jan., 1965), 34-105
16. Fama E.F., French K.R. "Permanent and Temporary Components of Stock Prices." The Journal of Political Economy, Volume 96, Issue 2 (Apr., 1988), 246-273
17. Fischer. L., "Some New Stock Market Indexes." Journal of Business 39 (1966), 191-225
18. Jegadeeesh N. "Evidence of Predictable Behavior of Security Returns." Journal of Finance 45, pp 881-898 (1990)
19. Jegadeeesh N. "Predictable Behavior of Security Returns and Tests of Asset Pricing Models." Ph.D. Dissertation, Columbia University (1987)
20. Kendall M.G., Hill A.B. "The Analysis of Economic Time-Series-Part I: Prices." Journal of the Royal Statistical Society. Series A (General), Volume 116, Issue 1 (1953)
21. Lo A.W., MacKinlay C.A. "An Econometric Analysis of non-synchronous trading." NBER Working Paper 2960 (1989). (Published: Journal of Econometrics, Vol. 45, pp. 181-211, (1990)).
22. Lo A.W., MacKinlay C.A. "Stock Market Prices Do not Follow Random Walks: Evidence from a Single Specification Test." The Review of Financial Studies / Spring 1988
23. Mandelbrot B. "The Variation of Certain Speculative Prices." The Journal of Business, Volume 36, Issue 4 (Oct., 1963), 394-419
24. Osborne M.F.M. "Brownian Motion in the Stock Market." Operations Research, 10, 345-379 (1959).
25. Roberts H.V. "Stock-Market "Patterns" and Financial Analysis: Methodological Suggestions." The Journal of Finance, Volume 14, Issue 1 (Mar., 1959), 1-10
26. Sentana E., Wadhwani S. "Feedback Traders and Stock Return Autocorrelations:

Evidence from a Century of Daily Data." The Economic Journal, Vol.102, No.411 (Mar., 1992), 415-425.

27. Working H. "A Random-Difference Series for Use in Analysis of Time Series." Journal of the American Statistical Association, Volume 29, Issue 185 (Mar., 1934), 11-24
28. Working H. "Note on the Correlation of First Differences of Averages in a Random walk." Econometrica, Volume 28, Issue 4 (Oct., 1960), 916-18
29. http://www.hex.ee
30. http://www.rfb.lv
31. http://www.nse.lt
32. Reuters

Appendix 1: Formulas Used in the Calculation of The Capitalization Weighted RSE Stock Market Index

$$I_t = \frac{\sum_i^n P_t^i \times N_t^i}{K_t}$$ where

I_t	value of the index in session t
P_t^i	company i average price of the shares in session t
N_t^i	total outstanding shares of company i in session t
K_t	index divisor for non-market changes in session t
$\sum P_t^i \times N_t^i$	total market capitalization of all companies included in the index in session t

and

$$K_t = K_{t-1} \times a_{t\_New} \times a_{t\_Delisted} \times b_t \times c_t$$ where

$$a_{t\_New} = 1 + \frac{\sum \left(N_t^{New} \times P_t^{New} \right)}{\sum_i^n \left(P_t^i \times N_t^i \right) - \sum \left(N_t^{New} \times P_t^{New} \right) - \sum_i^n \left[\left(N_t^i - N_{t-1}^i - N_{t,Bonus}^i \right) \times P_t^i \right]}$$ where

a_{t_New}	index divisor adjustment factor for the case of new company inclusion in the index in session t
N_t^{New}	outstanding shares of the newly included company in session t
P_t^{New}	share price of the newly included company in session t
$\sum \left(N_t^{New} \times P_t^{New} \right)$	total market capitalization of all newly companies included in the index in session t
N_{t-1}^i	total outstanding shares of company i in session $t-1$
$N_{t,Bonus}^i$	bonus hares calculated in session t

$$a_{t\_Delisted} = 1 - \frac{\sum\left(N_{t-1}^{Delisted} \times P_{t-1}^{Delisted}\right)}{\sum_{i}^{n}\left(P_{t-1}^{i} \times N_{t-1}^{i}\right)}$$ where

$a_{t\_Delisted}$ index divisor adjustment factor for the case of company delisting from the index in session $t-1$

$N_{t-1}^{Delisted}$ outstanding shares of the delisted company in session $t-1$

$P_{t-1}^{Delisted}$ share price of the delisted company in session $t-1$

$\sum\left(N_{t-1}^{Delisted} \times P_{t-1}^{Delisted}\right)$ total market capitalization of all from the index delisted companies in session $t-1$

$\sum_{i}^{n}\left(P_{t-1}^{i} \times N_{t-1}^{i}\right)$ total market capitalization of all companies included in the index in session $t-1$

$$b_t = 1 - \frac{\sum D_t^i}{\sum\left[\left(N_{t-1}^{i} + N_{t.Bonust}^{i}\right) \times P_t^i + D_t^i\right]}$$ where

b_t index divisor adjustment factor for the cash dividends session t

D_t^i total calculated dividends of company i in session t (ex-date)

$$c_t = \frac{\sum\left(N_t^i \times P_t^i\right)}{\sum\left(N_t^i \times P_t^i\right) - \sum_{i}^{n}\left[\left(N_t^i - N_{t-1}^i - N_{t,Bonus}^i\right) \times P_t^i\right]}$$ where

c_t index divisor adjustment factor for the share capital change in session t

Appendix 2: Formulas Used in the Calculation of The Equally Weighted RSE Stock Market Index

$$\frac{1}{n}\sum_{i=1}^{n}\left[\frac{I_t^i}{I_{t-1}^i}-1\right]$$ where

n number of companies in the equally weighted index composition

I_t^i value of company i specific stock index in session t calculated according to methodology for the capitalization weighted stock market index given in the Appendix 1

I_{t-1}^i value of company i specific stock index in session $t-1$ calculated according to methodology for the capitalization weighted stock market index given in the Appendix 1

Appendix 3: Dynamic of the RSE Most Liquid Capitalization Weighted Stock Portfolio Index, 02-Apr-96 to 01-Apr-04.