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Iikka Korhonen

Preliminary Tests on Price Formation and Weak-Form Efficiency in Baltic Stock Exchanges

Abstract

We test the informational efficiency of the three Baltic stock exchanges. It was found that the price indices used in testing are not even weak-form efficient, ie past returns can be used to predict future returns. It was also found that the time series of daily returns clearly exhibit autoregressive conditional heteroscedasticity.

We also test Granger causality amongst the Baltic stock exchanges and from three stock exchanges outside the region. Outside the region only US market seems to affect prices in the Baltic stock exchanges. Inside the region Tallinn and Riga stock exchanges have clear effects on Lithuanian stock market, but Lithuanian market does not affect the other two.

Keywords: Baltic countries, stock markets, efficiency

1 Introduction

The equity markets in all three Baltic countries are still in an early stage of development. Economic reforms in these countries did not begin until they were separated from the Soviet Union in 1991, and even then the establishment of organized markets for shares in companies was not high on the new governments' agenda. Over the subsequent years, privatization in the three countries gained momentum and the creation of private companies naturally enabled the operation of stock exchanges. The first stock exchange to be established in the Baltic countries was the National Stock Exchange of Lithuania (NSEL),¹ founded in Vilnius in 1992. In Latvia the Riga Stock Exchange (RSE) was established in March 1995, and in Estonia the Tallinn Stock Exchange (TSE) in May 1996. In Estonia there had been fairly active trading even prior to the establishment of the stock exchange, through the facilities of the Central Depository for Securities.

The purpose of this paper is to report on some preliminary tests on the informational efficiency of the Baltic stock exchanges and to assess the degree to which price changes in one exchange are influenced by price changes in other stock exchanges, both in the Baltics and elsewhere. To this writer's knowledge, no studies have yet been done on the informational efficiency of the three Baltic stock exchanges. Furthermore, because the Baltic countries are small and extremely open economies, it is of interest to examine the extent to which price variation in their stock exchanges can be explained by prices in other, larger equity markets. In the course of the empirical work, it was observed that the daily returns (defined as log-differences of indices) exhibit autoregressive conditional heteroscedasticity and hence it was decided to test weak-form efficiency in an ARCH framework.

¹ For an overview of the development of the Baltic securities markets, see Korhonen et al (1998), and for a detailed account of the development and operations of the Tallinn Stock Exchange, see Luštšik (1997).

Fama (1970) classifies a market as efficient if the prices fully and instantaneously reflect all available information. In this study I focus on a version referred to as weak-form efficiency. A market is said to be weak-form efficient if the past price movements contain no information about future changes. In most of the studies that have been done on the informational efficiency of equity markets in transition economies,² it has been found that price changes are at least to some degree autocorrelated at short lags, which leads to rejection of weak-form efficiency.

2 Baltic stock exchanges

The first of the stock exchanges established in the Baltics after the break-up of Soviet Union was the National Stock Exchange in Lithuania in September 1992. (For a fuller account of privatization and equity markets in the three Baltic countries, see Korhonen et al 1998.) A stock exchange was founded in Riga, Latvia in March 1995, and the last Baltic country to have a stock exchange was Estonia, where the Tallinn Stock Exchange was founded in May 1996.

In the initial phase of operations in Latvia and Lithuania, trading was not even on a daily basis. In Latvia daily trading began at the start of February 1997 and in Lithuania at the start of January 1997. This means that since I employ daily data in the testing, I am limited to the period starting in February 1997.

Although Estonia's stock exchange is the youngest in the Baltic countries, the volume of trading is by far the highest. For example, in the last quarter of 1997, average monthly trading there amounted to USD 140 million, whereas comparable figures for both Latvia and Lithuania were less than USD 20 million. As is evident, the markets are still in the early stages of development. At the end of 1997, total market capitalization was USD 1.7 billion for the NSEL, only USD 360 million for the RSE, and USD 1.1 billion for the TSE. Although the Lithuanian

² See eg Nivet (1997) for the Polish case and Dockery & Vergari (1997) for the Hungarian case.

market has the largest capitalization, the vast majority of shares listed on the NSEL are traded very infrequently.

3 Data

To test for weak-form efficiency and later for possible causality between Baltic stock exchanges, I used daily stock price indices calculated by the stock exchanges themselves. At the start of this year, the TSE's TALSE index covered the 18 most traded stocks. The RSE calculates the RICI index covering 14 stocks, and the NSEL's LITIN-A Index currently covers 58 issues. I used daily data for the period from the start of February 1997 to 14 August 1998. In addition to the Baltic stock indices, I used the stock indices from Finland (HEX general index), Russia (Moscow Times rouble-based index, MT-RUR), and the United States (Dow Jones Indus-

trial Average, DJIA) to test for possible Granger causality from these markets to the three Baltic stock exchanges. Chart 1 shows the time paths of the three Baltic stock indices. One can discern that the TSE's TALSE index, in particular, rose during the first half of 1997 and then slumped in November 1997. The RSE's RICI index also rose during the first half 1997, albeit to a much lesser extent than the TALSE. On the other hand, the LITIN-A has been declining quite steadily over the whole period studied. Chart 2 shows the daily price movements in the three indices, calculated as log-differences. Note first that the price changes are quite large (table 1) and that one can discern periods of very large price movements. The first such period for the TALSE and the RICI is in October - November 1997 and the second in May - June 1998. For the NSEL, the timing of these disturbances seems to be somewhat different. The LITIN-A index seems to reflect rather large disturbances in May 1997 and November 1997.

Chart 1 **Baltic stock indices, 3 Feb 1997 – 14 Aug 1998**

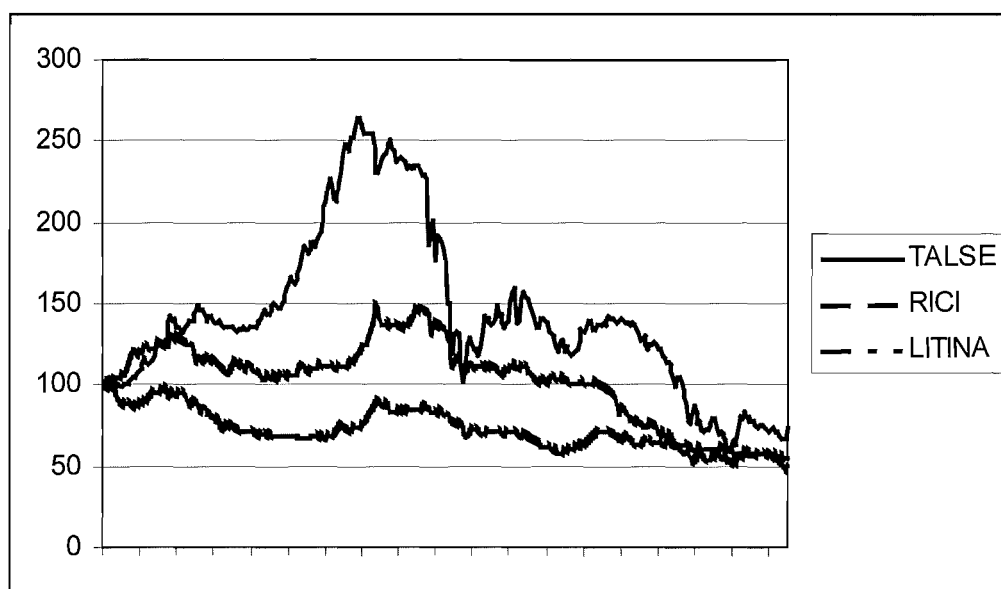
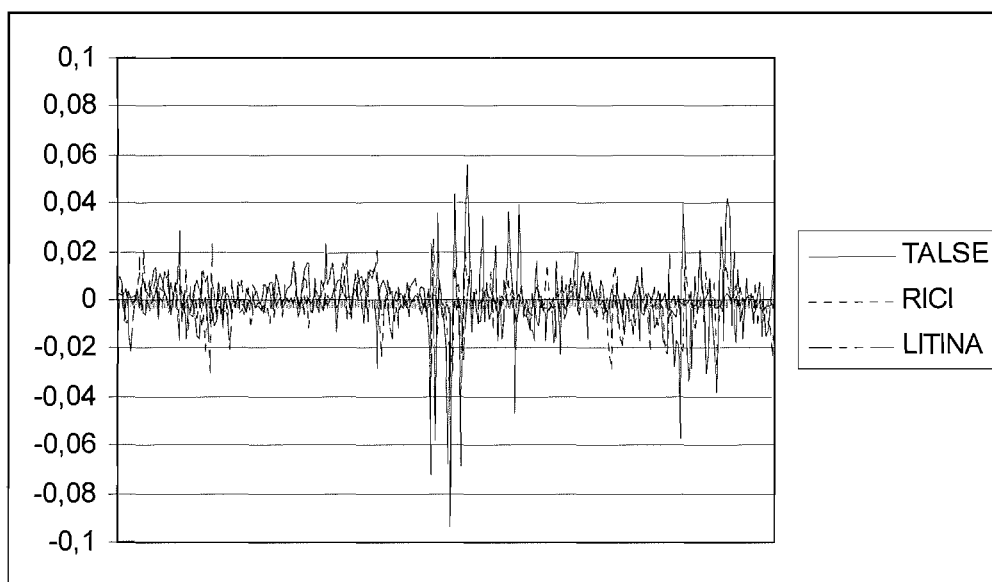


Chart 2 Daily returns on Baltic stock indices, 4 Feb 1997 – 14 Aug 1998



4 Results concerning weak-form efficiency

Weak-form efficiency of a given market is usually tested by regressing return in period t on returns from past periods. If the coefficients of past returns are statistically significant in explaining the present return, the hypothesis of weak-form efficiency is rejected. In broad terms, this is also the approach taken here. However, when daily returns were regressed on lagged returns, it became evident that the residuals exhibited heteroscedasticity.³ The results suggest the need to carry out the estimation using some type of ARCH (autoregressive conditional heteroscedasticity) model in order to take into account the evident tendency of large (in absolute value) observations to cluster together. If this is not taken into account, the estimated parameter

values could be biased. We also tried to include an ARCH effect in the mean of the variable, ie estimate an ARCH-M model. But because the coefficient of the ARCH-M effect was not statistically significant, only the results from the simple ARCH model are reported.

Table 1 Statistical properties of stock index returns

	TALSE	RICI	LITIN-A
Mean	-0.000891	-0.002126	-0.00176
Standard deviation	0.036363	0.019699	0.014446
Skewness	-1.219515	-0.880904	-0.996566
Excess kurtosis	7.259472	3.427679	4.884019
Normality $\text{Chi}^2(2)$	107.24***	49.468***	73.303***

*** indicates rejection of normality at 1% confidence level

³ To save space, the results are not reported here, but they are available from the author upon request.

Thus the equations to be estimated are

$$r_t = \alpha + \sum_{i=1}^n \beta_i r_{t-i} + \varepsilon_t$$

$$h_t = \delta + \sum_{i=1}^p \eta_i \varepsilon_{t-i}^2$$

Here r_t is the log-difference of the stock price index in question, and the residual, ε_t , has conditional variance h_t . The estimations were done using the RATS 4.30 econometric package. In practice, the estimations were started with six lags, which were then dropped one at a time until only the statistically significant lags were left.

The resulting models are reported in table 2. One can see that the hypothesis of weak-form efficiency is clearly rejected in all three cases. Past returns have been statistically significant in forecasting present returns. Moreover, it seems clear that ARCH effects are present in the data. The failure of weak-form efficiency is quite common for the stock exchanges of transition economies. The hypothesis is also more or less rejected for Poland in Nivet (1997) and Hungary in Dockery (1997) whereas it receives cautious support for Russia in Hall et al (1998), but only after several years of trading.

Table 2 **Estimated models**

	α	β_1	β_2	β_3	β_4	δ	η_1	η_2	η_3
TALSE	0.00099 (0.7092)	0.36003 (4.0145)	-0.0158 (-0.3063)	-0.0188 (-0.4786)	-0.1163 (-2.8409)	0.00024 (7.0945)	0.6638 (7.0740)	0.2969 (3.2153)	0.1350 (2.3821)
RICI	0.00022 (0.3038)	0.14077 (3.0306)	0.06443 (1.6836)	0.09393 (2.5207)	-	0.00014 (9.4047)	0.82172 (7.5255)	-	-
LITIN-A	-0.00009 (-1.3407)	0.3381 (5.7598)	-	-	-	0.000008 (8.52653)	0.4233 (5.1677)	0.1995 (2.8720)	-

t-values in parentheses

5 Bivariate Granger causality tests

The next test should help determine whether stock exchanges outside the three Baltic countries can be said to have an influence on the stock prices there. The Baltic stock exchanges, and indeed the economies as a whole, are very small and hence a priori would seem likely to be subject to foreign influences. In this connection, I tested to see whether the indices of the Helsinki, Moscow, and New York stock exchanges can be said to Granger-cause stock indices in the Baltic countries. In addition, I tested for Granger causality among the Baltic exchanges. In a bivariate setting, the variable y_t is said to Granger-cause (see Granger 1969) another variable x_t if, for the simple regression

$$x_t = \alpha + \sum_{i=1}^p \beta_i x_{t-i} + \sum_{i=1}^p \delta_i y_{t-i}$$

the F-test of the hypothesis that $\delta_1 = \dots = \delta_p = 0$ results in rejection. Table 3 reports the results of the bivariate Granger causality tests. One notes that there exists some feedback between the TALSE and the RICI, ie they Granger-cause each other. Moreover, the two indices seem to Granger-cause the LITIN-A. Outside the Baltic countries, only the US market seems to have a significant effect, ie the DJIA Granger-causes all three Baltic indices. The stock indices of two nearby exchanges, Moscow and Helsinki, have no effect. The fact that the US market seems to influence also the Baltic bourses is hardly surprising, given the relative importance of the US capital market. It is perhaps somewhat surprising that Moscow and Helsinki appear to have no influence, given the extensive trade and investment links that both Finland and Russia have with the Baltic countries.

Table 3 **Bivariate Granger causality tests**
F-test probability levels (p) with different lags

Endogenous variable	Exogenous variable	1 lag	2 lags	3 lags
TALSE	RICI	0.0011***	0.0054***	0.0065***
TALSE	LITIN-A	0.1718	0.5875	0.7793
TALSE	MT-RUR	0.2671	0.4540	0.4039
TALSE	HEX	0.8905	0.7905	0.8919
TALSE	DJIA	0.0021***	0.0021***	0.0047***
RICI	TALSE	0.0000***	0.0000***	0.0000***
RICI	LITIN-A	0.7899	0.3320	0.4881
RICI	MT-RUR	0.0071***	0.0218**	0.0251**
RICI	HEX	0.1052	0.2719	0.2659
RICI	DJIA	0.6686	0.8878	0.9095
LITIN-A	TALSE	0.0002***	0.0005***	0.0006***
LITIN-A	RICI	0.0000***	0.0000***	0.0001***
LITIN-A	MT-RUR	0.1582	0.3423	0.5491
LITIN-A	HEX	0.4979	0.6689	0.7696
LITIN-A	DJIA	0.0328**	0.0728*	0.1622

* denotes significance at 10% level, ** at 5%, and *** at 1%

6 Concluding remarks

We have seen that the stock price indices in the three small Baltic stock exchanges are not even weak-form efficient, ie past returns do predict future returns, even after taking into account the effects of conditional heteroscedasticity. The Baltic exchanges are still very small, and trading there is quite thin. If some shares are traded very infrequently, then their seldom-changing prices will affect the index. This could be the main reason for the failure of weak-form efficiency. However, one cannot argue that investors could consistently benefit from the failure of weak-form efficiency, as transaction costs might make such trading strategies unattractive. A natural next step would be to test for informational efficiency of individual stocks. Information disclosure requirements have been tightened in all the Baltic countries, and it would be of

interest to see whether the prices of individual stocks are even weak-form efficient.

In this study, evidence was found that, within the Baltic countries, the stock exchanges of Tallinn and Riga influence each other as well as the Lithuanian stock exchange. However, the NSEL did not Granger-cause price changes in other Baltic exchanges. From outside the Baltics, only the US stock market seems to influence the Baltic stock exchanges, although it is interesting to note that it does not Granger-cause the RICI index.

This paper reports on the first study on informational efficiency in the Baltic stock markets. Because the stock exchanges are so young, only a short time-span of data is available. When more data becomes available, it would be of interest to study whether the efficiency has changed over time. This is left for further research.

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