POSITIVE FEEDBACK TRADING AND RETURN AUTOCORRELATION IN THE TRANSITION MARKETS: CASE OF CEE COUNTRIES AND SELECTED CIS ECONOMIES

by

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Abstract

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This thesis investigates the behaviour of stock markets in transition economies. The analysis is carried out in the context of Shiller-Sentana-Wadhwani framework with two kinds of traders in the market, rational (smart-money) ones and technical (feedback traders) ones. We model the conditional volatility using EGARCH and TGARCH models. Our findings provide strong evidence of positive feedback trading in the stock markets of Hungary, Lithuania, Estonia, Slovenia, Bulgaria, Romania, Poland, and Russia. We don't find sufficient evidence for the presence of such traders in Latvia, Czech Republic, Slovakia, and Ukraine, and we argue that this absence of feedback traders can be explained by relative small size of stock markets and low liquidity of assets.

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GLOSSARY

Efficient Market Hypothesis (EMH). Efficient market is a market which reflects all available information. Thus, the changes in prices in the stock market are unforcastable.

Feedback traders. A type of stock market investors who form their demand based on the analysis of the historical values of indexes prices.

'Smart money' traders. A type of stock market investors with rational expectations: they base their asset decisions on market fundamentals setting prices exactly equal to them.

Chapter 1

INTRODUCTION

In recent years, there has been increasing interest in the financial markets of transition countries. This interest comes from the fact that these economies have faster economic growth than developed countries, and, thus, are expected to provide higher stock returns. Moreover, since the financial markets of the transition countries have low correlation with the markets of the developed economies, the investors can benefit from the diversification of their risks.

The most interesting question is whether prices accommodate new information accurately and fast, and this question could be related to the Efficient Market Hypothesis (EMH). If the EMH holds, the stock prices quickly reflect all available information. Here, we are interested in a weak form of EMH which claims that the current price of a stock reflects its own past prices. It implies that looking for particular behavior of prices in order to find misevaluated stocks doesn't work. However, there is a huge number of investors, who ground their decisions on the expectations of the trends in past stock prices.

In the modern finance literature, the predictability of stock returns is an essential topic of research. Most authors investigate the behavior of two types of trading in the market: fundamental (based on macroeconomic and other indicators that impact on income flow of securities) and technical (based on historical data of indexes' values). We can say that market is liquid and efficient if the trading is based on fundamental indicators. This type of trading is done by so called "rational investors" ("smart money"). They base their expectations on factors such as dividends, macroeconomic growth, unemployment, etc. Their purpose is to buy stocks that are undervalued, and sell the stocks that are overvalued from their market fundamental value. Those investors, who are looking for the trends in past stock prices, are called "feedback traders". If traders have the strategy of buying (selling) the stocks during increase (decrease) in their prices, they are positive feedback traders. The behavior of this type of investors causes the autocorrelation of the stock returns, and stock prices exceed their fundamental levels (DeLong et al., 1990, Shiller, 1984, Sentana and Wadhwani, 1992). This may result in the destabilization of stock prices. If traders have the strategy of buying (selling) the stocks during decrease (increase) in their prices, they are called the negative feedback traders.

There are studies that show the evidence of positive feedback trading in the developed and emerging stock markets (Sentana and Wadhwani, 1992, Koutmos, 1997, Koutmos and Saidi, 2001, Bohl and Reitz, 2002, Bohl and Siklos, 2004). I complement these studies by investigation of the problem of positive feedback trading in the transition economies, such as the economies of ten CEE countries together with Russia and Ukraine, using daily data of the stock market indexes over the 1994 – 2005 periods. The theoretical aspect is based upon the feedback trading model, developed by Shiller (1984), and Sentana and Wadhwani (1992). The methodology is grounded on Nelson's exponential GARCH model.

Nikulyak (2002) finds evidence of presence of positive feedback trading strategy in the Ukrainian stock market. However, in those years Ukraine didn't have the continuous trading process as it has now. Since the trade was done once a day, the speed of adjustment was very slow and prices were very volatile. Thus, I suppose that now the situation has changed. Other countries are subject of investigation because it is interesting to compare the trading behavior of all these economies during the same time period. The stock market indexes are the PX50 for Czech Republic, the BUX for Hungary, the SOFIX for Bulgaria, the BET-C for Romania, the SAX for Slovakia, the SBI20 for Slovenia, the WIG for Poland, the VILSE for Lithuania, the RIGSE for Latvia, the TALSE for Estonia, the RTS for Russia, and PFTS for Ukraine.

For Czech Republic, Hungary, Poland, and Russia the investigation of feedback trading was done in 2004 (data sample ends up at 2003) by Bohl and Siklos. However, these authors used another GARCH approach (TGARCH in particular), and their results for Poland and Russia don't fully support the theory.

There is no evidence of positive feedback trading for the stock markets of the Baltic countries (Estonia, Latvia, and Lithuania), Romania, and Bulgaria. The question about the presence of feedback trading is not investigated for Slovenia and Slovakia, but the volatility of stock returns in these countries is modeled by Kasch-Haroutounian and Price in 2001.

The rest of the paper is organized as follows. The second chapter gives short overview of the existing literature related to the problem of positive feedback trading and volatility of stock returns. Chapter 3 explores the theoretical framework of the topic. The methodology is introduced in the Chapter 4. Chapter 5 contains data description. The sixth chapter presents and discusses the empirical findings. Finally, Chapter 7 summarizes and concludes the paper.

Chapter 2

LITERATURE REVIEW

The question about the presence of positive feedback trading has long been investigated among economists. Taking into account the complexity of the problem, the literature review formally can be split into two different parts. The first part describes the studies related to the behavior of trading agents in the stock market; while the rest of the literature review is devoted to the description of the empirical research, concerning modeling of financial time series by modeling volatility of stock returns.

2.1 Trading Behaviour

There is a large quantity of papers dedicated to models of stock price determination. These papers are based on the assumption about the existence of heterogenous agents on the market. As was mentioned above, investors could be divided into two types: rational or smart money traders, and technical or feedback traders.

The fundamental paper about the behaviour of smart money investors is written by Shiller (1984). This paper mainly concerns the impact of social psychology in financial markets on stock prices. The author divides the traders in the market into two groups: smart money and ordinary traders. Smart money investors are supposed to behave rationally (subject to their wealth limitation), given the expected returns. Ordinary investors are those who don't take into account the optimally forecasted expected returns. In general, they follow fads and are unpredictable in their behaviour. Real stock prices in his model equal to the present value, discounted at the rate "risk-free rate of return + risk premium", of the expected future dividend payments, and the product of risk premium and the expected future demand by ordinary investors. The prices on the stock market are determined by ordinary investors when the risk premium goes to infinity, and by smart money investors, when the risk premium goes to zero. In his paper Shiller pays little attention on the volatility of returns. Moreover, he makes an assumption that stock prices in the long-run surely come to their fundamental values. However, they may not. Using the data on the U.S. stock market index, the author provides the evidence of overreaction of stock prices to the new information about the dividends.

Positive feedback trading strategies may be completely rational in the case when preferences have a level of risk aversion which decreases with wealth increase (Black, 1988). Buyers of portfolio insurance might exhibit such a strategy because as their wealth declines, their readiness to take a risk decreases also. Thus, when the values of shares decrease exogenously, this leads to the higher decrease in the amount of risky shares demanded.

Unlike Shiller's "ordinary investors" which follow fads and fashions, model about feedback trading behaviour assumes traders make up their demand using historical data on indexes prices. One of the most prominent papers about the development of the model of feedback trading in the CAPM framework was written by Sentana and Wadhwani (1992). Their model describes the behaviour of feedback traders and rational investors, which provide the reasons for correlation in stock returns. This model also gives the arguments for the central role of volatility for stock return autocorrelation. The authors provide the evidence about the presence of positive feedback traders on the U.S stock market, using daily data on stock market indexes on the period since 19^{th} century. These positive feedback trading strategies induce negative autocorrelation in stock returns. For measurement of the volatility Sentana and Wadhwani use the Exponential GARCH model.

There is the variety of studies related to the investigation of positive feedback trading and stock return autocorrelation on the stock markets of different countries. In general, recent papers follow Shiller-Sentana-Wadhwani model. According to Koutmos (1997), the positive feedback trading causes negative autocorrelation in returns on stock market indexes. The author investigates six developed countries (Australia, Belgium, Germany, Italy, Japan, UK), using daily data on stock market indexes. The results, provided by Koutmos are similar to ones obtained by Sentana and Wadhwani for US stock market. There is strong evidence about the presence of positive feedback trading in all six markets. However, in contrast to Sentana and Wadhwani, Koutmos uses symmetric GARCH methodology for modeling volatility in his paper, not allowing the conditional volatility to respond asymmetrically to positive and negative news.

The evidence of positive feedback trading in six emerging stock markets is provided by Koutmos and Saidi (2001). These emerging Asian stock markets are Hong Kong, Malaysia, Philippines, Singapore, Taiwan, and Thailand. The conditional variance of the returns is modeled using Threshold GARCH process, and provides the arguments that the negative innovations influence on volatility more than positive ones (leverage effect).

Bohl and Reitz (2002) contribute to the literature by finding out the patterns of return autocorrelation in German stock market. The data on three German stock indexes is investigated (C-Dax, Dax, and Nemax50), giving the similar outcomes. The authors apply Exponential GARCH model for measurement of the conditional volatility. Their findings show the strong evidence of the existence of leverage effect in the market.

Following Bohl and Siklos (2004), there is empirical evidence on presence of feedback trading in mature and emerging stock markets; in particular

Germany, UK, US, Czech Republic, Hungary, Poland, and Russia. The stock return volatility is described through the Threshold, Exponential, and Power GARCH models. The results, consistent with the previous research, were obtained. The asymmetry coefficients are significant in all these markets but Russia. Thus, the effect of positive and negative innovation on volatility is different.

The evidence of positive feedback trading in Ukrainian stock market was obtained by Nikulyak (2002). In this research he uses the data on the non-continuously compounded indexes (trade was done ones a day), and this may be the reason of slow adjustment to new information in the market.

Different patterns of stock return autocorrelation are widely discussed in the financial literature. One of them is non-synchronous trading. According to Cohen, Hawawani, Maier, Schwartz, Whitcomb (1980), and Lo and MacKinlay (1990) the spurious autocorrelation in stock returns may be due to infrequent trading of stocks which are included in the index. But this autocorrelation does not mean the predictability of the returns. However, stock returns could be predictable when the autocorrelation is a result of changes in risk factors, or risk premiums (Fama and French, 1988, Conrad and Kaul, 1988). But later empirical researches show little evidences that autocorrelation comes from time-varying risk premiums (McQueen, Pinegar, and Thorley, 1996, and Ogden, 1997).

Mech (1993) points out that transaction costs could be a cause of positive autocorrelation in stock returns. Costs of obtaining new information are high, thus, delaying the delivery of information into stock prices. Since index contains many stocks, and some of them react on news quickly while others may not, this results in positive autocorrelation of index returns. However, posterior empirical paper written by Boudoukh, Richardson, and Whitelaw (1994) provides the evidence that the degree of daily aggregate return autocorrelation is too large to be completely explained by transaction costs and non-synchronous trading hypothesis.

Stock return autocorrelation is related inversely to trading volume (Campbell, Grossman, Wang, 1993), and trading volume, in turn, is positively correlated with volatility (Schwert, 1989).

2.2 Modelling Conditional Volatility

The Autoregressive Conditional Heteroskedasticity model was proposed by Engle (1982). Some years later, Bollersev (1986) extended this model to Generalized ARCH model (GARCH). The main difference between these models is in the following. The conditional variance in the GARCH model is explained not only by past squared residuals, but also by past value of the conditional variance. Both (ARCH and GARCH) methodologies were used for modelling financial time series.

The comparison of ARCH and GARCH models is done by Pagan and Schwert (1990). They provided strong arguments in favour of GARCH model, and concluded that this model serves better for modelling conditional volatility of financial time series.

The idea of Black (1976) about the leverage effect brings up the question of provision of asymmetry in the volatility equation. Nelson (1991) proposes Exponential GARCH model, which allows for non-linearity and asymmetry in the conditional variance equation. Later, in the nineties, many different asymmetric GARCH models were developed. Since not all of them are used in this research, just brief overview of these models is provided. Zakoian (1994) developed the Threshold GARCH (TGARCH) model and applied it for modelling volatility of French stock returns. Glosten, Jagannathan, and Runkle

(1993) proposed GJR-GARCH process; Sentana (1995) introduced Quadratic GARCH (QGARCH) model, and Fornari and Mele (1997) – Volatility Switching GARCH (VS-GARCH).

Which asymmetric model to choose is a moot point because the existing literature provides opposite evidences. In particular, Fornari and Mele (1997) empirically estimate volatility of stock market indexes of US, France, Japan, and Italy using GJR-GARCH and VS-GARCH processes, and conclude that Volatility Switching GARCH better states the asymmetry in these markets. In contrast to findings of Fornari and Mele (1997), Omran and Avram (2002) investigate the same countries with the same models, but indicate that GJR-GARCH methodology is better for modelling the volatility of returns in these countries.

A variety of asymmetric models is tested by Kasch-Haroutounian and Price (2001) for the stock markets of Hungary, Poland, Czech Republic, and Slovakia. They estimated seven models of time-varying volatility, and five of them provide evidence about asymmetry in the reaction of volatility on new information. The period of estimation is 1992-1998.

Egert and Koubaa (2004) investigate conditional variance of index stock returns of Canada, France, Germany, Italy, Japan, UK, US, Czech Republic, Hungary, Poland, Russia, Slovakia, and Slovenia using linear and non-linear GARCH approaches. The authors conclude that for modelling volatility of returns on developed stock markets linear type of GARCH models suits better, while volatility of returns in CEE economies could be better modelled with asymmetric models (GJR-GARCH and QGARCH).

Taking all these into account, this thesis is aspired to investigate the influence of positive feedback trading on the autocorrelation of stock returns using two types of asymmetric GARCH models (TGARCH and EGARCH). This research contributes to the existing literature by exploring the question of stock return autocorrelation in continuously trading Ukrainian stock market, stock markets of Baltic countries, Bulgaria, and Romania. Other economies are investigated for making a reasonable comparison among them for investment purposes.

Chapter 3

THEORETICAL FRAMEWORK: FEEDBACK TRADERS, AUTOCORRELATED STOCK RETURNS AND VOLATILITY

The stimuli for smoothing the expectations with optimal predictions are particularly important for the stock markets, because in these markets people who have better forecasts enrich themselves. The most interesting question is whether stock prices accommodate new information accurate and fast, and this question could be related to the Efficient Market Hypothesis (EMH). If the EMH holds, the stock prices quickly reflect all available information. Here, we are interested in a weak form of EMH which claims that the current price of a stock reflects its own past prices. It implies that looking for particular behavior of prices in order to find misevaluated stocks doesn't work. However, there are a huge number of investors who ground their decisions on the expectations of the trends in past stock prices.

Following Shiller-Sentana-Wadhwani model (Shiller, 1984, Sentana and Wadhwani, 1992), we can consider two heterogeneous groups of traders. One group is represented by rational investors, who form their demand on stock based on risk-return considerations, and this demand could be expressed by an intertemporal Capital Asset Pricing Model (CAPM). They base their expectations on factors such as dividends, macroeconomic growth, unemployment, etc. Rational investors follow the strategy of buying stocks that are undervalued, and selling the stocks that are overvalued from their market fundamental value. Their relative demand for stocks is given by

$$S_t = \frac{E_{t-1}(R_t) - \alpha}{\mu_t}, \qquad (1)$$

where S_t is the fraction of shares demanded by this group, E_{t-1} is the expectation operator, which consists all available information of period t-1, R_t is ex-post return at period t, α is the rate of return on a risk-free asset (with this return the request for shares by rational investors is zero), and μ_t is the risk premium, essential to impel the traders to have all the stocks. The risk measure is assumed to be a positive linear function of the conditional variance, σ^2_t, of returns in period t (determined at t-1), $\mu_t = \mu(\sigma^2_t)$. Hence, an increase in the expected volatility should be accompanied by an increase in the expected excess return ($E_{t-1}(R_t)-\alpha$) in order to hold the demand of rational traders the same (rational investors are assumed to be risk averse - $\mu'(\sigma^2_t)>0$). Otherwise, as expected volatility rises, fewer shares are demanded.

If the market is rational (represented by rational investors), the demand $S_t = 1$ would result in CAPM

$$\mu_t = E_{t-1}(R_t) - \alpha. \qquad (2)$$

Another group of traders is represented by feedback traders, who don't take into account market fundamentals, instead making up their demand by using historical data of indexes' values. The relative demand for stocks by feedback traders is given by

$$F_t = \gamma R_{t-1}, \qquad (3)$$

where F_t is the fraction of shares demanded by this group, R_{t-1} is the return in the previous period, and γ is the coefficient, which sign helps to distinguish between the two kinds of feedback traders. The negative feedback trading behavior ($\gamma<0$)

implies the purchase (sale) of stocks after a decrease (increase) in the prices of these stocks.

The positive feedback trading behavior ($\gamma>0$) implies the purchase (sale) of stocks after an increase (decrease) in the prices of these stocks. This trading strategy could incorporate so called "stop-loss orders" (selling of assets after a certain amount of damages) and portfolio insurance (in a rising (falling) market higher (lower) proportion of wealth should be in stocks).

In the equilibrium all shares of the market portfolio must be held

$$S_t + F_t = 1. \tag{4}$$

Thus, $\dfrac{E_{t-1}(R_t) - \alpha}{\mu_t} + \gamma R_{t-1} = 1$

If we assume rational expectations, then $R_t = E_{t-1}(R_t) + \varepsilon_t$, and, after rearrangement,

$$R_t = \alpha + \mu(\sigma_t^2) - \gamma\mu(\sigma_t^2)R_{t-1} + \varepsilon_t . \tag{5}$$

It can be seen that, in the presence of feedback traders ($\gamma \neq 0$), current return depends on past return. This means that stock returns exhibit autocorrelation of order one. Moreover, the sign of the parameter γ indicates the type of autocorrelation. The presence of negative feedback trading ($\gamma<0$) implies positively correlated stock returns. The positive feedback trading behavior ($\gamma>0$) results in negatively correlated stock returns.

After rearranging Equation (5), we get something comparable to the CAPM (2) equation:

$$E_{t-1}(R_t) - \alpha = \mu(\sigma_t^2) - \gamma\mu(\sigma_t^2)R_{t-1}$$

This, in contrast to CAPM, contains a term $(-\gamma\mu(\sigma_t^2)R_{t-1})$. Hence, the returns exhibit autocorrelation, which varies with volatility. Stock returns have larger autocorrelation when expected volatility increases. In such a case, rational traders need higher expected returns, thus, permitting a larger swerving of the price from its fundamental value. This means that stock prices inconsequences are larger when volatility is high.

Since $\mu(\sigma_t^2)$ is a linear function on volatility (by assumption, $\mu(\sigma_t^2) = \beta_1 + \beta_2\sigma_t^2$), the equation (5) can be written as

$$R_t = \alpha_0 + \alpha_1\sigma_t^2 - (\gamma_0 + \gamma_1\sigma_t^2)R_{t-1} + \varepsilon_t, \qquad (6)$$

where γ_0 is negative feedback trading ($\gamma_0<0$), and γ_1 is positive feedback trading ($\gamma_1>0$). From the equation above it can be seen that at low levels of volatility negative feedback trading dominates positive one. As risk level increases, the impact of $\gamma_1>0$ increases also (positive feedback trading dominates) and induces negative autocorrelation in stock returns (Sentana and Wadhwani, 1992).

At this point, it is essential to realize that if preferences of investors exhibit risk aversion, which decreases as wealth increases, the portfolio insurance strategy would be completely rational. Following Black (1989) and Marcus (1989), an exogenous decrease in the value of risky assets (stocks) would result in a larger decrease in the demand for shares. In addition, the less wealth investors initially have, the more portfolio insurance is needed to respond to the decrease in wealth.

Moreover, if there are observed changes in the value of stocks by equal amount but different sign, the traders respond to these variations asymmetrically. This is the result of changes in the investor's risk aversion, which increases rapidly with wealth reduction. In particular, as stock prices fall, an investor's wealth decreases and risk aversion increases. In contrast, risk aversion decreases as a result of increase in wealth due to rising stock prices. When traders become highly risk averse, more portfolio insurance is needed as the volatility rises, and this results in more positive feedback trading. Thus, high risk aversion leads to more positive feedback trading (and as a consequence, to negative autocorrelation of returns) when prices decrease than when prices increase by the same amount. This situation is called the "leverage effect".

Positive autocorrelation in stock returns may result not only from negative feedback trading. Another potential explanation suggested in the finance literature is non-synchronous trading. As proposed by Lo and MacKinlay (1990), trade prices of the stocks in the index are taken non-synchronously. This means that stocks are traded during the day, but only last price before point *t* is put in the index at time *t*. However, the last trade of different stocks may happen at different points of time. As a result, the value of index is a composition of outdated and present trade prices. Since the index is composed of traded and non-traded shares, return in period *t* has information from previous periods *t-1, t-2* and so on. This may induce the positive autocorrelation in index returns.

According to Mech (1993), another explanation of the source of positive autocorrelation in stock returns are transaction costs. If the profits from trading are less than information and transaction expenses, the investors would not trade. The transference of news into the prices of shares could be postponed because of trading encumbering due to expenses of processing information and direct transaction costs. Since the index is composed of stocks that reflect new information instantly and slowly, this may induce the positive autocorrelation in index returns.

Recent empirical papers (Boudoukh, Richardson, and Whitelaw, 1994) demonstrate that the degree of daily aggregate return autocorrelation is too large to be completely explained by Mech's (1993) transaction costs model, and Lo and MacKinlay's (1990) non-synchronous trading model. This provides extra motivation for the approach taken here.

METHODOLOGY

Following Shiller (1984) and Sentana and Wadhwani (1992) we are going to estimate equation

$$R_t = \alpha_0 + \alpha_1\sigma_t^2 + (\gamma_0 + \gamma_1\sigma_t^2)R_{t-1} + \varepsilon_t, \qquad (7)$$

where R_t is the return in period t, R_{t-1} – the return in the previous period, α_0 is the rate of return on a risk-free asset (measure of return when rational investors don't hold shares), σ^2_t is a conditional variance of returns and it is based on information about its past values. The coefficient α_1 is a measure of impact of the rational investors on returns. When the expected volatility rises, rational investors influence prices negatively, and in such a case α_1 would be negative. The coefficient γ_0 is the rate of return autocorrelation from non-synchronous trading, which causes positive autocorrelation in the returns.

As was shown in chapter 3, the index return autocorrelation may change with time, depending on the dominance of positive or negative feedback trading, which is a function of stock return volatility. In the empirical finance literature, the stated feature of return volatility is the asymmetry in the conditional variance.

There are several alternative methods of modeling the conditional variance. To insert a volatility term into the mean equation I use two asymmetric GARCH models. It is interesting to investigate which one would be better in the description of the volatility of stock returns. In asymmetric GARCH models the conditional variance is determined not only by the size but also by the sign of the residuals, received from the mean equation.

The first asymmetric GARCH model is Threshold GARCH (TGARCH), introduced by Zakoian (1994). This results in equation (7) being jointly estimated with

$$\sigma_t = \omega + \beta_0 \left| \varepsilon_{t-1} \right| + \beta_1 \varepsilon_{t-1} I_{t-1} + \beta_2 \sigma_{t-1}, \qquad (8)$$

where $I_{t-1} = 1$ if $\varepsilon_{t-1}<0$, and $I_{t-1} = 0$ if $\varepsilon_{t-1} \geq 0$. The constant term ω is the long term average volatility, ε_{t-1} is the last period's innovations, σ_{t-1} is the last period's conditional volatility.

Thus, the equation (8) shows that if β_1 is statistically significant and positive, the influence of positive news, β_0, on the conditional variance is lower than the influence of negative news, $\beta_0 + \beta_1$. For the conditional variance to be positive the coefficients ω, β_0, and β_2 should be non-negative. To secure the covariance stationarity of the conditional variance the following must hold

$$\frac{\beta_0 + \beta_1}{2} + \beta_2 \prec 1 \cdot$$

Another asymmetric GARCH model is the Exponential GARCH (EGARCH), proposed by Nelson (1991), which is grounded on the log-transformed conditional variance. This results in equation (7) being jointly estimated with

$$\ln(\sigma_t^2) = \omega + \beta_0 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \beta_1 \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right) + \beta_2 \ln(\sigma_{t-1}^2) \qquad (9),$$

where $|\varepsilon_{t-1}/\sigma_{t-1}|$ is the absolute value of innovations. Stationarity is ensured by $\beta_2 < 1$.

This model allows for a leverage effect. Asymmetry is denoted by statistical significance of β_1, which negative sign implies that volatility increases more when there is bad news. In compliance with the leverage effect the reduction in the stock prices raises the debt to equity ratio. In this situation investors want to have higher returns, and the stock return volatility increases.

Equation (7) is a mean equation and equations (8) and (9) are the variance equations. Equations (7) and (8) (as well as (7) and (9)) are estimated jointly employing an iteration process in order to maximize the log-likelihood function. The initial values for the garch (σ_{t-1}^2) parameter in the mean equation are obtained using OLS method, and proxing it for garch.

Daily returns on national indexes are computed as following

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right),$$

where P_t is the index price.

Chapter 5

DATA DESCRIPTION

The time series used for empirical investigation consist of daily data of the main indexes of ten Central and Eastern European countries together with Russia and Ukraine. In order to avoid the problem of non-synchronous trading in the markets, the indexes which are chosen for the analysis contain the most heavily traded stocks.

All the data on indexes' values comes from the Internet sites of countries' stock exchanges. The following table provides the information about the indexes and countries.[1]

Table 2. Indexes by countries

Country	Index Name
Czech Republic	PX50
Hungary	BUX
Bulgaria	SOFIX
Romania	BET-C
Slovakia	SAX
Slovenia	SBI20
Poland	WIG
Lithuania	VILSE
Latvia	RIGSE
Estonia	TALSE
Russia	RTS
Ukraine	PFTS

[1] Czech Republic - www.pse.cz, Hungary – www.fornax.hu, Bulgaria, Romania – www.karoll.net, Slovakia – www.bsse.sk, Slovenia – www.ljse.si, Poland – www.wse.com.pl, Lithuania – www.omxgroup.com/vilnus, Latvia – www.omxgroup.com/riga, Estonia – www.omxgroup.com/tallinn, Russia – www.rtsnet.ru, Ukraine – www.pfts.com

Daily returns on national indexes are computed as following

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right),$$

where P_t is the index price.

Table 2 and Table 3 provide a general overview of the data and the descriptive statistics for the return series.

Table 2. Data overview and descriptive statistics for the return series of the economies of Central Europe

	Czech Republic (PX50)	Hungary (BUX)	Slovakia (SAX)	Bulgaria (SOFIX)	Romania (BET-C)	Slovenia (SBI20)
Period	14.09.1993-21.03.2005	03.01.1991-28.02.2005	03.07.1995-28.04.2005	23.10.2000-28.04.2005	16.04.1998-29.04.2005	11.01.1993-15.03.2005
N.of obser	2728	3543	2381	1121	1756	3053
Mean	0.000441	0.000822	0.000411	0.001826	0.000633	0.00066
SD	0.014086	0.016387	0.013961	0.021746	0.015409	0.013385
Max	0.153905	0.136157	0.095738	0.210733	0.117695	0.18933
Min	-0.07566	-0.18033	-0.114839	-0.208995	-0.211692	-0.11613
Skew	1.272568	-0.87006	-0.416001	-0.429552	-1.390129	0.428263
Kurt	17.08739	17.9663	9.192408	29.60316	29.77783	26.59255
Jarque-Bera	23293.97	33513.56	3872.909	33091.27	53029.88	70898.56
(prob)	0.00000	0.00000	0.00000	0.00000	0.000000	0.00000

Table 3. Data overview and descriptive statistics for the return series of the economies of Baltic countries, Poland, Russia, and Ukraine

	Lithuania (VILSE)	Latvia (RIGSE)	Estonia (TALSE)	Russia (RTS)	Poland (WIG)	Ukraine (PFTS)
Period	02.01.2000-04.04.2005	02.01.2000-04.04.2005	02.01.2000-04.04.2005	01.09.1995-05.03.2005	03.01.1994-29.04.2005	03.11.1997-05.03.2005
N.of obser	1861	1862	1863	2375	2794	1810
Mean	0.000661	0.00082	0.00085	0.000827	0.000244	0.000665
SD	0.007426	0.014644	0.009637	0.029797	0.020206	0.042352
Max	0.045801	0.094609	0.120197	0.155569	0.154261	0.965877
Min	-0.10216	-0.14705	-0.058741	-0.211025	-0.158723	-0.96309
Skew	-1.06221	-1.39849	1.288929	-0.355365	-0.346728	-0.23249
Kurt	26.82981	29.86609	22.30338	8.249314	10.71759	304.4874
Jarque-Bera	44382.75	56605.56	29440.52	2776.813	6989.904	6854988
(prob)	0.00000	0.00000	0.00000	0.00000	0.000000	0.00000

The first feature is that the mean of daily returns is higher in Bulgaria, Hungary, Latvia, Estonia, and Russia, and in the most cases these markets have higher standard deviation. This can be explained as the higher risk associated with higher returns. The only exception is Ukraine, which has relatively moderate mean of returns together with the highest standard deviation among these countries. This may be due to the fact that Ukraine has high risks (economical, political, etc.). In addition, it has highest maximum and lowest minimum values, which could be explained by low liquidity of the Ukrainian stock market.

The skewness and kurtosis measures are highly significant meaning that none of the series is normally distributed. The kurtosis of all the series is much higher than three, so the distribution is peaked (leptokurtic) in comparison with normal. The most of the series have negative skewness, which implies that the distribution has a long left tail. As a result, the Jarque-Bera test rejects the null hypothesis of normality.

Then unit root tests were applied to all return series. In all cases the null hypothesis about non-stationarity is rejected.

Table 4. Unit root test for return series

	ADF in levels	1% Crit. Value*
PX50	-20.55597	-3.4358
BUX	-26.03401	-3.4353
SBI20	-22.32937	-3.4356
SAX	-20.75074	-3.4361
SOFIX	-15.58350	-3.4390
BET-C	-17.15243	-3.4370
WIG	-22.27496	-3.4358
VILSE	-17.22759	-3.4368
RIGSE	-15.31518	-3.4368
TALSE	-17.99569	-3.4368
RTS	-20.88868	-3.4361
PFTS	-20.47094	-3.4369

EMPIRICAL RESULTS

The results obtained by estimating equations (7), (8), and (9) are reported in the Table 5 and Table 6 for mean equation, and in the Table 7 and Table 8 for the variance equation. Table 5 and Table 6 contain main coefficients which provide the information about presence of feedback traders in the market (γ_0 and γ_1).

Table 5. EGARCH model for mean equation

	EGARCH		
	α_0	γ_0	γ_1
Hungary (BUX)	0.0000395	0.19093*	-57.72545**
Lithuania (VILSE)	-0.002333*	0.198519*	-2084.134***
Estonia (TALSE)	0.000729	0.249929*	-1009.77**
Latvia (RIGSE)	0.00082*	-0.073431*	82.71067*
Slovenia (SBI20)	0.000191***	0.324335*	-101.9779*
Slovakia (SAX)	-0.00117**	-0.07383	126.7108
Bulgaria (SOFIX)	0.001258*	0.145334*	-56.90089*
Romania (BET-C)	0.000640**	0.198190*	-27.58144
Czech (PX50)	0.000484***	0.198263	110.6328**
Poland (WIG)	0.000584	0.194012*	-60.31625**
Ukraine (PFTS)	0.003855*	-0.207837*	25.08503*
Russia (RTS)	0.002182*	0.190214*	-43.09234*

* 1% level of significance, ** 5% level of significance, *** 10% level of significance

Table 6. TGARCH model for mean equation

	TGARCH		
	α_0	γ_0	γ_1
Hungary (BUX)	0.00006490	0.187093*	-69.96236**
Lithuania (VILSE)	-0.001066*	0.148782*	-69.04228
Estonia (TALSE)	-0.000924	0.186041*	-256.8945***
Latvia (RIGSE)	0.000818*	-0.059443***	37.99896
Slovenia (SBI20)	0.00019	0.32301*	-108.5364*
Slovakia (SAX)	-0.000495	-0.033142	55.45599
Bulgaria (SOFIX)	0.001855*	0.108959*	-45.76966**
Romania (BET-C)	0.000546***	0.213917*	-47.98062
Czech (PX50)	0.000267	0.206865*	102.2779
Poland (WIG)	0.000677***	0.190665*	-57.17581**
Ukraine (PFTS)	0.002305	-0.186706*	-0.059083
Russia (RTS)	0.001745*	0.207813*	-43.57617**

* 1% level of significance, ** 5% level of significance, *** 10% level of significance

The coefficient α_0 is positive and statistically significant in most cases estimated using EGARCH, and implies that the investors may obtain positive returns without investment in stocks, but investment in risk-free bonds. The estimations of α_0 using TGARCH are insignificant in half of the cases; however, mostly, they are positive.

In the Appendix A the estimation of the volatility return coefficient (α_1) is provided. This GARCH effect coefficient is insignificant for the most part of countries (Latvia, Slovenia, Bulgaria, Romania, Poland, Czech Republic, Ukraine, and Russia), and this outcome agrees with findings for the US stock market (Nelson, 1991). This means that, on the whole, rational traders don't essentially influence prices when the volatility changes. Positive and significant α_1 coefficient in Hungary, Lithuania, Estonia, and Slovakia implies that investors are compensated by greater returns for taking higher risks.

In this thesis the coefficients of interest are ones, which govern the autocorrelation of returns: γ_0 and γ_1. The constant component of the autocorrelation, γ_0, is statistically significant in the most part of markets (except Slovakia under EGARCH and TGARCH methodology), possibly because of non-synchronous trading. At high frequency of data, this trading can cause positive autocorrelation in returns. On the other hand, negative autocorrelation in returns can arise due to positive feedback trading, which increases with the increase in volatility. For eight out of twelve indexes the Exponential GARCH model gives negative and statistically significant γ_1 coefficient. These countries are Hungary, Lithuania, Estonia, Slovenia, Bulgaria, Romania, Poland, and Russia. The TGARCH estimation provides less well-defined evidences about the presence of positive feedback trading. Strong evidences of such type of trading are found out in six markets (Hungary, Estonia, Slovenia, Bulgaria, Poland, and Russia). Hence, positive feedback trading is an important reason of short-term movements in these economies. These results of estimations are consistent with the theory, which says that as return volatility increases, the feedback traders follow positive feedback trading strategy, and the autocorrelation of returns becomes negative. These findings are in accordance with the results of Sentana and Wadhwani (1992) for the US stock market, and Koutmos (1997) for other developed European countries.

Moreover, the model for these countries consists of only one lag (more lags, included in the model, are insignificant), which means that markets react on news fast.

Since positive feedback trading is present in the most part of stock markets, and stock markets are interdependent, we can say that countries have similar movements of stock returns. Positive feedback traders cause negative autocorrelation in returns, and as a result, higher predictability of returns. But this predictability will not result in arbitrage opportunities for smart money investors because volatility also increases. Moreover, increasing impact of feedback traders on stock prices during high volatility periods implies that the scope of mispricing increases during these periods.

Table 7 and Table 8 contain main coefficients which describe the conditional variance process (β_0, β_1, and β_2) for EGARCH and TGARCH models. The estimation results for all coefficients of the variance equation are given in Appendix B.

Table 7. EGARCH model for the variance equation

	EGARCH		
	β_0	β_1	β_2
Hungary (BUX)	0.357799*	-0.03458*	0.934826*
Lithuania (VILSE)	0.303759*	0.026103	0.134478***
Estonia (TALSE)	0.120889*	-0.012170*	0.977109*
Latvia (RIGSE)	0.285533*	0.021702*	0.969271*
Slovenia (SBI20)	0.388442*	-0.004074	0.977850*
Slovakia (SAX)	0.202106*	0.019638**	0.920678*
Bulgaria (SOFIX)	0.294194*	0.015452	0.985430*
Romania (BET-C)	0.392035*	-0.034605**	0.940643*
Czech (PX50)	0.268939*	-0.009447	0.962597*
Poland (WIG)	0.26462*	-0.040702*	0.963437*
Ukraine (PFTS)	0.998765*	-0.327990*	0.116669*
Russia (RTS)	0.363720*	-0.021149**	0.948274*

* 1% level of significance, ** 5% level of significance, *** 10% level of significance

Table 8. TGARCH model for the variance equation

	TGARCH		
	β_0	β_1	β_2
Hungary (BUX)	0.181457*	0.04734*	0.771039*
Lithuania (VILSE)	0.184618*	-0.018026	-0.17743*
Estonia (TALSE)	0.241324*	-0.097467*	0.055521
Latvia (RIGSE)	0.146045*	-0.027601*	0.848204*
Slovenia (SBI20)	0.231944*	0.000505	0.806464*
Slovakia (SAX)	0.085939*	-0.025117*	0.887368*
Bulgaria (SOFIX)	0.125944*	-0.022928	0.902288*
Romania (BET-C)	0.251764*	0.105334*	0.685121*
Czech (PX50)	0.132394*	0.019636	0.845322*
Poland (WIG)	0.100723*	0.059297*	0.849413*
Ukraine (PFTS)	0.074355*	-0.127639*	0.588005*
Russia (RTS)	0.17374*	0.031453***	0.797906*

* 1% level of significance, ** 5% level of significance, *** 10% level of significance

The coefficients of conditional variance equation are statistically significant for almost all indexes. This means that current volatility depends on last period's squared innovation and last period's volatility (this conditional variance is updated to the new information, and the impact of last period innovation is given by β_1). In particular, the coefficient β_1 in EGARCH estimations gives us strong evidence of the presence of asymmetry in the reliance of the volatility from positive and negative news in all countries but Lithuania, Slovenia, Czech, and Bulgaria. In most economies (Hungary, Estonia, Romania, Poland, Ukraine, and Russia) the impact of negative news is much larger than impact of positive news (volatility tends to rise more as a result of negative news). Thus, in these countries the leverage effect is present.

The results from TGARCH estimations mostly coincide with those from EGARCH. In particular, TGARCH model does not find any evidence of asymmetry in Lithuania, Slovenia, Czech, and Bulgaria. The asymmetric component is found to be significant in all other markets.

The past volatility coefficient, β_2, is highly significant and close to unity for almost all indexes (especially for EGARCH approach), showing a high degree of shock persistence. The stationarity condition for EGARCH specification holds, since $\beta_2<1$ for all countries.

Concerning the conditional variance equation for the Threshold GARCH model, it can be verified for the indexes of all countries, but Lithuania. For this country the constraint for positivity is failed. For other countries both constraints hold (positivity and stationarity).

$$\omega, \beta_0, \beta_2 > 0$$

and $$\frac{\beta_0 + \beta_1}{2} + \beta_2 \prec 1$$

Thus, the estimation of the feedback trading model (7) together with the conditional variance equation, using two different asymmetric GARCH models (8,9), gives us a strong evidence about presence of positive feedback trading strategy in the stock markets of Hungary, Slovenia, Estonia, Lithuania, Bulgaria, Romania, Poland, and Russia.

Chapter 7

CONCLUSIONS

The central objective of this thesis was to identify the problem of positive feedback trading strategies in the stock market, and to provide the evidences of presence of these traders in the stock markets of Czech Republic, Hungary, Bulgaria, Romania, Slovakia, Slovenia, Poland, Lithuania, Latvia, Estonia, Russia, and Ukraine.

The impact of feedback trading on stock returns results in negative autocorrelation of returns. The actions of feedback traders produce predictable returns but this predictability does not result in profitable opportunities for risk-averse "smart-money" traders since the degree in predictability increases together with rise in risk level. Moreover, stock market prices go away from their fundamental values as a result of actions of positive feedback traders.

The theoretical basis is provided using Shiller – Sentana – Wadhwani model. For empirical estimations asymmetric (Exponential and Threshold) GARCH models were applied. These types of models were chosen because they allow the conditional variance to react asymmetrically on positive and negative news.

The empirical findings under both (EGARCH and TGARCH) methodologies support the hypothesis about presence of positive feedback trading in stock markets of Hungary, Lithuania, Estonia, Slovenia, Bulgaria, Romania, Poland, and Russia. Hence, in these economies stock market prices are subject of influence of feedback traders, and the behavioral approach can construe some facts in financial markets. These findings coincide with the results obtained by Bohl and Siklos (2004) for Hungary, Poland, and Russia. For other markets there is no evidence of positive feedback trading under this model. This may be due to the low liquidity of these economies. Since the markets have low liquidity, they are not subject of interest of feedback traders.

Although, previously, there was found evidence of presence of feedback trading in the Ukrainian stock market (Nikulyak, 2002), this fact does not hold any more. The main reason for present results consists in the huge privatization process that took place during nineties years of the last century, and now this process slows down. So the stocks were traded heavily before, and there were profitable opportunities for feedback traders.

The examination of impact of new information on volatility provides the evidence of leverage effect in some economies. The Exponential GARCH model captures the leverage effect for Hungary, Estonia, Romania, Poland, Ukraine, and Russia; the Threshold GARCH finds the presence of this effect in Hungary, Romania, Poland and Russia. In these economies the impact of negative news on volatility of stock returns is higher than impact of positive news. The reason of this asymmetry is different microstructure of markets, margin requirements, and stop-loss orders.

BIBLIOGRAPHY

Black, F. (1976) *Studies of Stock Market Volatility Changes*. Proceedings of the American Statistical Association, 177-81.

Black, F. (1988) *An Equilibrium Model of the Crash*, NBER Macroeconomic Annual, 269-76.

Black, F. (1989) *Mean Reversion and Consumption Smoothing*, NBER Working Paper, 2946.

Bohl, M., Reitz, S. (2002) *The Influence of Positive Feedback Trading on Return Autocorrelation: Evidence for the German Stock Market,* Working Paper Series of Postgraduate Research Programme "Capital Markets and Finance in the Enlarged Europe", 1/2002.

Bohl, M., Siklos, P. (2004) *Empirical Evidence on Feedback Trading in Mature and Emerging Stock Markets*. Quantitative Finance Research Papers, Sidney

Bollersev, T. (1986) *Generalized Autoregressive Conditional Heteroscedasticity*. Journal of Econometrics, 31, 307-27.

Boudoukh, J., Richardson, M.P., Whitelaw, M.P. (1994) *A Tale of Three Schools: Insights on Autocorrelations of Short-Horizon Stock Returns*, Review of Financial Studies, 7, 539-73.

Campbell, J.Y., Grossman, S.J., Wang, J. (1993) *Trading Volume and Serial Correlation in Stock Returns*, Quarterly Journal of Economics, 108, 905-39.

Cohen, K.J., Hawawani, G.A., Maier, S.F., Schwartz, R.A., and Whitcomb, D.K. (1980) *Implications of Microstructure Theory for Empirical Research on Stock Price Behavior*, Journal of Finance, 35/ 2, 249-57.

Conrad, J., Kaul, G. (1988) *Time-Variation in Expected Returns*, Journal of Business, 61, 409-25.

DeLong, B.J., Shleifer, A., Waldmann, R.J. (1990) *Positive Feedback Investment Strategies and Destabilizing Rational Speculation*, Journal of Finance, 45, 379-95.

Egert, B., Koubaa, Y. (2004) *Modelling Stock Returns in the G-7 and in the Selected CEE Economies: a Non-linear GARCH Approach*, William Davidson Institute Working Paper #663.

Engle, R.F. (1982) *Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of the United Kingdom Inflation*, Econometrica, 50, 987-1007.

Fama, E.F., French, K.R. (1988) *Permanent and Transitory Components of Stock Prices*, Journal of Political Economy, 96, 246-73.

Formari, F., Mele, A. (1997) *Sign- and volatility-switching ARCH Models: Theory and Applications to International Stock Markets*, Journal of Applied Econometrics, 12, 49-65.

Glosten, L.R., Jagannathan, R., Runkle, D.E. (1993) *On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks*, Journal of Finance, 48, 1779-801.

Kasch-Haroutounian, M., Price, S. (2001) *Volatility in the Transition Markets of Central Europe*, Applied Financial Economics, 11, 93-105.

Koutmos, G. (1997) *Feedback Trading and the Autocorrelation Pattern in Stock Returns: Further Empirical Evidence*, Journal of International Money and Finance, 16, 625-36.

Koutmos, G., Saidi, R. (2001) *Positive Feedback Trading in Emerging Capital Markets*, Applied Financial Economics, 11, 291-97.

Lo, A., MacKinlay, A.C. (1990) *An Econometric Analysis of Nonsynchronous-Trading*, Journal of Econometrics, 45, 181-212.

Marcus, A.J. (1989) *An Equilibrium Theory of Excess Volatility and Mean Reversion in Stock Market Prices*, NBER Working Paper, 3106.

McQueen, G., Pinegar, M., Thorley, S. (1996), *Delayed Reaction to Good News and the Cross-Autocorrelation of Portfolio Returns,* Journal of Finance, 51, 889-919.

Mech, T. (1993) *Portfolio Return Autocorrelation,* Journal of Financial Economics, 34, 307-44.

Nelson, D. (1991) *Conditional Heteroskedasticity in Stock Returns: A New Approach*, Econometrica, 59, 347-70.

Nikulyak, M. (2002) *Return Behavior in an Emerging Stock Market: the Case of Ukraine*. MA thesis, Economics Education and Research Consortium, National University of Kiev-Mohyla Academy.

Ogden, J.P. (1997) *Empirical Analyses of Three Explanations for the Autocorrelation of Short Horizon Stock Index Returns*, Review of Quantitative Finance and Accounting, 9, 203-17.

Omran, M.F., Avram, F. (2002) *An Examination of the Sign and Volatility Switching ARCH Models under Alternative Distributional Assumptions*, 18th International Symposium on Forecasting in Edinburgh.

Pagan, A.R., Schwert, G.W. (1990) *Alternative Models for Conditional*

Stock Market Volatility, Journal of Econometrics, vol. 45, 267-90.

Sentana, E., Wadhwani, S. (1992) *Feedback Traders and Stock Return Autocorrelations: Evidence from a Century of Daily Data*, Economic Journal, 102, 415-25.

Sentana, E. (1995) *Quadratic ARCH Models*, Review of Economic Studies, 62, 639-61.

Shiller, R.J. (1984), *Stock Prices and Social Dynamics*, Brookings Papers on Economic Activity, 2, 457-98.

Schwert, G.W. (1989) *Why does Stock Market Volatility Change over Time?*, Journal of Finance, 44, 1115-53

Zakoïan, J.-M. (1994) *Threshold Heteroskedastic Models*, Journal of Economic Dynamics and Control, 18, 931-55.

Internet Sources (by countries):
Czech Republic - www.pse.cz
Hungary – www.fornax.hu
Bulgaria, Romania – www.karoll.net
Slovakia – www.bsse.sk
Slovenia – www.ljse.si
Poland – www.wse.com.pl

Lithuania – www.omxgroup.com/vilnus
Latvia – www.omxgroup.com/riga
Estonia – www.omxgroup.com/tallinn
Russia – www.rtsnet.ru
Ukraine – www.pfts.com