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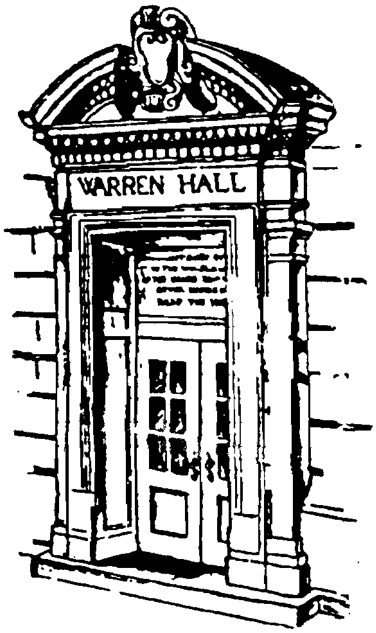

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Price Behavior in Emerging Stock Markets

Cases of Poland and Slovakia

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PRICE BEHAVIOR IN EMERGING STOCK MARKETS

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Abstract:
This paper analyzes serial correlation in stock returns, and informational role of volume and volatility in Polish and Slovakian stock markets. Results indicate that prices tend to overshoot to new information in the Slovakian market, while new information gets impounded into prices with a one-day lag in the Polish market. In the context of feedback trading models, the Slovakian stock market seems to be dominated by traders who sell high and buy low, while stop-loss or distress selling type traders prevail in the Polish market. Traders became more sophisticated over time, as market efficiencies increased. Informational role of volume and volatility appears to be consistent with that found in developed stock markets.

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With the advance of market economies and privatization in transition countries of Europe, financial markets have emerged to facilitate access to capital. They were mostly set up following a structure of one of the developed and well functioning stock exchanges in Europe, Japan, or US. How well the new institutions are performing has been of interest to both practitioners and researchers.

Capital markets in transition economies are subject to many limitations including low capital endowment of the population, its inexperience in investing, and inadequate information distribution. These factors, as well as easier market manipulation due to underdeveloped legal institutions and unsatisfactory monitoring and regulation enforcement, result in low liquidity in the markets. The objective of this study is to analyze price movements in two emerging equity markets, Warsaw Stock Market in Poland and Bratislava Stock Markets in Slovakia. The analysis focuses on the behavior of stock returns and the informational role of volume and volatility in the two markets.

Both markets, although to a different degree, are characterized by a smaller number of investors, lower liquidity, and most likely a higher volatility than developed markets. Results indicate that prices do not adjust immediately, implying inefficiency in the markets. Both markets exhibit economically and statistically significant first-order autocorrelation. Bratislava stock returns tend to move in the opposite direction on the subsequent day, while Warsaw stock returns show positive serial correlation. Negative autocorrelation can be a result of price readjustment due to over-shooting to information. Positive autocorrelation would indicate information queues. On the other hand, feedback trading models suggest that most traders in

Bratislava market follow a 'buy low, sell high' trading strategy, while Polish traders are more of stop-loss order or distress selling types.

Further investigation of the theoretical hypotheses suggests that trader sophistication in both markets increased over time and market efficiencies improved. In the context of feedback trading, as more traders in the Polish market adopt the profit taking strategy of 'buy low, sell high', autocorrelation in returns decreases or becomes negative in the later part of the sample period. Price changes on high volume days tend to be reversed in both markets, and volatility appears not to have an effect on serial correlation in stock returns. Empirical findings are generally consistent with those evidenced in developed stock markets.

The paper is organized as follows. The next section describes the stock markets in Warsaw and Bratislava, their systems of trading and microstructure features. Section two reviews relevant literature and models. Section four introduces hypotheses to be tested, and describes data and methodology used in the analysis. Section four presents empirical results and discusses possible explanations. The last section concludes and offers suggestions for future research.

I. Stock Markets in Poland and Slovakia

Since 1989, when a dramatic change in political and economic orientations in the countries of Eastern and Central Europe took place, the countries have advanced on their way towards market economies. One of the main tasks to be accomplished was to transfer state owned firms into private ownership. Commensurate with this effort arose the need for financial institutions, capital markets, and other instruments for raising capital.

Warsaw Stock Exchange (WSE)

Trading of securities in Poland was launched in 1990, when government bonds started to trade. In March 1991, the Act on Public Trading in Securities and Trust Funds was passed by the

Parliament, followed by the establishment of the Warsaw Stock Exchange (WSE) in April 1991. WSE, the only stock exchange in Poland, is a self-regulatory organization whose structure and legal regulations follow the pattern of the French capital market system.

WSE is an order-driven electronic stock exchange system where transactions are concluded via single-price auction (call market), continuous auction, and block trades. Buying or selling of securities has to be performed through a licensed stockbroker. All equities are traded via the call market system and the most liquid ones also trade in the continuous auction. In the call market system, the session's price is determined by the specialist, a brokerage house appointed into this role by the issuer of the security. The upper limit on the price change from the previous day's session is +/- 10%. If the single price arrived at by matching buy and sell orders is within the 10% price change limit, the market is balanced and orders are cleared. Only the orders whose price limit is equal to the session's price may be left partially or completely unexecuted. If the equilibrium price exceeds the upper or lower limit for a price change, the price is settled at the highest/lowest acceptable price. The market thus remains unbalanced at the end of the session. The specialist will eliminate or reduce the market imbalance by counterbalancing offers from his/her own inventory or in the post-auction balancing phase.

The continuous trading follows the principles of a double-auction. The opening price is established using the call market mechanism and cannot be more than 10% higher or lower than the previous session's closing price or previous session's call market price. Transactions are executed in round lots with value of about PLN 10,000 ($4,000).

Large blocks of securities can be traded off-session as block trades. To qualify for a block trade the number of shares in the transaction must be at least equal to the average number of securities sold in the previous three sessions. The upper limit on the price change from previous session is 30% (for details on trading systems see *http:/www.atm.com.pl/gpw/systemen.htm*).

Bratislava Stock Markets

Slovakia has two markets where securities are traded. The Bratislava Stock Exchange (BSSE) and RM-System Slovakia (RMS). Trading in BSSE is based on the principle of call market, continuous double-auction, and block trades systems. Only the most actively traded shares are traded via a continuous auction. Transactions are electronically executed and anonymous. Direct transactions and repo trades are also executable in the market. Rules of trading are comparable with those of WSE. The crucial difference between RMS and BSSE is the principle of non-membership. All entities, individuals as well as institutions and companies, can trade in the RMS market provided they comply with the Trading Rules. RMS uses only continuous auction for trading.

Given the small size of the Slovakian capital endowment, BSSE and RMS have entered into an agreement that establishes a BSSE-RMS Common Price Rate. The common price unifies daily price spreads in both markets. It is published at the end of a trading day and serves as a middle price band within the range in which trading is allowed.

II. Serial Correlation in Returns, Volume and Volatility

The impossibility of informationally efficient markets in a rational expectation framework, demonstrated by Grossman and Stiglitz (1980), motivated researchers to consider prices as partially revealing and markets as semi-strong-form-efficient. In the presence of differentially informed traders, the adjustment of prices to new information is not instantaneous and is a result of trading behavior of informed and uninformed traders. The price at each instant reflects all public information, but not necessarily all private information. Trading behavior may reveal the additional information necessary for the prices to eventually adjust to the new-information value. Volume, volatility, and timing of trades are all assumed to be factors in the price adjustment process. Studying the price process may in turn provide insight into how markets should be structured and regulated.

Multiple studies of developed stock markets have demonstrated that stock returns exhibit serial correlation and that they vary considerably over time. Lo and MacKinley (1988) and Campbell, Grossman, and Wang (CGW, 1993) find positive autocorrelations in weekly returns of NYSE-AMX indexes and daily returns of the Dow Jones Index, respectively. Positive autocorrelation in index returns is often attributed to the spurious effect of non-synchronous trading of individual components; French and Roll (1986) and Lo and MacKinley find negative serial correlation in individual stock returns. Explanations for serial correlation in returns include informational lag and feedback trading (O'Hara 1995, Sentana and Wadhwani 1992).

Volume is usually considered an indication of private information flow or differing interpretations among traders of the meaning of public information. In Wang's model (1994), uninformed traders opt not to trade if the risk of information based trading is high and large price changes are required to induce uninformed traders to trade. A positive correlation between volume and absolute price changes follows, a relation widely documented in the empirical literature (Smirlock and Starks, 1988). Wang's model also explains the empirical findings of large increases in volume accompanied by large increases or decreases in price (Ying 1996).

The positive relationship between volume and price changes *per se,* predicted by some theoretical models, has been given only weak support in the empirical literature. Rogalski (1978) documents a contemporaneous relationship between volume and price changes, but finds no evidence of a lagged one. Some of his results are contrary to the expectation of positive correlation. More recent support for the positive correlation is presented by Gallant, Rossi, and Tauchen (1992) who show that large price movements are followed by high volume. Karpoff (1987) documents the empirical results and explains the empirical inconsistencies in a simple model of non-monotonic relationship between volume and negative and positive price changes.

The relationship between volume and serial correlation is modeled in CGW based on informational asymmetries between investors and their heterogeneity in risk aversion. The model assumes some agents to be "liquidity" traders, who trade based on reasons exogenous to the market, and the rest to be risk averse market makers. Noninformational, or liquidity trading arises as a result of shifts in risk aversion of some market agents. The noninformational trading pressure is accommodated by the markets makers who require a higher expected return. The theoretical predictions of CGW model for the relationship between volume and serial correlation are confirmed by their empirical findings. Using daily data over 26 years, they demonstrate that high-volume days are associated with lower serial correlation in stock returns.

Volatility is another factor thought to be indicative of how information is impounded into prices. An asymmetry in the impact of negative and positive information shocks is documented in the literature, where bad news is found to lead to larger return volatility than good news (Schwert 1990; Shields 1997). Consistent with models of investors with heterogeneous believes, volatility is shown to be positively correlated with volume (Schwert, 1989; Gallant, Rossi, and Tauchen,1992). Sentana and Wadhwani (1992) document a higher degree or serial correlation in returns in times of higher volatility. As risk averse agents restrict demand when risk is high, the impact of feedback traders on price is more pronounced.

III. Model, Data and Methodology

Model

Serial correlation in stock returns can be accounted for by models of feedback trading (Sentana and Wadhwani, 1992). The models assume that a set of traders follows a feedback trading strategy and reacts to price changes. Negative feedback traders buy low and sell high, and positive feedback traders buy after price increases and sell after decreases. The positive feedback trading is consistent with trading using stop-loss orders, or 'distress' selling in times of large market declines. If negative feedback trading prevails, stock returns are negatively correlated, if positive feedback is dominant, positive autocorrelation in returns follows.

In addition to feedback traders, a group of risk averse agents, the so called 'smart money', is assumed to participate in the market. As a result of their risk aversion, their demand for stocks is adversely affected by volatility. In times of higher volatility, 'smart money' are more cautious and restrict their trading. This enables the feedback traders to have a larger impact on price, resulting in higher degree of serial correlation.

The informational role of volume and its relation to serial correlation of returns is modeled and empirically documented in CGW model. Two sets of agents are assumed to participate in the market. Noninformational agents, who trade for exogenous reasons, and risk averse utility maximizers, who demand a reward for accomodating the trades of noninformational traders. Thus, selling pressure from noninformational traders results in a lower price and higher expected returns.

A price change could also be a result of new public information. In this case, risk averse agents do not revise their expected returns, since the price change occurred due to a change in valuation of the stock in all investors. No price revision is expected on subsequent days.

CGW argue that noninformational trading is accompanied by higher volume whereas public information trading is not. Consequently, price changes on high volume days tend to be reversed, implying weaker positive and stronger negative autocorrelation in returns on high volume days. Similarly, Morse's model (1980) based on sequential information arrival predicts serially correlated absolute returns to be more likely during high volume days.

To investigate the price behavior and informational role of volume and volatility in the Polish and Slovakian stock markets, the following model is estimated

$$r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r_{t-2} + \beta_3 (h_{t-1} \cdot r_{t-1}) + \beta_4 (\Delta vol_t \cdot r_{t-1}) + u_t \,,$$

where r_t is the stock return, h_{t-1} is volatility and Δvol_t represents a change in volume from previous day, $vol_t - vol_{t-1}$. A nested procedure is used to arrive at a parsimonious representation of the autocorrelation, volume, and volatility effects as the model is gradually reduced by excluding variables not significantly different from zero.

Negative autocorrelation may be a sign of overshooting to new information, while a positive one may be a sign of information queues. In the context of feedback models, returns are positively autocorrelated if positive feedback traders prevail in the market and negative if negative feedback traders are dominant. The signs of β_1 and β_2 will be indicative of the price adjustment and/or prevalent trading pattern. High volatility decreases 'smart money' demand for stocks and thus reinforces the effect on price of feedback trading. Therefore, β_3 is likely to be positive if returns are positively correlated and negative if negatively correlated. Finally, the coefficient on the volume change/lagged return interaction term is expected to be positive as price changes on high volume days tend to be reversed.

Data

Daily return and volume data for five most frequently traded "blue chip" stocks are used in the study of the Warsaw Stock Exchange. The stock prices averaged 20 zloty over the period under study with daily average of 3898 shares traded. Daily data from April 1996 through January 1998 are used in the analysis. The data are publicly available at the website - *http:// www.dmbos.com.pl/ pub/ omega/omegaall.zip*. Daily returns and trading volume for the five most actively traded Slovakian blue chip stocks are investigated for the Bratislava stock markets. Trading volume is the sum of the number of shares traded on both markets, BSSE and RMS. The price of the selected stocks averaged 1042 SK during the analyzed period from January 1996 to February 1998, with daily trading volume of 382 shares[1]. The average price and trading volume of individual stocks are summarized in Table 1.

Table 1. Average Price and Volume.

Bratislava Stock Markets			Warsaw Stock Markets		
Stock	Price in SK[a]	Volume	Stock	Price (zloty)	Volume
VUB	1436	145	BUDIMEX	22	1884
VSZ	644	1438	EXBUD	32	458
HP	647	55	WBK	17	3671
SLOVNAFT	900	200	MOSTAL-EXP	9	11586
NAFTA	1584	74	OKOCIM	20	1891

a. Price is the closing price and volume represents the number of shares traded. Both are averages over the periods January 1996 through February 1998 for Bratislava and April 1996 through January 1998 for Warsaw.

The time span of the data is chosen based on several considerations. First, the starting years for the two markets are likely to be subject to irregularities of a newly-launched market, factors rather intractable and exogenous to the analyzed problem. Second, trading in some of the stocks used in the present analysis was initiated only in later years. Third, by 1996, all the regulations had been implemented and forms of trading stabilized in both markets. According to the available information, the markets did not undergo any structural changes during the period under study. Finally, political uncertainty in Slovakia in 1998, due to an upcoming election, resulted in extremely low volume of trading, rendering the year 1998 unsuitable for the analysis. To keep the results comparable, most of year 1998 is excluded from the analysis for both markets.

Stock returns are calculated as a daily percentage change in the closing price. Trading volume represents the number of shares of a security traded on that day. Estimates of conditional variance from a simple AR(1) model are used as a measure of volatility. Figures 1 and 2 in the Appendix illustrate the movement of daily returns and volume for the Polish and Slovakian stocks respectively. Both the returns and volume show nonconstant variances. Returns do not exhibit any trend but an investigation of stationarity of volume shows evidence of trend for six of the stocks. Volume series for all stocks are first differenced to ensure stationarity. The differenced volume series are still characterized by high persistence, with the first-order autocorrelation averaging -0.35 for the detrended volume series in both markets.

Methodology

Theory as well as empirical evidence from developed stock markets suggests that error term of the stock return series is generated through an autoregressive conditional heteroscedasticity process. The process is implied by the Mixture of Distributions Hypothesis (MDH), a popular model of the joint distribution of returns and volume. Under the hypothesis, the unconditional joint distribution of returns and volume is a mixture of the conditional normal distributions. The mixture is directed by the distribution of a mixing variable, which is assumed to count the number of information arrivals during the day. After each arrival, trading takes place. One of the implications of MDH is volatility that varies through time if the distribution of the mixing variable changes.

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[1] The data for Slovakia were provided by Miroslav Vester, Infin, Bratislava, Slovakia.

In the presence of heteroscedasticity, ordinary least squares estimators are inefficient. ARCH/GARCH models correct for the changing variance and provide heteroscedasticity-consistent estimators. The generalized autoregressive conditional heteroscedasticity model (GARCH) is used as a parsimonious representation of long memory processes that use the information from all the past squared residuals in determining the current variance. Under GARCH (p,q), the conditional volatility is assumed to be a function of p lagged variances and q squared lagged errors

$$y_t = x'_t \beta + u_t$$

$$u_t = \sqrt{h_t} \cdot v_t$$

$$h_t = w + \sum_{i=1}^{q} \alpha_i u_{t-i}^{\ 2} + \sum_{j=1}^{p} \gamma_j h_{t-j} ,$$

where y_t is the dependent variable, x'_t is a vector of explanatory variables, h_t is the conditional variance, and $v_t \sim i.i.d.(0,1)$.

Tests for heteroscedasticity are conducted and stock return series are tested for ARCH/GARCH effects. In addition, a backstep procedure is used to test for autoregressive lags in the error term generating process and to determine the lag length. Based on the LM and Portmanteu Q statistics, a pure GARCH (1,1) return generating process is determined for three Polish and three Slovakian stocks. A mixed AR(n)-GARCH(1,1) model is used for two Polish and two Slovakian stocks. Under this specification, the error term is assumed to be autocorrelated in addition to the assumption of conditional volatility,

$$y_t = x'_t \beta + u_t$$

$$u_t = e_t - \sum_{k=1}^{n} \lambda_k \cdot u_{t-k}$$

$$e_t = \sqrt{h_t} \cdot v_t$$

$$h_t = w + \sum_{i=1}^{q} \alpha_i e_{t-i}{}^2 + \sum_{j=1}^{p} \gamma_j h_{t-j}$$

$v_t \sim i.i.d.(0,1)$.

Table 2 details autoregressive and conditional-heteroscedasticity return generating processes determined for each stock. Corresponding AR(n)-GARCH(p,q) models are used in the analysis.

Table 2. Stock Return Generating Process

Warsaw Stock Market		Bratislava Stock Markets	
Budimex	GARCH (1,1)	VUB	GARCH (1,1)
Exbud	GARCH (1,1)	VSZ	AR (5)-GARCH (1,1)
WBK	AR (3)-GARCH (1,1)	HP	AR (2)-GARCH (1,1)
Mostal-Export	AR (5)-GARCH (1,1)	Slovnaft	GARCH (1,1)
Okocim	GARCH (1,1)	Nafta	GARCH (1,1)

IV. Results

The results of the estimation of first and second order autocorrelations of returns and of the effect of volume and volatility on the autocorrelations are reported in Tables 3 through 5. Individual columns represent heteroscedasticity-consistent estimates of coefficients and t-ratios that are based on heteroscedasticity-consistent standard errors. The R^2 statistic from GARCH estimation is a measure of how well the next value can be predicted using the structural part of the model and the past values of residuals. Low values indicate weak GARCH effects. The R^2s in this analysis are low, 0.2% to 5%, but not unusual for this type of estimation (CGW). Since at such low values the informational content of the statistic is weak, R^2s are not reported here.

Table 3 presents results from estimating a simple AR(1) process in returns. Although the coefficients of the model may suffer from omitted variable bias, the results suggest an expected direction of the volume and volatility effects on the autocorrelation. Returns for Slovakian stocks have negative first-order autocorrelation, an economically and statistically significant result for all stocks. On the other hand, price process for Polish stocks is characterized by a positive first-order autocorrelation in returns.

Table 3. First-Order Autocorrelation of Stock Returns

Estimated model: $r_t = \beta_0 + \beta_1 \cdot r_{t-1}$			
Bratislava Stock Markets		Warsaw Stock Exchange	
Stock	β_1 *(t-stat)*	Stock	β_1 *(t-stat)*
VUB	-0.359 (-9.5)	BUDIMEX	0.207 (4.5)
VSZ	-0.180 (-2.8)	EXBUD	0.053 (1.1)
HP	-0.377 (-6.8)	WBK	0.205 (4.2)
SLOVNAFT	-0.362 (-7.5)	MOSTAL-EXP	0.141 (3.1)
NAFTA	-0.300 (-4.6)	OKOCIM	0.120 (2.2)

The GARCH estimates of conditional variance from this model are used in further analysis as a measure of volatility. Dummies for the day of the week were also included in the regression. No significant weekday effect was found for any of the stocks. Consequently, dummies are not included in further analysis.

Table 4. Full Model of Autocorrelations of Returns, Volume, and Volatility

Estimated model: $r_t = \beta_0 + \beta_1 \cdot r_{t-1} + \beta_2 \cdot r_{t-2} + \beta_3 \cdot (h_{t-1} \cdot r_{t-1}) + \beta_4 \cdot 1000^2 \cdot (\Delta vol_t \cdot r_{t-1})$									
Bratislava Stock Markets					Warsaw Stock Market				
Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*	β_4 *(t-stat)*	Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*	β_4 *(t-stat)*
VUB	-0.384 (-8.3)	0.044 (1.1)	6.667 (0.8)	-238.0 (-0.7)	BUDIMEX	0.331 (3.0)	-0.050 (-1.0)	-108.120 (-1.1)	0.858 (1.5)
VSZ	-0.154 (-2.0)	0.043 (0.8)	-0.585 (-0.1)	63.384 (1.2)	EXBUD	0.094 (1.1)	-0.076 (-1.3)	-57.283 (-0.5)	2.496 (1.5)
HP	-0.476 (-5.4)	-0.154 (-0.9)	53.524 (1.4)	1331.0 (1.3)	WBK	0.173 (1.1)	-0.001 (-0.1)	40.353 (0.2)	0.806 (1.8)
SLOVNAFT	-0.355 (-6.7)	-0.060 (-1.6)	4.708 (0.1)	1201.0 (3.3)	MOSTAL-EXP	0.205 (1.8)	-0.024 (-0.5)	-51.717 (-0.5)	0.446 (1.8)
NAFTA	-0.300 (-3.2)	-0.050 (-1.0)	-6.559 (-0.2)	1384.0 (2.1)	OKOCIM	0.373 (3.3)	0.035 (0.8)	-282.203 (-2.5)	2.089 (3.1)

Results from estimating the full model of serial autocorrelation, volume and volatility effects are reported in Table 4. Results for first-order autocorrelation remain fairly robust relative to Table 3, with negative autocorrelation for Slovakian and positive for Polish stock returns. The first-order autocorrelation in Slovakian returns ranges from -0.47 to -0.15, averaging -0.33. The average first-order autocorrelation for Polish returns is 0.24, ranging from 0.1 to 0.37.

The two-period lagged return usually does not enter significantly for either market, indicating that information gets impounded into prices with a one-day lag only. Volatility does not have an effect on serial correlation except for one Slovakian stock and one Polish stock (at 15% significance level). Volume coefficients appear to have a positive sign in both markets.

To increase efficiency of the estimates, the model is re-estimated in a simpler form as insignificant variables are dropped from the individual stock regressions. A relatively high level of significance, up to 20% in some cases, is used in this process. Table 5 presents the estimated coefficients from the parsimonious representation of the price process, volatility and volume effects. The robustness of the autocorrelation results is confirmed for both stock markets as they retain their economic and statistical significance. Negative first-order autocorrelation in the Slovakian stock markets is as low as –0.46 for HP. Okocim is the stock with the highest price predictability in the Polish stock market, with the largest autocorrelation coefficient reaching 0.38.

Table 5. Reduced Model of First-Order Autocorrelation of Returns, Volume, and/or Volatility

Estimated model:

$$r_t = \beta_0 + \beta_1 \cdot r_{t-1} + \beta_2 \cdot (h_{t-1} \cdot r_{t-1}) + \beta_3 \cdot 1000^2 \cdot (\Delta vol_t \cdot r_{t-1})$$

Bratislava Stock Markets				Warsaw Stock Market			
Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*	Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*
VUB	-0.359 (-9.5)			BUDIMEX	0.204 (4.2)		0.870 (1.6)
VSZ	-0.172 (-2.7)		63.307 (1.2)	EXBUD	0.044 (1.5)		2.454 (1.5)
HP	-0.465 (-5.6)	51.264 (1.5)	1083.0 (1.0)	WBK	0.207 (4.3)		0.783 (2.1)
SLOVNAFT	-0.324 (-6.7)		1311.0 (3.6)	MOSTAL-EXP	0.149 (3.2)		0.462 (1.9)
NAFTA	-0.279 (-4.3)		1510.0 (2.5)	OKOCIM	0.381 (3.5)	-287.035 (-2.6)	2.0 (3.1)

The empirical results indicate, that price changes in the Slovakian markets tend to overestimate new information and are followed by a price correction on the subsequent day. The Polish market appear to be characterized by information queues, where new information gets impounded into the price with a lag. In the context of feedback traders, the Slovakian stock markets seem to have a prevalence of traders who buy low and sell high, whereas Polish traders are more of the portfolio insurers and stop-loss order types.

Volume has a significant restricting effect on the positive serial correlation in Polish stock returns, indicating that price changes due to noniformational trading pressure, as revealed by high volume, force prices to reverse to their equilibrium. An analogous result holds for Slovakian stocks, although it is significant only in two cases. The negative first-order autocorrelation is strengthened by volume as price change reversals are reinforced after noniformational trading. The results for the two emerging markets are consistent with the theory and empirical findings in developed markets (CGW).

The lagged volatility effect is in most cases insignificant. For the one Polish stock where volatility has a significant effect, it tends to reduce the positive first-order autocorrelation. This result would not conform to the models of 'smart money', which predict a reinforcing price effect of feedback traders in times of increased risk. However, in the context of these models, the insignificant volatility effect could be indicative of a lack of risk averse traders.

To further investigate the hypotheses about possible causes of serial correlation in returns, the sample for each market is sub-divided into two time periods. Trader sophistication may have increased over time, possibly reversing the way prices in the market behave. Mainly, if a learning effect is present, serial correlation should become less significant. We would expect the positive autocorrelation in the Polish market to decrease or become negative as more feedback traders adopt the profit taking strategy of buying low and selling high.

Results for the two sub-samples suggest an increase in sophistication of traders in both markets. Market efficiency has in general increased as over time, serial correlation in returns decreased in absolute value and in significance (Tables 6 and 7). Within the feedback trading framework, the tendency of price changes in the Polish market to be reversed in the later period indicates that more Polish traders are adopting the profit taking strategy of 'buy low, sell high'. First-order autocorrelation in returns tends to decrease or becomes negative. In most cases, stock returns in the Slovakian markets remain negatively correlated.

Table 6. First-Order Autocorrelation of Returns, Volume, and/or Volatility for Two Sub-Periods – Bratislava Stock Markets

Estimated model:

$$r_t = \beta_0 + \beta_1 \cdot r_{t-1} + \beta_2 \cdot (h_{t-1} \cdot r_{t-1}) + \beta_3 \cdot 1000 \cdot (\Delta vol_t \cdot r_{t-1})$$

April 1996 – September 1997				September 1997 – February 1998			
Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*	Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*
VUB	-0.118			VUB	-0.116		
	(-2.1)				(-1.1)		
VSZ	-0.117		107	VSZ	-0.147		107
	(-2.0)		(1.9)		(-2.0)		(1.9)
HP	-0.477			HP	0.156		1388
	(-7.1)				(1.2)		(2.9)
SLOVNAFT	-0.341		531	SLOVNAFT	-0.182		395
	(-5.9)		(1.9)		(-1.6)		(3.1)
NAFTA	-0.299		2592	NAFTA	-0.310		
	(-3.8)		(4.6)		(-2.6)		

Table 7. First-Order Autocorrelation of Returns, Volume, and/or Volatility for Two Sub-Periods - Warsaw Stock Market

Estimated model:

$$r_t = \beta_0 + \beta_1 \cdot r_{t-1} + \beta_2 \cdot (h_{t-1} \cdot r_{t-1}) + \beta_3 \cdot 1000 \cdot (\Delta vol_t \cdot r_{t-1})$$

February 1996 – September 1997				September 1997 – January 1998			
Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*	Stock	β_1 *(t-stat)*	β_2 *(t-stat)*	β_3 *(t-stat)*
BUDIMEX	0.213		2.24	BUDIMEX	0.161		
	(3.9)		(3.3)		(1.5)		
EXBUD	0.034			EXBUD	-0.174		
	(0.6)				(-1.6)		
WBK	0.258		0.76	WBK	-0.014		
	(5.1)		(2.1)		(-0.1)		
MOSTAL-	0.158		0.49	MOSTAL-EXP	0.158		
EXP	(2.0)		(2.0)		(1.7)		
OKOCIM	0.473	-372.6	0.961	OKOCIM	-0.027		
	(3.3)	(-2.6)	(1.0)		(-0.2)		

V. Summary and conclusions

This paper examines the behavior of stock returns in two emerging markets, Polish and Slovakian. The focus is on investigating lagged effects in returns and the effects of volume and volatility on the autocorrelation. The study finds positive first-order autocorrelation in the Polish stock market and negative first-order autocorrelation in the Slovakian markets. In terms of price adjustment to new information, the Polish stock market appears to be characterized by information queues. Prices in the Slovakian market tend to overshoot to new information with next day correction to the equilibrium value. In the context of feedback trading models, the Polish market appears to be dominated by stop-loss order traders or distress selling types, while Slovakian traders buy low and sell high. Further analysis suggests that traders' sophistication increased in both markets as the markets became more efficient. The positive autocorrelation in Polish returns decreased or became negative, indicating that more feedback traders adopted the 'buy low, sell high' strategy.

Price changes on high volume days tend to be reversed in both markets as volume has a weakening effect on positive autocorrelation of Polish returns and reinforcing effect on negative serial correlation of Slovakian stock returns. High volume is considered to be an indicator of noninformational trading. Volatility appears to have no significant effect on returns in either of the markets.

The present study is subject to limitations, suggesting directions for future research. First, better information on the microstructure aspects of the two markets would shed light on the possible reasons for the disparate results in the two markets. The two exchanges/one price structure of the Slovakian equity market may help explain the behavior of returns. Second, returns are not adjusted for stock splits due to lack of information. If splits occurred, failure to adjust for them would cause the estimates to be biased. Finally, including market indexes in the analysis would reveal more about the generalizability of the results of this study.

REFERENCES

Campbell, J.Y., S. Grossman and J. Wang. "Trading Volume and Serial Correlation in Stock Returns." *The Quarterly Journal of Economics, (*Nov.1993), 905-939.

French, K. and R. Roll: "Stock Return Variances. The Arrival of Information and the Reaction of Traders." (1986) *Journal of Financial Economics* 17, 5-26.

Gallant, A.R., P.E. Rossi, and G. Tauchen. "Stock Prices and Volume." *Review of Financial Studies,* V (1992), 199-242.

Grossman, S.J. and J.E. Stiglitz: "On the Impossibility of Informationally Efficient Markets." (1980) *American Economic Review* 70, 393-408.

Harris, L. "Cross-Security Tests of the Mixture of Distribution Hypothesis."(March 1986) *Journal of Financial and Quantitative Analysis* 21, 39-46.

Karpoff, J.M. " The Relation between Price Changes and Trading Volume: A Survey." *Journal of Financial and Quantitative Analysis,* XXII, (1987), 109-26.

LeBaron, B. "Some Relations between Volatility and Serial Correlation in Stock Market Returns." *Journal of Business*, LXV (1992), 199-219.

Lo, A.W. and A.C. MacKinlay. "Stock Prices Do Not follow Random Walks: Evidence from a Simple Specification Test." (1988) *Review of Financial Studies* 1, 41-66.

Morse, D. "Asymmetrical Information in Securities Markets and Trading Volume." (1980) *Journal of Financial and Quantitative Analysis* 15, 1129-46.

O'Hara, M. "Market Microstructure Theory." (1995) Cambridge, MA. Blackwell Publishers

Schwert, G.W. "Indexes of US Stock Prices from 1802-1987." (1990) *Journal of Business* 63, 399-426.

Schwert, G.W. "Why Does Stock Market Volatility Change Over Time? (December 1989) *Journal of Finance* XLIV, 1115-53.

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

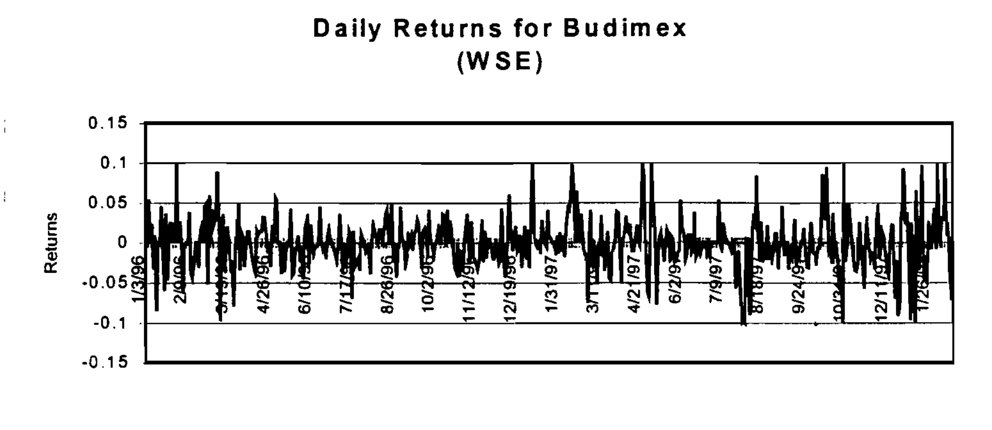
Shields, K.K. "Stock Return Volatility on Emerging Eastern European Markets." (1997) *Manchester School of Economic and Social Studies* 65, No. 0 Supplement 1997. 18-38.

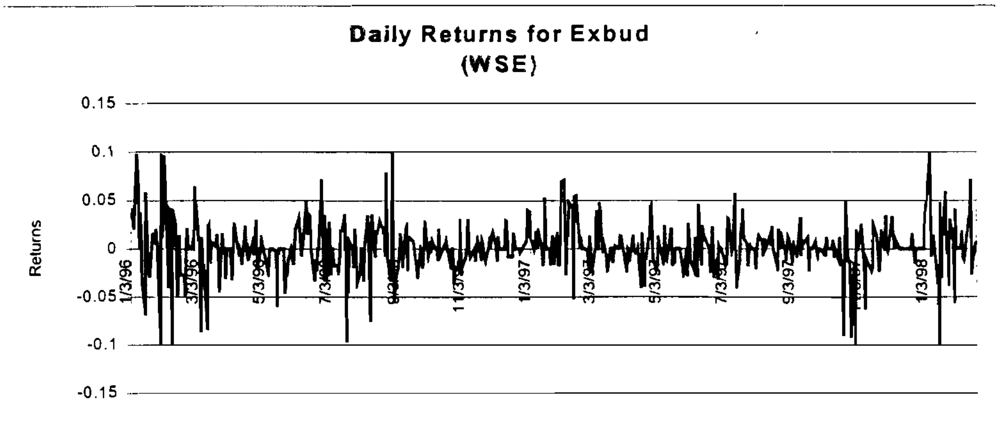
Tauchen, G.F. and M.Pitts "The Price Variability-Volume Relationship on Speculative Markets." *Econometrica,* 51 (1983), 485-505.

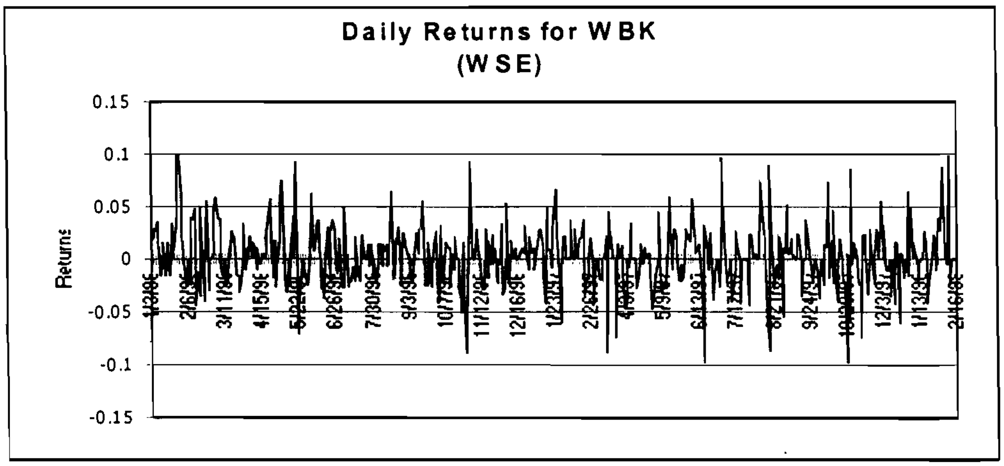
Wang, J. "A Model of Competitive Stock Trading Volume." (1994) *Journal of Political Economy* 102, 127-168.

Appendix

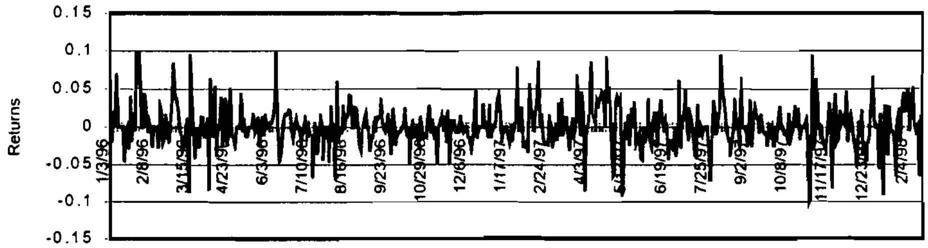
Figure 1a







Daily Returns for Mostal-Export
(WSE)



Daily Returns for Okocim
(WSE)

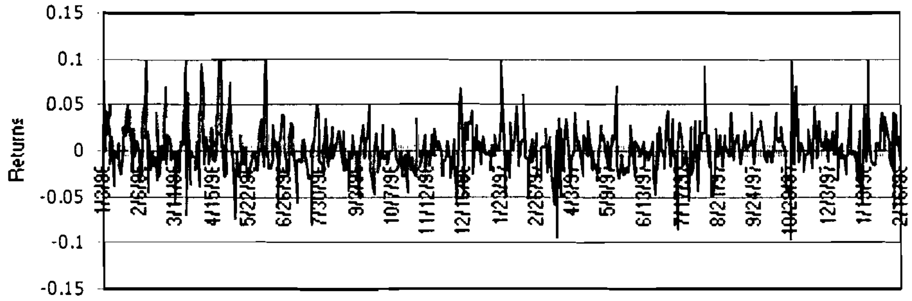
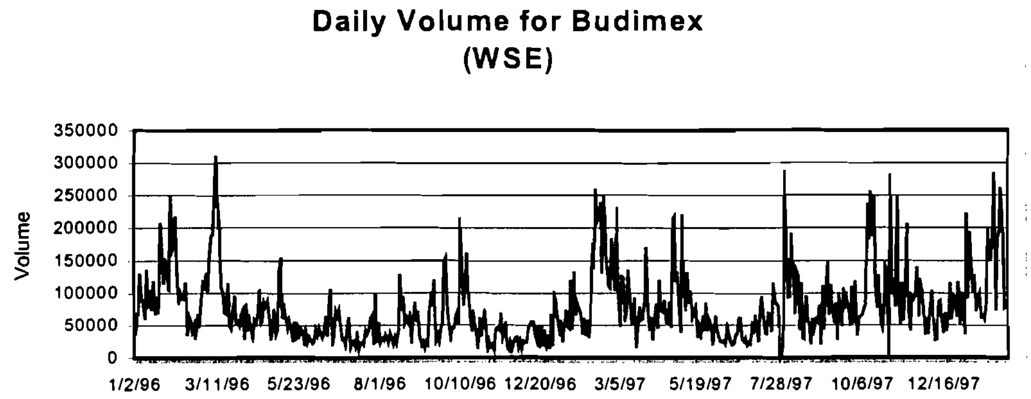


Figure 1b


Daily Volume for Budimex
(WSE)
Volume
350000
300000
250000
200000
150000
100000
50000
0
1/2/96
3/11/96
5/23/96
8/1/96
10/10/96
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3/5/97
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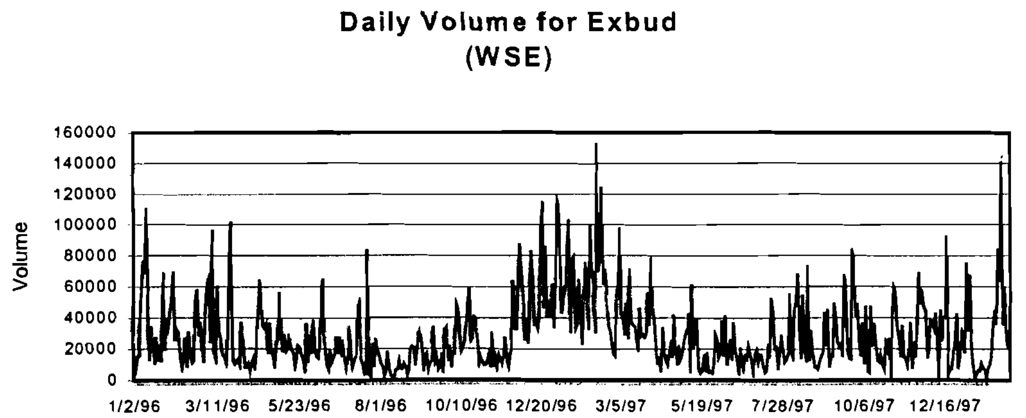
7/28/97
10/6/97
12/16/97


Daily Volume for Exbud
(WSE)
Volume
160000
140000
120000
100000
80000
60000
40000
20000
0
1/2/96
3/11/96
5/23/96
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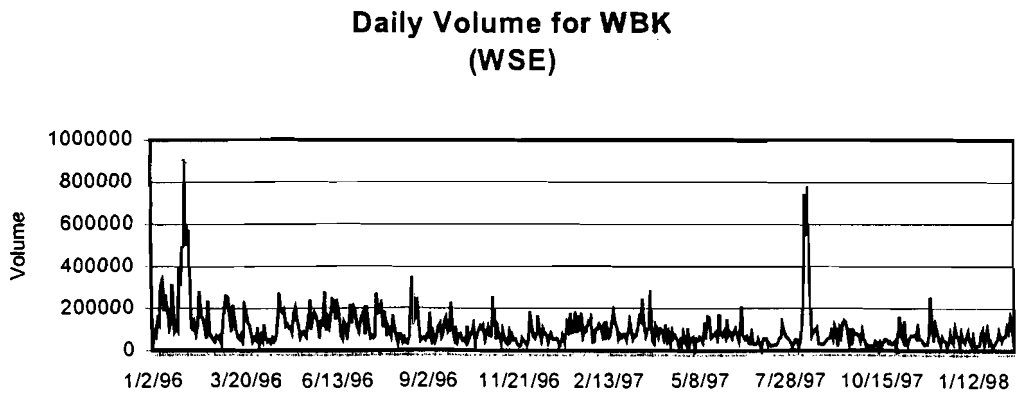
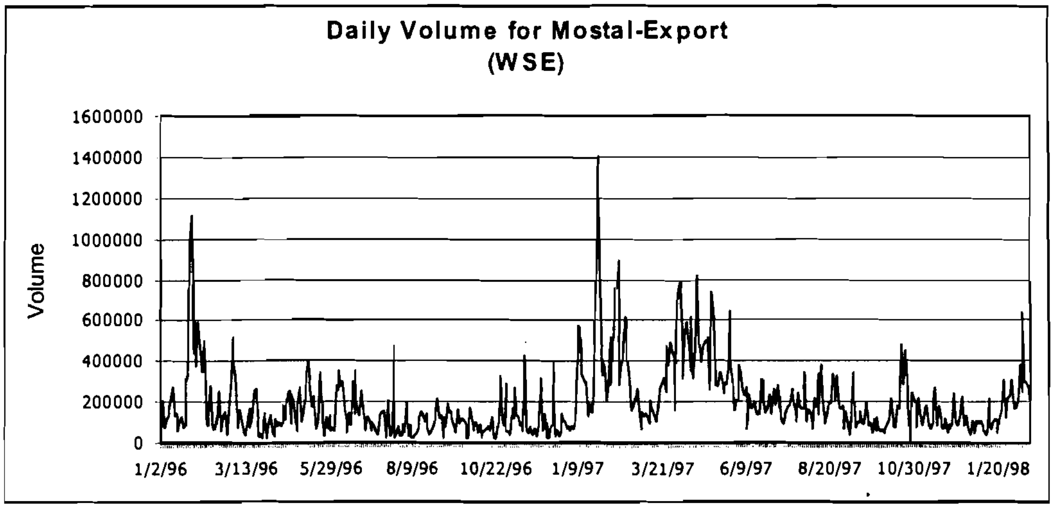
10/6/97
12/16/97


Daily Volume for WBK
(WSE)
Volume
1000000
800000
600000
400000
200000
0
1/2/96
3/20/96
6/13/96
9/2/96
11/21/96
2/13/97
5/8/97
7/28/97
10/15/97
1/12/98


Daily Volume for Mostal-Export
(WSE)
Volume
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1/2/96
3/13/96
5/29/96
8/9/96
10/22/96
1/9/97
3/21/97
6/9/97
8/20/97
10/30/97
1/20/98

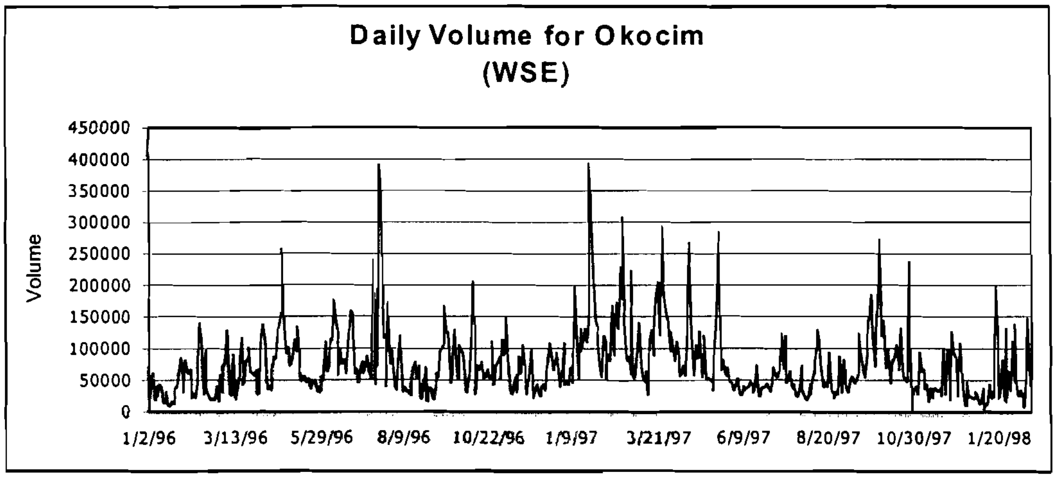
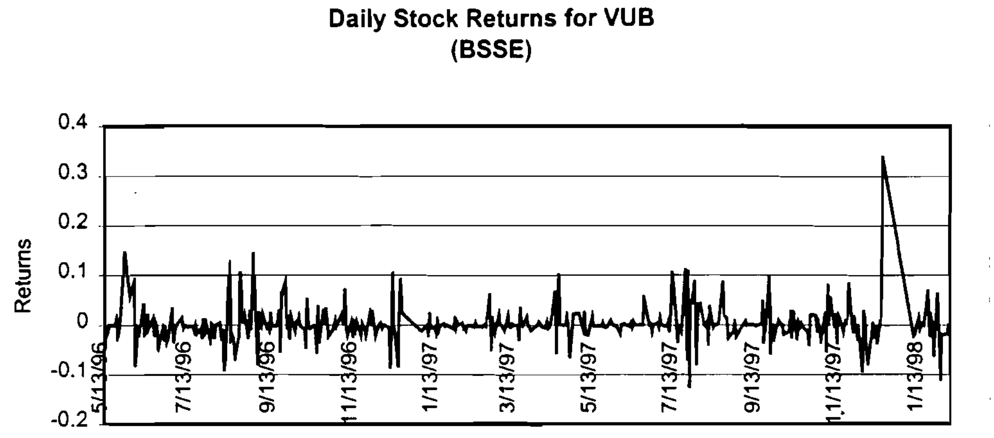
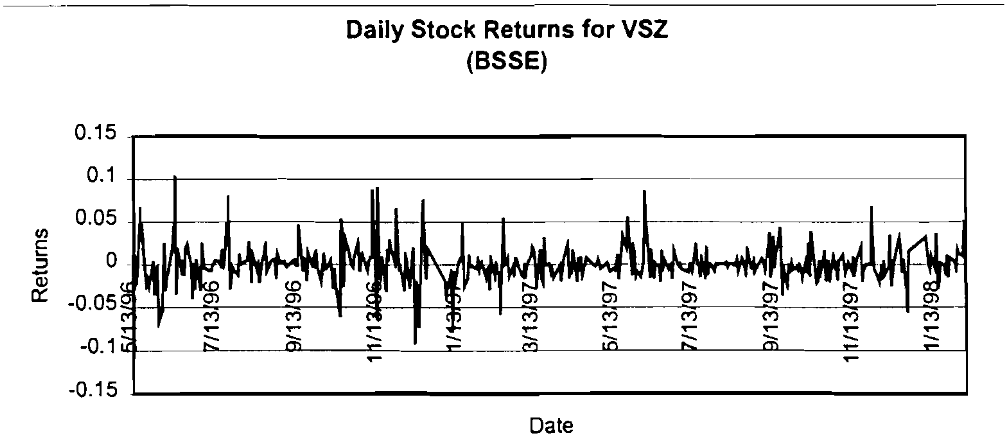
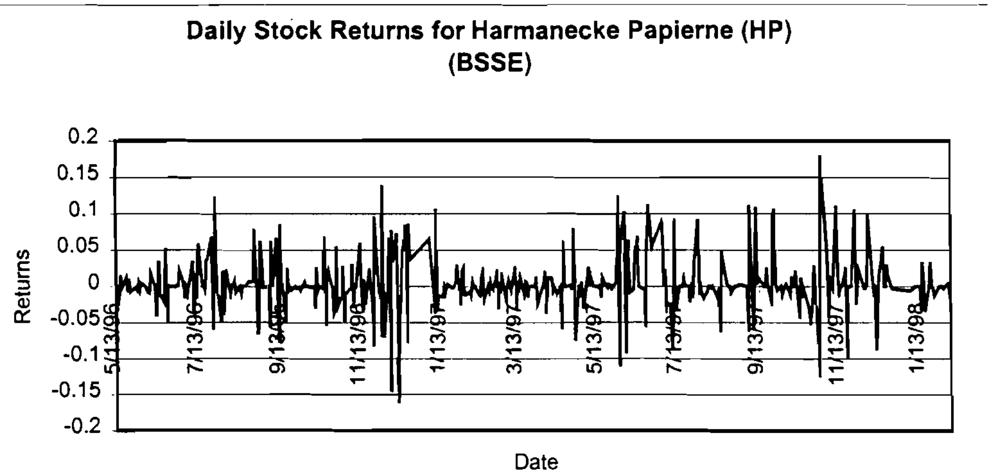

Daily Volume for Okocim
(WSE)
Volume
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1/2/96
3/13/96
5/29/96
8/9/96
10/22/96
1/9/97
3/21/97
6/9/97
8/20/97
10/30/97
1/20/98

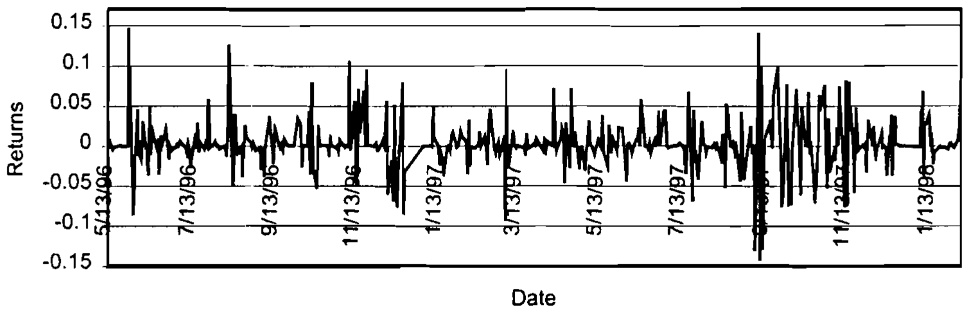
Figure 2a


Daily Stock Returns for VUB
(BSSE)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Returns
5/13/96
7/13/96
9/13/96
11/13/96
1/13/97
3/13/97
5/13/97
7/13/97
9/13/97
11/13/97
1/13/98


Daily Stock Returns for VSZ
(BSSE)
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
Returns
Date
5/13/96
7/13/96
9/13/96
11/13/96
3/13/97
5/13/97
7/13/97
9/13/97
11/13/97
1/13/98


Daily Stock Returns for Harmanecke Papierne (HP)
(BSSE)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Returns
Date
5/13/96
7/13/96
11/13/96
1/13/97
3/13/97
5/13/97
9/13/97
11/13/97
1/13/98

Daily Stock Returns for Slovnaft
(BSSE)



Daily Stock Returns for Nafta
(BSSE)

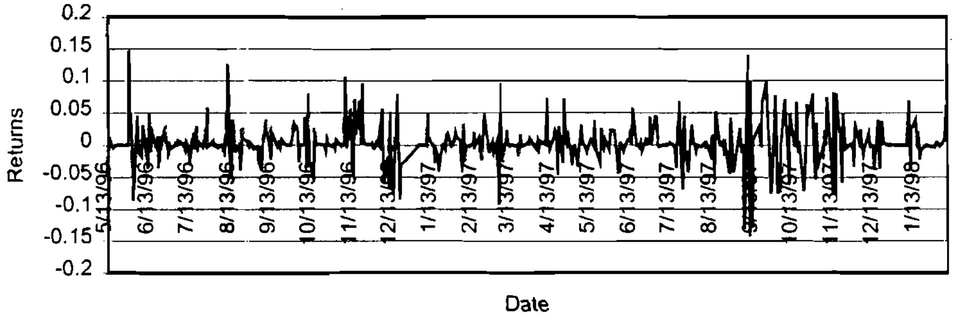
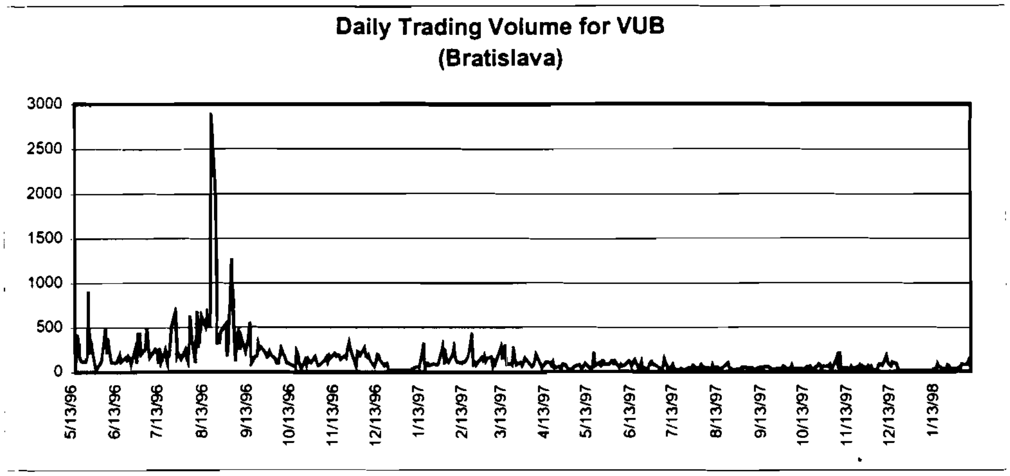


Figure 2b


Daily Trading Volume for VUB
(Bratislava)
3000
2500
2000
1500
1000
500
0
5/13/96
6/13/96
7/13/96
8/13/96
9/13/96
10/13/96
11/13/96
12/13/96
1/13/97
2/13/97
3/13/97
4/13/97
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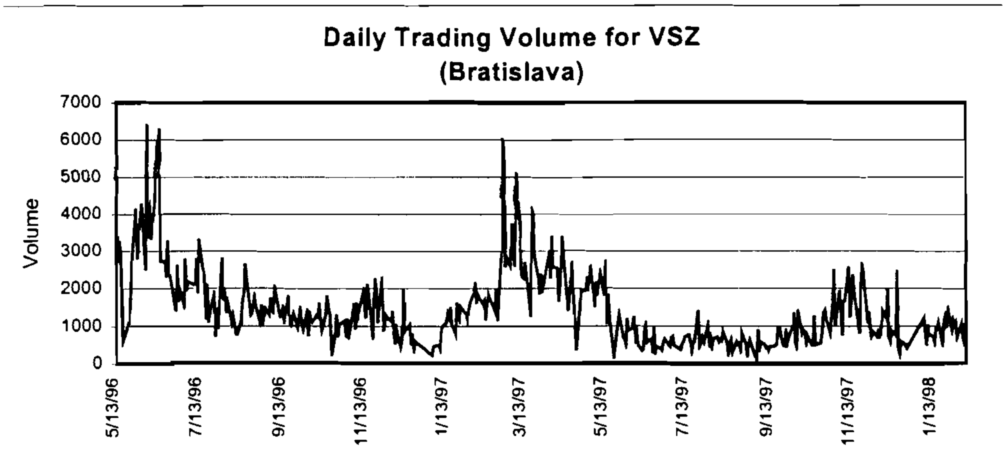
12/13/97
1/13/98


Daily Trading Volume for VSZ
(Bratislava)
Volume
7000
6000
5000
4000
3000
2000
1000
0
5/13/96
7/13/96
9/13/96
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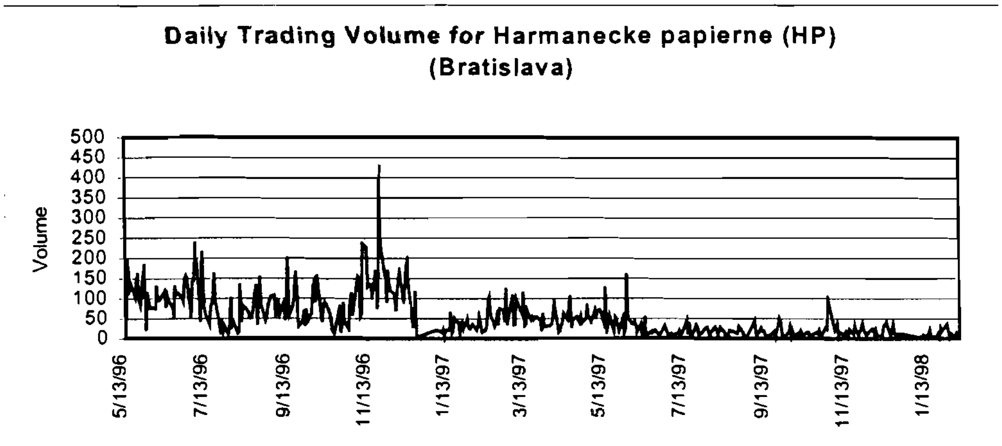
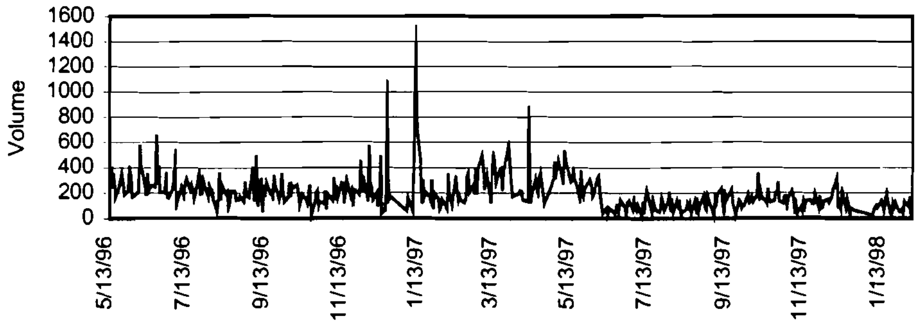
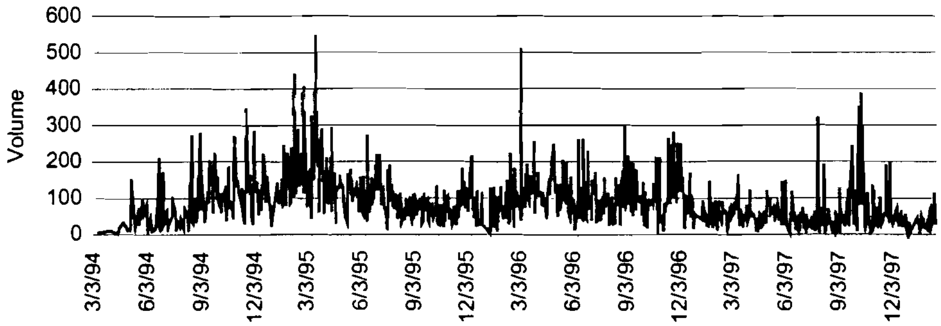
11/13/97
1/13/98


Daily Trading Volume for Harmanecke papierne (HP)
(Bratislava)
Volume
500
450
400
350
300
250
200
150
100
50
0
5/13/96
7/13/96
9/13/96
11/13/96
1/13/97
3/13/97
5/13/97
7/13/97
9/13/97
11/13/97
1/13/98

Daily Trading Volume for Slovnaft (Bratislava)



Daily Trading Volume for Nafta (Bratislava)



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