STOCK PRICE VOLATILITY AND TRADING VOLUME: EVIDENCE FROM SELECTED CEE FINANCIAL COMPANIES

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Abstract

One of the documented features of stock returns is their time-varying volatility that tends to become persistent and receives influences from daily trading volume. Our study proposes an empirical research regarding the relationship between stock prices volatility and trading volume for listed financial companies in seven CEE countries, all EU members. We use daily data of twelve selected CEE financial companies between January 2015 and December 2018 and we calculate daily stock returns. Also, we use daily trading volume of the stocks. Moreover, we estimate a Multivariate GARCH model based on the logarithmic transformation of daily stock returns and the respective trading volume and we apply Granger causality tests on the selected data in order to determine the relationship between the variables. The results show that for selected stocks from CEE countries a significant relationship between stock prices volatility and trading volume does not exist, compared to results of previous research on EU developed economies. Taking into consideration that we discover that in most situations the robustness of the models suffers from non-significant variance equation, in this region trading volume does not seem to have a predictive power for the CEE financial companies' share prices.

Key words: stock prices, volatility, trading volume, Central and Eastern Europe, GARCH.

JEL Code: G12, G15.

Introduction

Nowadays stock price changes and trading volume represent fundamental variables in the research on global financial markets. One of the documented features of stock returns is their time-varying volatility that tends to become persistent and receives influences from daily trading volume. In our investigation we consider CEE countries a very interesting region to examine because the stock markets are still underdeveloped and economically insignificant compared with the situation in Western European countries. The stock market from Poland, Czech Republic and Hungary are the best developed markets among the CEE countries. On the

other hand, the least developed CEE stock market is the Slovakian one[1]. At the same time, financial companies, and in particular banks, are considered systemically important institutions and their stability is essential both at national and European Union level.

This paper is structured as follows. Section 1 presents the empirical literature on the subject of the relationship between stock prices volatility and trading volume. Section 2 describes the data and the methodology. In the next section we presented and then discuss our results. Finally, Section 4 concludes and indicates directions for future research.

1 Literature Review

The relationship between stock prices volatility and trading volume fascinated financial researchers over the past three decades and this topic has been widely debated in the empirical literature. Karpoff (1987) explained the reasons why this relationship is so important to study. The author provided four main reasons. The first reason refers to the fact that this relationship provides insights into the financial markets structure, which can detail how information is disseminated. The second reason points out the great significance for event studies that use a combination of stock market returns and trading volume data in order to draw inferences. The third reason is represented by the fact that studying the relationship between stock prices volatility and trading volume is an integral part of the empirical distribution of speculative prices. The last reason is related to providing insights into future markets.

Even if most studies have confirmed the existence of positive contemporaneous relationship between stock prices volatility and trading volume, the study of different stock markets has offered mixed results regarding this relationship. For example, Gallant et al. (1992) examined the joint dynamics of price changes and volume using daily NYSE data from 1928 to 1987. They found that daily trading volume proved to be positively and nonlinearly related to the daily price movements. Also, Louhichi (2011) analysed the relationship between trading volume and volatility on Euronext. The author discovered a strong positive relationship and found out that introducing trading volume in the conditional variance of stock returns substantially diminishes the persistence of volatility. Moreover, the author discovered that the relationship between volatility and trading volume is intermediated by the number of trades. Furthermore, Chen (2012) found strong evidence of asymmetry in contemporaneous correlation between price changes and trading volume. The author concluded that stock returns are able to predict trading volume, but trading volume is not so capable in predicting returns, the evidence

[1] Considering their market capitalization of listed domestic companies at the end of 2018: Poland - €264,984 million, Czech Republic - €48,648 million, Hungary - €24,779 million and Slovakia - €4,841 million.

being weaker. On the other hand, Gebka and Wohar (2013) investigated the causality between trading volume and index returns in the Pacific Basin countries and found no causal relationship between trading volume and index returns.

While a huge amount of empirical evidence on the relationship between stock prices volatility and trading volume exists for developed and highly liquid stock markets, there are only a few studies on stock markets from CEE countries, to our knowledge. Thus, Bohl and Henke (2003) examined the relationship between daily stock returns and trading volume for twenty Polish stocks listed on the Warsaw Stock Exchange between 1999 and 2000. The authors used GARCH models and the results showed that in the most situations volatility persistence tends to fade when trading volume is incorporated in the conditional variance equation. Also, Gursoy et al (2009) investigated the relationship between trading volume and conditional volatility of stock returns using twelve emerging stock market indices between 2000 and 2006. Two Eastern European countries were included in their investigation, Czech Republic and Hungary. For the Czech stock market index, the coefficient for total trading volume proved to be insignificant. Overall, their findings demonstrated that all stock markets indices in their sample displayed a high degree of volatility persistence. The authors noticed that when trading volume is incorporated in the conditional variance equation, as a proxy for information flow, there is a small to moderate reduction in the volatility persistence of the stock market indices.

Rotila et al (2015) also investigated the relation between the stock market returns, trading volume and return volatility in the CEE countries but taking into account only the bank stocks for the period between 2005 and 2014 and using a GMM model, Granger causality and a variance decomposition technique. Their findings revealed that this relationship exists only under certain circumstances and it is a unidirectional relationship rather than a bidirectional relationship. Due to the relationship between the stock returns and trading volume after the financial crisis, their results showed that the relationship between stock returns, trading volume and volatility occurs only in the situation of small size stocks traded in the European Union zone, where the stock returns depend on both trading volume and their past values. Their results from Granger causality tests showed that the past values of trading volume could be used in order to forecast the values of stock return for domestic and large banks. Furthermore, for the financial crisis period, their findings confirm that the trading volume could be used in order to predict the future values of the return volatility. Another study on CEE countries belongs to Gurgul and Syrek (2017), who aimed at showing the differences in intraday patterns of volatilities and volumes across CEE stock markets at the company level. The authors discovered that the regularity of autocorrelation and intraday patterns depends a lot on the maturity level

of the CEE stock market. Overall, the limited amount of studies on stock markets from CEE countries provided mixed results regarding the relationship between stock prices volatility and trading volume. The researchers seem not to be so interested on investigating the companies from CEE.

2 Data and research methodology

Our study proposes an empirical research regarding the relationship between stock prices volatility and trading volume for listed financial companies in seven CEE countries, all members of the European Union: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania and Slovakia. For our research we use daily data of twelve selected CEE financial companies between January 2015 and December 2018 and we calculate daily stock returns. Also, we use daily trading volume of these stocks.

The logarithmic transformation of daily stock returns was calculated based on the following formula:

$$R_{i,t} = Ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \qquad (1)$$

Where $R_{i,t}$ represents the logarithmic return of the financial company's stock price i in period t, $P_{i,t}$ is the closing price of the financial company's stock price i in period t and $P_{i,t-1}$ is the closing price of the financial company's stock price i in period $t-1$.

Table 1 presents each selected CEE financial listed company, their market capitalization at end 2018 and the percentage in the total stock exchange market capitalization of the country.

Tab. 1: Selected financial companies and their market capitalization (2018)

Country	Country's market capitalization (€ million)	Financial company	Companies' market capitalization (€ million)	Share of company's market capitalization (%)
Bulgaria	1,712	CB First Investment Bank	190	11.07%
		Eurohold Bulgaria	163	9.50%
Croatia	1,457	Zagrebacka Banka	96	6.59%
Czech Republic	48,648	Erste Group Bank	15,150	31.14%
		Komercni Banka	6,664	13.70%
Hungary	24,779	Takarek Mortgage Bank	1,487	6.00%
		Forras Vagyonkezelesi Befektetesi	249	1.00%
Poland	264,984	Bank Polska Kasa Opieki	7,165	2.70%
		ING Bank Slaski	5,914	2.23%
Romania	30,658	Banca Transilvania	2,215	7.22%
		BRD Groupe Societe Generale	1,949	6.36%
Slovakia	4,841	Vseobecna Uverova Banka	673	13.90%

Source: The national stock exchanges (The Bulgarian Stock Exchange, The Zagreb Stock Exchange, The Prague Stock Exchange, The Budapest Stock Exchange, The Warsaw Stock Exchange, The Bucharest Stock Exchange and The Bratislava Stock Exchange), The World Bank, and www.investing.com.

ARCH models, introduced by Engle (1982), were the first to propose a conditional variance process with an autoregressive structure and log returns modelled as a white noise multiplied by the volatility. Later, Bollerslev (1986) extended the ARCH models in order to permit the variance to have a supplementary autoregressive structure within itself, thus creating the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model. In particular, the GARCH (1,1) model is widely used in the academic literature; the model consists of two main equations, one for the mean and another one for the variance of the time series:

$$R_t = \theta X' + \epsilon_t \qquad (2)$$

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (3)$$

Where the equation for the mean (2) includes exogenous variables (X') and an error term (ϵ), i.i.d. with an expectation of 0 and variance of 1. The conditional variance σ_t^2 specified in equation (3) is the one-period ahead forecast variance based on information from the past (σ_{t-1}^2), news about the volatility of the previous period – i.e. the one-period lag of the squared residuals in equation (2), or the ARCH term – and the constant ω. The GARCH(1,1) means that a first-order autoregressive GARCH term (the first 1 in parentheses) and a first-order moving average ARCH term (the second 1 in parentheses) are present in the estimation. The coefficients α and β are the parameters of the model.

We use a two-stage GARCH(1,1) model proposed by Omran and McKenzie (2010) to investigate the link between trading volume and stock prices volatility building on the information flow hypothesis (Karpoff, 1987). This hypothesis explains the positive correlation between the trading volume and the absolute returns of stock prices by the positive correlation between volume and variances of returns, on one hand, and the unobserved number of new information arrivals to the market. In the first stage of the model we estimate a GARCH(1,1) for each stock in our sample as follows:

$$R_{i,t} = a_{i,0} + b_1 R_{i,t-1} + \varepsilon_{i,t} \qquad (4)$$

$$\sigma_{i,t}^2 = \alpha_{i,0} + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \beta_{i,1}\sigma_{i,t-1}^2 \qquad (5)$$

Where $R_{i,t}$ is the logarithmic return of stock prices and $\varepsilon_{i,t} \sim N(0, \sigma_{i,t}^2)$. We include in Equation (4) an autoregressive term of order 1 in order to correct the small but significant first-order autocorrelation in mean returns. Equation (5) describes the variance of unexpected stock return as a GARCH (1,1) process where the sum of parameters $\alpha_{i,1}$ and $\beta_{i,1}$, which lies between 0 and 1, measures the volatility persistence in stock returns.

In the second stage of the model we add a term for trading volume in the conditional variance equation:

$$\sigma_{i,t}^2 = \alpha_{i,0} + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \beta_{i,1}\sigma_{i,t-1}^2 + \omega_{i,1}V_{i,t} \qquad (5)$$

Thus, if trading volume is a proxy for new information that arrives in the market, then coefficient $\omega_{i,1}$ is higher than zero and the sum of $\alpha_{i,1}$ and $\beta_{i,1}$ is negligible.

In both stages of the model, the parameters are estimated jointly using the Berndt-Hall-Hall-Hausman optimization algorithm in Eviews and the Q-statistic is used to test the hypothesis of the lack of GARCH effects in the residuals (Omran and McKenzie, 2010).

The GARCH(1,1) model is complemented by a Granger causality test on the relationship of stock returns' unconditional volatility and trading volume. The Granger causality tests were developed by Granger (1969) and represents a statistical concept of causality between two variables in time series data based on prediction power; thus, in terms of Granger causality, a variable X causes (more specifically, Granger-causes) another variable Y if past values of X help predicting Y above and beyond the past values of Y alone. The mathematical formulation of Granger causality is based on linear regression.

3 Main results and discussions

Table 2 displays the results of the first-stage GARCH(1,1) model estimations that do not include trading volume in the equation. We notice that the Q-statistic at the lag 10 for the squared returns are statistically significant for half of the investigated CEE financial companies. This fact indicates the existence of GARCH effects for these six financial companies. Moreover, these results suggest that the persistence in volatility as measured by the sum of α_1 and β_1 proved to be very high in half of the cases, higher than 0.9 in the case of six out of twelve financial CEE companies. On the other hand, the Q-statistics at the lag 10 for the squared standardized residuals do not display significant GARCH effects except for only one CEE financial company (Eurohold Bulgaria).

Table 3 presents the results of the second-stage GARCH(1,1) model estimations. We find that the coefficient of trading volume is statistically significant for five out of twelve CEE financial companies. As in the case of the first-stage GARCH(1,1) model estimations, the persistence in volatility as measured by the sum of α_1 and β_1 proved to be very high in half of the cases, higher than 0.9 in the case of six out of twelve financial CEE companies. Also, the Q-statistics at the lag 10 for the squared standardized residuals do not display significant GARCH effects except for only one CEE financial company (Eurohold Bulgaria). Moreover, the values for coefficient $\omega_{i,1}$ are not different than zero, which confirms the lack of the trading volume as an explanatory variable for the conditional volatility of returns of financial

companies in CEE countries. Overall, these results suggest that when including the trading volume in the variance of stock returns, the persistence in volatility does not change very much and GARCH effects are no longer present in the residuals of this model. This may be explained by the general lower volume of trading in the regions' stock exchanges and we expect this relationship to be altered once CEE financial markets increase their liquidity.

Tab. 2: Results of the first-stage GARCH(1,1) model estimations

Financial companies	$\alpha_1 + \beta_1$	$Q^2_{10}R$	$Q^2_{10}U$
CB First Investment Bank	0.735	20.568*	4.395
Eurohold Bulgaria	1.031	22.973*	34.916*
Zagrebacka Banka	0.902	28.829*	4.764
Erste Group Bank	0.943	9.533	7.180
Komercni Banka	0.997	16.678	13.952
Takarek Mortgage Bank	0.905	10.055	3.406
Forras Vagyonkezelesi Befektetesi	0.830	20.093*	4.300
Bank Polska Kasa Opieki	0.953	10.606	6.365
ING Bank Slaski	0.835	10.937	5.692
Banca Transilvania	0.871	15.357	1.082
BRD Groupe Societe Generale	0.666	20.097*	2.768
Vseobecna Uverova Banka	0.899	63.160*	4.307

Note: * indicates statistically significant at least at the 5% level.
Source: Authors' calculations.

Tab. 3: Results of the second-stage GARCH(1,1) model estimations

Financial companies	ω_1	$\alpha_1 + \beta_1$	Q^2_{10}
CB First Investment Bank	0.000	0.725	4.388
Eurohold Bulgaria	0.000	1.025	40.642*
Zagrebacka Banka	0.000	0.908	4.905
Erste Group Bank	0.000*	0.900	9.479
Komercni Banka	0.000	0.967	7.937
Takarek Mortgage Bank	0.000*	0.881	12.243
Forras Vagyonkezelesi Befektetesi	0.000*	0.820	4.615
Bank Polska Kasa Opieki	0.000*	0.930	5.576
ING Bank Slaski	0.000*	0.859	5.242
Banca Transilvania	0.000	0.947	2.652
BRD Groupe Societe Generale	0.000	1.117	3.990
Vseobecna Uverova Banka	0.000	0.879	3.699

Note: z-statistics are in brackets and * indicates statistically significant at least at the 5% level.
Source: Authors' calculations.

The causal relationship between stock prices volatility and trading volume was tested using F-statistic test, by applying the Granger Causality approach. The results in Table 4 show causal relationships between stock prices volatility and trading volume. The first null hypothesis supposes that stock prices volatility does not Granger causes trading volume and the second null hypothesis supposes that trading volume does not Granger causes stock prices

volatility. Our findings revealed the fact that in most cases there is no significant causal relationships between stock prices volatility and trading volume. We discover that in the case of only three out of twelve financial CEE companies, stock prices volatility causes trading volume and in the case of only one company, trading volume causes stock prices volatility.

Tab. 4: Causal relationships between stock price changes and trading volume

Financial companies	F-statistic	
	Null hypothesis: $VOL_t \Rightarrow V_t$	Null hypothesis: $V_t \Rightarrow VOL_t$
CB First Investment Bank	1.423	1.505
Eurohold Bulgaria	0.125	0.982
Zagrebacka Banka	0.447	0.363
Erste Group Bank	1.128	0.154
Komercni Banka	2.229*	0.498
Takarek Mortgage Bank	0.112	0.396
Forras Vagyonkezelesi Befektetesi	0.122	1.191
Bank Polska Kasa Opieki	2.043*	0.789
ING Bank Slaski	0.882	0.777
Banca Transilvania	0.638	2.565*
BRD Groupe Societe Generale	0.175	0.138
Vseobecna Uverova Banka	1.863*	0.385

Note: VOL_t denotes return volatility and * indicates statistically significant at least at the 5% level.
Source: Authors' calculations.

Conclusion

Our study proposes an empirical research regarding the relationship between stock prices volatility and trading volume for listed financial companies in seven CEE countries, all EU members. The results of this research show that for selected stocks from CEE countries does not exist any significant relationship between stock prices volatility and trading volume, which contradicts the results of previous research on EU developed economies. Taking into consideration that we discover that in most situations the robustness of the models suffers from non-significant variance equation, in this region trading volume does not seem to have a predictive power on these twelve selected CEE financial companies' share prices. This may be explained by the general lower volume of trading in the regions' stock exchanges and we expect this relationship to be altered once CEE financial markets increase their liquidity.

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