ZESZYTY NAUKOWE UNIWERSYTETU SZCZECIŃSKIEGO nr 854
Finanse, Rynki Finansowe, Ubezpieczenia nr 73 (2015)

s. 633–644

Do Public News Announcements Matter? The Case of Intraday Returns, Volume and Volatility Relations in Selected European Markets*

Henryk Gurgul, Łukasz Lach**

Abstract: *Goal* – The main goal of this paper is to analyse information flow on and between three European stock markets operating in Frankfurt, Vienna and Warsaw.
Methodology – We used ARMA(1,1)-EGARCH-M(1,1) to model conditional variance and then we investigated Granger causality on three stock exchanges operating in Frankfurt, Vienna and Warsaw using the Bayesian large sample correction of the critical values in significance tests.
Results – The results of our study confirm the dominant role of the Frankfurt Stock Exchange since the most significant relationship is the causality from DAX30 returns to the returns of ATX20 and WIG20 which is observed irrespective of the time of the day and the presence of important public news. Moreover, the empirical results of this paper confirm the strong impact of the announcements of macroeconomic news from the U.S. economy on the structure of causal links on the markets analysed.
Originality – To the best of our knowledge, this paper is one of the first contributions that fills the gap in the existing literature by examining the impact of U.S. macroeconomic news announcements on dynamic relations between intraday returns, volatility and trading volume on the three selected European markets.

Keywords: trading volume; return volatility; public news; sequential information arrival; Granger causality

Introduction

In economic literature there are two main conjectures about the way that new information impacts the dynamic relationships between variables describing stock prices – the *Sequential Information Arrival Hypothesis* (SIAH), introduced by Copeland (1976) and assuming that not all traders receive new information at exactly the same time (they receive it sequentially), and the *Mixture of Distribution Hypothesis* (MDH) from Clark (1973) which in turn assumes that new public information is received by all investors contemporaneously.

In order to judge which of the abovementioned hypotheses is supported by empirical evidence an analysis of causal relations between returns, volatility and trading volume on

* Financial support for this paper is from the National Science Centre of Poland (Research Grant DEC-2012/05/B/HS4/00810) is gratefully acknowledged.

** prof. Henryk Gurgul, Head of Department of Applications of Mathematics in Economics, AGH University of Science and Technology in Cracow, al. A. Mickiewicza 30, 30-059 Cracow, e-mail: henryk.gurgul@gmail.com; Łukasz Lach, PhD, Department of Applications of Mathematics in Economics, AGH University of Science and Technology in Cracow, al. A. Mickiewicza 30, 30-059 Cracow, e-mail: llach@zarz.agh.edu.pl.

a given stock market in the presence of public news and without them is usually conducted. Such an analysis also reflects the behaviour of investors and allows analysing cross-country dependencies which in turn can help to describe information flow between different stock markets and answer the question which market is the leading one that generates signals to investors on other stock markets.

The main goal of this paper is to analyse information flow on and between three stock markets: in Frankfurt, Vienna and Warsaw. These are very different stock markets as the capitalization of the Frankfurt Stock Exchange (FSE) is about ten times greater than the capitalization of the Warsaw Stock Exchange (WSE) and the Vienna Stock Exchange (VSE).[1] However, in some aspects the VSE and WSE are similar and have been quoted for a similar period of time (ATX20 index (VSE) is quoted from January 2 1991 and the WIG20 index (WSE) is used from April 16 1994). The VSE and WSE are among the largest stock markets in Central and Eastern Europe. In addition, in recent years the VSE and WSE have been competing markets. On the other hand, the FSE and VSE are developed markets, while the WSE is still an emerging market. Last but not least, Germany is the most important trading partner for both the Austrian and Polish economies. These observations show that the FSE, VSE and WSE may be interrelated.

1. Literature overview

Since this paper focuses on intraday relations we will not refer to the large body of papers concerned with an analysis of dynamic dependencies between stock returns, volatility and trading volume on the basis of daily data. Moreover, an analysis of this type of dependencies seems much more comprehensive when looking from the perspective of detailed information included in high frequency data.

Rossi and de Magistris (2010) analysed the relationship between volatility and trading volume on the basis of intraday data. The authors showed that volume and volatility exhibit long memory but they are not driven by the same latent factor as suggested by the fractional cointegration analysis. They showed that past (filtered) log-volume has a positive effect on current (filtered) log-volatility and current log-volume.

Using a nonparametric test based on Bernstein copula Bouezmarni et al. (2012) tested for causality between stock returns and trading volume using high frequency data. They showed that the results of a nonparametric test support causality running from returns to volume.

In the literature it is often underlined that series of log-volume and log-volatility are dependent on extremes. Luu and Martens (2003) conducted some tests with a mixture of distributions hypothesis using realized volatility. They found bidirectional causality between re-

[1] For more details see Federation of European Securities Exchanges, www.fese.eu.

alized volatility and the trading volume of S&P500 index future contracts. However, MDH was not supported when using daily returns.

Also Darrat et al. (2003) using intraday trading data for 30 stocks in the DJIA found that high trading volume causes high return volatility in accordance to the SIAH, but contrary to the MDH. The crucial role in the assessment of the validity of MDH versus SIAH for particular stock markets plays the pattern (contemporaneous or dynamic) of dissemination of public news to market participants. It is also widely accepted that the announcement of macroeconomic data may be a source of important public information for market participants. However, the methods applied by Darrat et al. (2003) were not able to distinguish between SIAH and other plausible explanations of the observed causal relationships (like the overconfidence hypothesis). One of the ways to distinguish between these two alternative views is to take into account information at the exact time of the announcement of public news. When there are no public signals, rational investors do not change their positions and thus no causal link between volume and volatility is expected. When looking from the perspective of a behavioural approach, investors do not require the presence of public signals to trade, however. Therefore, even in case of the absence of public signals, quasi-rational investors may still overreact to their individual signals which may result in trading execution.

In one of the more recent papers Darrat et al. (2007) re-examined lead-lag relations between trading volume and the volatility of stocks issued by large and small companies from the NYSE in two cases: periods with and without identifiable public news.[2] The authors provided evidence supporting the SIAH during periods with public news but they also showed that the trading volume Granger-causes return volatility also in periods without public news. Moreover, all these results were invariant with respect to the different times of the day. It is worth noting that some of the results of Darrat et al. (2007) support the self-attribution model of Daniel et al. (1998) suggesting that investors are often *overconfident*.

2. Methodology and dataset

2.1. Testing for Granger causality using sizeable data

One of the most common approaches in the research concerning returns, return volatility and trading volume interrelations is the concept of *Granger causality* (Granger, 1969) that can be understood as a special kind of conditional dependency. Since nowadays this idea is rather well known and has been widely used in previous studies there is no need to explain it in detail. By and large, this concept is used to investigate whether knowledge of the past

[2] This contribution refers to the works of Pritamani and Singal (2001) and Chan (2003), who proposed a similar procedure although in different contexts. Taking into account a subset of stocks from the time period of 1990–1992 Pritamani and Singal (2001) analysed return predictability following announcements and large price changes. Chan (2003) collected news headlines for a subset of Center for Research in Security Prices (CRSP) stocks from 1980–2000. He compared monthly returns following public news and returns after similar price movements in the absence of public news.

values of one (stationary) variable is helpful in predicting the future values of another one or not. In practice, the statistical significance of the coefficient estimators of the potentially causal (explanatory) variable in the respective Vector AutoRegression (VAR) model implies the existence of linear causality running from this explanatory variable to the endogenous variable. In case of a non-stationary time series the results of the traditional (VAR-based) test for Granger causality can be spurious (Granger and Newbold, 1974; Phillips, 1986), thus one should use an alternative approach depending on whether the time series under study are cointegrated (testing for causality via Vector Error Correction Models) or not (differencing, the Toda-Yamamoto (1995) approach).

However, in case of sizeable data the traditional asymptotic-based test for causality often leads to over rejection (Darrat et al. 2007). At this place one may ask an interesting question about the critical sample size. The larger samples are sources of significant size distortion. To shed some light on this issue we ran a simple Monte Carlo simulation. First, we generated N=1000 realizations of two independent time series, each with a length of n = 6000 observations. For each time series we assumed AR (5) structure in the mean equation and EGARCH (1,1) structure in the variance equation.[3] Next, for the generated data we used EGARCH (1,1) filtering and tested for Granger in-mean-causality using estimated VAR models with different lag lengths. To check the dependence between sample size and test size we used the first 200, 400, 600 and finally all 6,000 observations. For each chosen sample size we considered three lag levels and ran causality tests at 5% significance level. As a criterion of the bad size performance of the causality test we used the suggestions of Dolado and Lütkepohl (1996), Mantalos (2000) and Lach (2010) and considered a two-sided confidence interval given by the following formula:

$$T_s \pm 2\sqrt{\frac{T_s(1-T_s)}{N}},$$

where T_s denotes nominal size (5%) and N = 1000 stands for the number of repetitions.[4] This is how the confidence interval [3.2%; 6.3%] was created. This approach leads to the criteria of bad performance, namely, actual test size is significantly distorted whenever it lies outside the suitable confidence interval.

[3] Such features are typical for financial intraday data (Darrat et al., 2007). Details on the Monte Carlo exercise are available from the authors upon request.

[4] We decided to use N = 1000 replications to allow the comparability of our results with previous papers dealing with the size performance of the Granger causality test (the same number of replications in the Monte Carlo experiments was used by Dolado and Lütkepohl (1996), Hacker and Hatemi (2006), Mantalos (2000) and Lach (2010), among others). Moreover, the same type of confidence intervals was used by Dolado and Lütkepohl (1996), Mantalos (2000) and Lach (2010).

Table 1

Actual size performance of the traditional causality test – Monte Carlo example*

VAR lag length	Sample size			
	200	400	600	6,000
5	0.0505	0.0611	0.0921	0.1221
10	0.0514	0.0625	0.0932	0.1332
15	0.0540	0.0670	0.0982	0.1582

* Shading indicates significant over rejection according to the confidence interval. Nominal size is equal to 5%. In each case the number of replications is equal to 1,000.

Source: own elaboration

As one can see from Table 1, increasing sample size and lag length leads to more significant size distortion in the asymptotic variant of the Granger causality test. It is important to underline that size distortion becomes a serious problem already for around 600 observations. To avoid the problem of the over rejection implied by the large size of the data in the causality tests instead of asymptotic critical values we applied the Bayesian critical values suggested by Darrat et al. (2007).

2.2. Empirical applications

Describing information flow on the stock markets under study and between them requires examining causal relationships in the presence of important public information and in periods without such information. Because of on-going globalization leading to the continuous inflow of new information it is rather difficult to indicate periods without important information understood here as news essential to investors on all of the three stock markets under study. Among the possible candidates, the macroeconomic news announcements from the U.S. economy seem to be suitable events. This prediction follows from previous contributions which supplied evidence that some macroeconomic news announcements may significantly impact stock markets.[5] Since the U.S. economy plays a predominant role all over the world macroeconomic news from this economy is most influential. Henceforth we define *trading session with information* when at least one of the following U.S. macroeconomic indicators was announced: Consumer Price Index, Producer Price Index, Industrial Production, Retail Sales, Durable Goods Orders, Nonfarm Payrolls, Existing Home Sales, Housing Starts, New Home Sales and Consumer Confidence.[6] In this paper we applied intraday data covering the period of April 2013 – August 2013. Data comes from the Vienna Stock

[5] In most cases the impact of U.S. announcements is even stronger than the impact of domestic macroeconomic data announcements (see e.g. Andersen et al., 2007; Nikkinen and Sahlström, 2004; Nikkinen et al., 2006; Harju and Hussain, 2011; Gurgul and Wójtowicz, 2014).

[6] These macroeconomic indicators are released monthly on different days of the month between 14.00 CET and 16.00 CET. The latter ensures that the impact of these announcements can be directly observed in stock prices, particularly in the values of all the indices.

Exchange, the Warsaw Stock Exchange and Bloomberg data bases. We considered 1-minute log-returns of the main index of each of the markets, namely DAX30 (FSE), ATX20 (VSE) and WIG20 (WSE).[7] We used the ARMA (1,1)-EGARCH-M (1,1) model of Darrat et al. (2007) to obtain conditional variances which we then used as proxies of return volatility.

In the economic literature one may find several measures of investors trading activity among which trading volume (the number of shares traded) and turnover (the total value of shares traded) are most often used. To allow comparability with the outcomes of previous studies in the empirical part of our study we used the intraday trading volume.[8] More precisely, we computed the difference between the total trading volume index at the end and at the beginning of each 1-minute interval. Such a quantity describes the number of shares from a given index traded during a given 1-minute interval. This 1-minute trading volume, however, is highly skewed. To deal with this issue in further analysis we applied natural logarithms of 1-minute trading volume. The stock markets under study are open in different hours and there are intraday auctions at different times during the day.[9] At the same time causal relationships must be analysed only in the periods when all three markets are open and thus may influence each other. Taking into account these observations along with an increased return volatility at the beginning and at the end of trading session, we studied the relationships between intraday returns, return volatility and trading volume of the DAX30, ATX20 and WIG20 in two periods during trading days. The first period ranged from 9:15 to 11:45 and the second lasted from 14:35 to 16:50. These periods started at least 15 minutes after the beginning of continuous trading on each of the markets and ended at least 30 minutes before the end of trading sessions. To avoid potential problems with modelling the increased volatility just before or just after intraday auctions on the Frankfurt or Vienna Stock Exchanges we also applied 15-minute gaps before and after the intraday auctions.

3. Empirical results

3.1. Morning session

One may refer to the first period (9:15–11:45) as to a *morning period* when there are no U.S. news announcements observed, whereas in the second period (14:35–16:50) – the *afternoon period* – U.S. stock markets are opened and U.S. macroeconomic news is announced. The analysis of the relationships between returns, volatility and trading volume in these two periods on days when the U.S. macroeconomic news is announced and on days without such

[7] We applied 1-minute returns (instead of, for example 5-minute returns) because as indicated by the literature (Dimpfl, 2011; Gurgul and Wójtowicz, 2014) new public information on the efficient stock markets implies investors' reaction as soon as it is announced, often even in the first minute after the release of news.

[8] See e.g. Bollerslev and Jubinski (1999), Lobato and Velasco (2000), Darrat et al. (2007), Rossi and de Magistris (2010).

[9] On the FSE there is the intraday auction from 13:00 to 13:02. On the VSE the intraday auction lasts from 12:00 to 12:07:30 on settlement days or from 12:00 to 12:04 on non-settlement days of the derivatives market.

announcements allows for describing causality in the presence of public information and without it which is particularly important in the context of SIAH and the overconfidence hypothesis.

In the first step we analysed causalities during morning sessions on days without important U.S. macroeconomic news announcements. In that time trading is based on private information only and – in consequence – it is possible to examine the rationality of investors. In the next step we focused on the days with U.S. news announcements. This way we could test the effects of public news announcements on the structure of causal links on and between the markets under study.

Table 2 presents the results of the Granger causality tests for both periods (with and without information flow). Since the sample size exceeds 600 by far we rely on Bayesian critical values in order to avoid the over rejection. The empirical results indicate that in the morning period there are only two significant causal links which lead from returns of DAX30 to the returns of ATX20 and WIG20. This result indicates the dominant role of the Frankfurt Stock Exchange between the stock markets under study. If stock exchanges in the U.S. are closed and no important news from the U.S. economy is expected, traders in Vienna and Warsaw make their investment decisions upon the observation of price movement on the larger and the more liquid stock exchange in Frankfurt. Hence, prices on the VSE and WSE simply follow prices on the FSE.

When important macroeconomic data from the U.S. economy is expected to be announced, causalities on the FSE, VSE and WSE in the morning period from 9:15 to 11:45 do not change significantly. As in previous cases, the significant Granger causality from DAX30 returns to the returns of ATX20 and WIG20 is observed and one may claim this is the main way that information form the FSE is transmitted to the CEE stock markets under study.

3.2. Afternoon session

Analysing the results presented in Table 3 (causalities in the afternoon periods with and without important U.S. macroeconomic news announcements) one can notice several important facts. First of all, in both types of periods causalities from DAX30 returns to returns of ATX20 and WIG20 are also observed. In days without important U.S. macroeconomic announcements, however, one may additionally notice two feedbacks between the volatilities of DAX30 and ATX20 as well as between the volatilities of DAX30 and WIG20.

After important macroeconomic data from the U.S. economy are announced, causalities on the FSE, VSE and WSE in the afternoon period change significantly. First of all, we can see an increased causal impact running from DAX30 returns and return volatility to returns and the volatilities of stock markets in Warsaw and Vienna. After the arrival of new information in the afternoon session one can also notice that causal links between WIG20 and ATX20-related variables become significant with a stronger impact of the Warsaw Stock

Table 2

F statistics in Granger causality tests between returns (R), volatility (σ) and trading volume (V) of DAX30, WIG20 and ATX20 on the morning session

		Days without information inflow									Days with information inflow								
		WIG20			DAX30			ATX20			WIG20			DAX30			ATX20		
Cause		R	σ	V	R	Σ	V	R	σ	V	R	Σ	V	R	σ	V	R	σ	V
	R							2.11							2.01		4.69		
WIG20	σ						2.13	2.61			1.68		2.01	3.52	1.72		2.46		
	V		3.98							1.87		1.98					1.86		
	R	6.73	2.19			2.69		12.45	2.57		11.83		1.64				13.30		
DAX30	σ		2.80		2.55		2.30	2.63	2.88	3.36	2.36	3.31							
	V				2.57	2.11		1.76	2.52			2.58	3.47					1.86	3.24
	R	1.71	2.45							1.96		1.78							
ATX20	σ	1.91						2.72			2.42	3.99	2.66				1.75		1.93
	V	1.72				2.03							1.85						

Notes: Bayesian critical value is equal to 6.50. Asymptotic critical value for 10% significance level is equal to 1.61. Shading indicates significant Granger causality (based on the Bayesian critical value).

Table 3

F statistics in Granger causality tests between returns (R), volatility (σ) and trading volume (V) of DAX30, WIG20 and ATX20 on the afternoon session.

		Days without information inflow									Days with information inflow								
		WIG20			DAX30			ATX20			WIG20			DAX30			ATX20		
Cause		R	σ	V	R	σ	V	R	σ	V	R	Σ	V	R	σ	V	R	σ	V
	R				2.14	4.99		2.01				6.28					4.69		6.571
WIG20	σ				2.55	**14.66**					**10.35**			1.82	4.50		5.97	14.48	
	V		1.66										2.82						1.879
	R	5.99		2.15				**7.64**	2.72	1.637	9.40	7.95			1.76		18.94	6.11	
DAX30	σ	1.79	**6.26**		2.51		1.81	3.93	**6.78**	1.952	6.46	19.47		3.61		1.88	**6.46**	**21.39**	1.689
	V					2.19		1.80		1.661		1.87	1.94					2.73	2.138
	R					2.54			3.26		3.54	3.51						3.14	
ATX20	σ				5.08	**7.10**				2.368	3.63	**9.88**		4.97	3.03		5.99		
	V						1.68										1.80		

Notes: Bayesian critical value is equal to 5.96. Asymptotic critical value for 10% significance level is equal to 1.61. Shading indicates significant Granger causality (based on the Bayesian critical value).

Exchange on the Vienna Stock Exchange.[10] One can notice that in case of the WSE and VSE the domestic causal links from return volatility to returns become significant.[11] On the other hand, in case of the FSE no domestic causal relation was identified in any period.

The results for the afternoon session confirmed the dominant role of the Frankfurt Stock Exchange. After the arrival of new information both returns and return volatility on smaller markets are strongly influenced by the corresponding variables on the FSE.

Conclusions

To the best of our knowledge, this paper is one of the first contributions that fills the gap in the existing literature by examining the impact of U.S. macroeconomic news announcements on dynamic relations between intraday returns, volatility and trading volume on three selected European markets. We used ARMA(1,1)-EGARCH-M(1,1) to model the conditional variance and then investigated Granger causalities on three stock exchanges operating in Frankfurt, Vienna and Warsaw using the Bayesian large sample correction of the critical values in significance tests.

The results of our study confirm the dominant role of the Frankfurt Stock Exchange since the most significant relationship is the causality from DAX30 returns to the returns of ATX20 and WIG20 which is observed irrespective of the time of the day and the presence of important public news. The significant causalities form DAX30 returns to the returns of WIG20 and ATX20 indicated the possibility of using the DAX30 data to improve the modelling and forecasts of stock prices on CEE stock markets.

The second important conclusion refers to the role of public news announcements on the structure of causal links on and between the markets under study. The empirical results of this paper confirm the strong impact of the announcements of macroeconomic news from the U.S. economy on the structure of causal links between returns, volume and return volatility on the European stock markets under study. After the arrival of new information more causal links become significant, especially those running from DAX30 returns and volatility to the corresponding variables on the remaining two markets.

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[10] The only significant (with respect to the Bayesian critical value) causal link involving trading volume is the link running from WIG20 returns to ATX20 trading volume. On the other hand, there is a group of trading-volume-related links which turned out to be significant only in an asymptotic-based variant.

[11] In the case of WSE there is even a feedback relation between returns (R) and volatility (σ).

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DO PUBLIC NEWS ANNOUNCEMENTS MATTER? THE CASE OF INTRADAY RETURNS, VOLUME AND VOLATILITY RELATIONS IN SELECTED EUROPEAN MARKETS

Abstract: *Cel* – Głównym celem pracy jest analiza przepływu informacji na/pomiędzy trzema europejskimi giełdami działającymi we Frankfurcie, Wiedniu i Warszawie.
Metodologia – Oszacowania zmienności uzyskano w oparciu o model ARMA (1,1)-EGARCH-M (1.1), a następnie zbadano zależności przyczynowe w sensie Grangera na trzech analizowanych giełdach, używając (ze względu na rozmiar próbki) bayesowskiej korekty wartości krytycznych.
Wyniki – Wyniki badań potwierdzają dominującą rolę Frankfurckiej Giełdy Papierów Wartościowych - najbardziej znaczącym oddziaływaniem jest związek przyczynowy przebiegający w kierunku od stóp zwrotu DAX30 do stóp zwrotu ATX20 i WIG20, który obserwuje się niezależnie od pory dnia i obecności (lub braku) napływu ważnych informacji publicznych. Co więcej, wyniki empiryczne potwierdzają silny wpływ makroekonomicznych ogłoszeń dotyczących amerykańskiej gospodarki na strukturę związków przyczynowych na analizowanych rynkach.
Oryginalność – Zgodnie z najlepszą wiedzą autorów, artykuł ten jest jedną z pierwszych prób wypełnienia luki w literaturze przedmiotu poprzez analizę wpływu makroekonomicznych ogłoszeń dotyczących amerykańskiej gospodarki na strukturę związków przyczynowych pomiędzy stopami zwrotu, zmiennością i wolumenem transakcji na trzech wybranych europejskich rynki w oparciu o wykorzystanie danych typu intraday.

Słowa kluczowe: obrót, powrót zmienności, wiadomość publiczna, przyczynowości Grangera

Citation

Gurgul H., Lach Ł. (2015), *Do Public News Announcements Matter? The Case of Intraday Returns, Volume and Volatility Relations in Selected European Markets*, Zeszyty Naukowe Uniwersytetu Szczecińskiego nr 854, „Finanse, Rynki Finansowe, Ubezpieczenia" nr 73, Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin, s. 633–644; www.wneiz.pl/frfu.