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The Impact of Macro News on Volatility of Stock Exchanges[†]

A b s t r a c t. The vast of literature concerning the reaction to macroeconomic announcements focus on American releases and their impact on returns and volatility. We are interested if the news from the German and the Polish economy are significant for the stock exchanges in these two countries. Using high-frequency 5-minute returns from 2009-2010 we show that the periodical patterns of the German and the Polish main indices is very similar and their reaction to the macroeconomic announcements too. In both cases the domestic and neighbor-country announcements are much less important comparing to American releases.

K e y w o r d s: high frequency data, macroeconomic announcement, flexible Fourier form, intraday periodicity, volatility modeling.

Introduction

A growing literature has documented the significance of macroeconomic news announcements in price formation process. The literature on the effect of macro news on returns and volatility is huge and includes surveys concerning foreign exchange market (Bauwens, Omrane, Giot, 2003), bond market (Dominguez, 2003) and equity market (Hanousek, Kocenda, Kutan, 2008). It is worth to stress that surveys focused on FOREX are most popular and exhaustive (see for instance works of Andersen and Bollerslev, 1998, Faust et al., 2007). The literature considering high frequency returns of the European stock markets in the presence of US macroeconomic announcements is very much limited. Harju and Hussein (2011) examine four major European equity markets in the aspect of US announcements. They find that US fundamentals have an impact on Europeans investor's behavior. Both equity returns and volatility are sensitive to American macro releases. Moreover, the indices (CAC40, DAX, DMI and FTSE100) show similar strong intraday seasonality pattern and react in the similar direction to the macroeconomic information.

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Routinely the announcements considered in the literature are from US, mainly due to the importance of American economy and the timing of US macroeconomic releases. These releases are characterized by specific features that make them useful: they are periodically publicized with timing of announcements being strictly predetermined to the date and the hour. Additionally the releases are preceded by the expectations which are obtained as a consensus between different financial analytics (Li, Engle, 1998). The crucial is the fact that the announcements are released at the time when European stock exchanges are open providing the area for the research of market reaction to the news. Contrary to this, majority of European macroeconomic announcements is released before the opening or after the closing of the session, only some of them being announced within the session time.

The impact of news releases may be observed on returns and in volatility with the latter more popular. What in fact is influencing the prices is not a news itself, but the surprise content of the news – the more surprising it is, the more volatility increases. In the world of continuously flowing information the only way to measure the reaction to announcements is to focus on intraday data.

Hanousek, Kocenda and Kutan (2008) estimate the impact of EU-wide macroeconomic news from different countries on composite stock returns of three markets, the Czech, the Polish and the Hungarian. They conclude that the emerging markets react similarly to foreign news and this reaction is in line with the reaction of more advanced western European markets. However, in their paper all observations from the opening and the closing of the sessions are removed from the sample.

Our analysis contributes to the existing works in several ways. We study the reaction to several macroeconomic announcements, domestic and neighbor-country as well as the American and compare which of them have a stronger influence on intraday volatility. We focus on the Polish and the German stock markets and macroeconomic releases from these two markets. From the previous works we know that on both markets the reaction to American macro releases is quite strong (Będowska-Sójka, 2010), but the size or the strength of the reaction to Polish or German releases is unknown. From the seminal paper of Wood et al. (1985) it is known that high-frequency series are characterized by the strong periodical pattern in volatility and that the reasonable intraday dynamic analysis requires the estimation of intraday periodic component. Following works of Andersen and Bollerslev (1998) we use flexible Fourier form framework to model intraday series and find out what is the reaction to the announcements on both European markets. Two approaches are adopted: in the first the announcement effects are estimated within the flexible Fourier form regression, whereas in the second the regression is used only for the purpose of filtering from periodicity and the filtered series are introduced to FIGARCH models.

Considering the reaction to macro releases from different countries in the short 5-minute interval our main finding is that volatility of indices react stronger to American announcements than to similar in category macro news from Germany or from Poland. For the domestic releases the reaction is weak in Germany and not significant in Poland. The intraday periodical pattern is quite similar on both markets and the reaction to American news is similar in size and direction.

The rest of the paper is as follows: in Section 1 we describe the data, in Section 2 periodical pattern is considered. Section 3 is devoted to the intraday effect of macroeconomic announcements. In Section 4 we present the methodology of volatility modeling and in Section 5 the results of AR-FIGARCH models are presented. Section 6 concludes.

1. The Data

We use the data of the German and the Polish indices in conjunction with the data on expectations and realizations of scheduled macroeconomic announcements from the American, the German and the Polish markets.

1.1. The Return Series

The sample consists of 5-minute intraday percentage logarithmic returns of the German DAX and the Polish WIG20 main stock exchange indices within the period 5.01.2009-30.12.2010. We consider the percentage logarithmic returns, observed with frequency $1/\Delta$ (with $1/\Delta$ being an integer bigger than 0). As quite common when dealing with intraday data the overnight return is excluded from the analysis. The length of the trading day is normalized to unity and therefore the time that elapses between two consecutive returns is equal (Boudt et al., 2010).

The DAX index is quoted from 9am to 5.30pm, and WIG20 from 9am to 4.10pm. After excluding overnight return we obtain 101 observations per day on the German market and 85 on the Polish. We use the data available at database www.stooq.pl. The estimation and charts are made in OxMetrics 6.0, in particular G@RCH 6 software and Ox codes (Laurent, Peters, 2010).

The sample mean of the five minute returns in both series is not distinguishable different from zero with standard deviation higher for WIG20 series. The distribution of both series is asymmetric and the kurtosis is very high. Hence, the distribution is not Gaussian. The significant autocorrelation in the series is observable only for low lags. This changes diametrically when we move to absolute returns which are characterized by very strong autocorrelation function – we will focus on this issue when describing periodical pattern in the intraday series.

Table 1. Descriptive statistics of DAX and WIG20 returns

	DAX	WIG20
Mean	-0.0002	-0.0005
Standard deviation	0.1235	0.1569
Minimum	-1.8979	-1.9750
Maximum	1.1926	1.9750
Skewness	-0.2765	-0.2319
Excess kurtosis	7.0612	11.1270
Observations	51510	42755

1.2. The Macroeconomic Announcements

From the broad spectrum of macroeconomic announcements we choose only few that are very often used in the papers and are regularly released together with forecasts on the three markets: the American, the German and the Polish. We consider only announcement surprises, that means that the release is treated as a news only when it is different from the value of previously announced expectation. The macroeconomic data are from websites: www.macronext.pl and www.deltastock.com.

Some announcements are released regularly before the opening of the markets. These could not be included in the study (and are marked in the Table 2 with grey color). Therefore we get only 5 types of announcements from Germany, 8 from Poland and 10 from United States.

Table 2. The macroeconomic announcement and the timing on the three markets

	Germany	Poland	United States
Gross Domestic Product GDP	08:00	10:00	14:30
Consumer Price Index CPI	08:00	14:00	14:30
Producer Price Index PPI	08:00	14:00	14:30
Unemployment Rate UN	09:55	10:00	14:30
Industrial Production IP	12:00	14:00	15:15
Retail Sales RS	08:00	10:00	14:30
Economic Sentiment Indicator ESI*	11:00	10:00	16:00
Durable Goods Order DGO**	12:00	na	14:30
Trade Balance TB	08:00	14:00	14:30
Purchasing Manager Index PMI	09:30	09:00	15:45

Note: * for Germany we take ZEW (Zentrum für Europaische Wirtschaftsforschung Economic Sentiment) that measures institutional investor sentiment. In Poland it is consumers' confidence indicator published by GUS on 10:00 or 14:00. In case of US it is Conference Board Consumer Confidence; ** in Germany the Factory Orders are taken into account. There is no such announcement that could stand for proxy in Poland. For the United States it is Durable Goods Order ex Transportation.

As the Daylight Saving Time is changing in different time in Europe and America, we control for that when modeling the reaction to American announcements.

2. The Intraday Pattern in Volatility

The intraday periodical pattern is very well described in number of papers (see e.g. Dacorogna et al., 2001, Rossi, Fantanzzini, 2008) and usually described as U-shaped or inverted J curve of averages of absolute returns. What is characteristic for the shapes of averages of absolute returns for European stock markets is a sharp increase in volatility at the time of American macroeconomic announcements at 14:30 and 16:00 (Będowska-Sójka, 2010, Harju, Hussein, 2011).

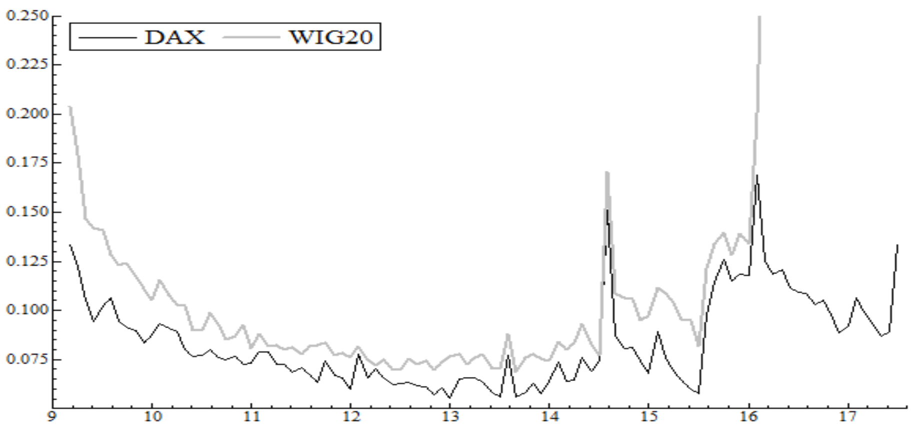

Figure 1. Average absolute returns for DAX and WIG20

Both the U-shape of autocorrelation of absolute returns (Figure 1) and the inverted J shape in averages of absolute returns (Figure 2) are visible for DAX and WIG20. In case of averages of absolute returns they reach higher values at the opening of the markets and then decrease in the lunch time. Finally they go up at the closing. This pattern is very similar in both series – the only difference is that in case of WIG20 at the end of the session volatility goes up higher.

The repeating pattern of autocorrelation function is observed every 101 lags for DAX and 85 lags for WIG20 (Figure 2). This structure of the ACF and shape of intraday volatility demand the proper treatment of periodicity. Additionally numerous studies have found the day-of-the-week effects, that should be accounted for (Bauwens et al., 2000).

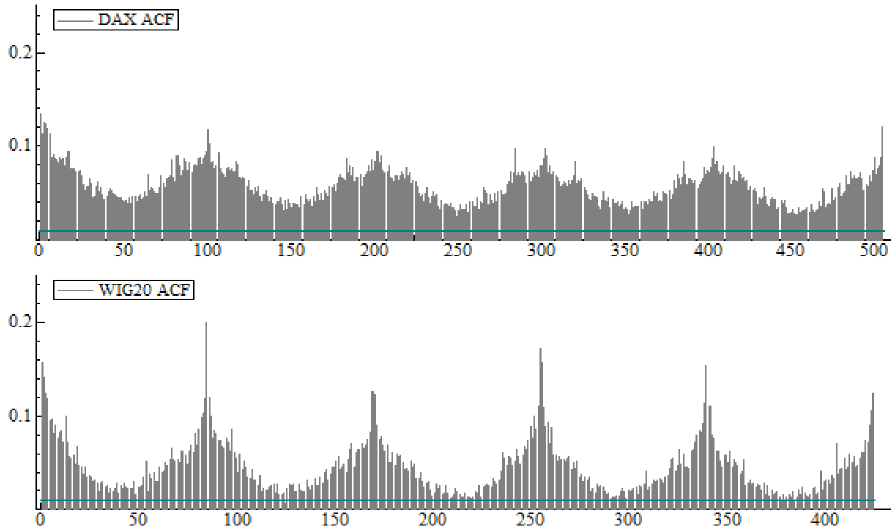

Figure 2. Sample autocorrelation function (ACF) of the DAX and WIG20 series of absolute returns

In the paper the periodicity removal is achieved with Gallants' (1981) flexible Fourier form regression adopted by Andersen and Bollerslev (1998).

We consider the 5-minute returns, where n refers to the number of intraday returns per day ($n = 1,\ldots,N$), and t is the number of trading days in the sample ($t = 1, \ldots, T$):

$$r_{t,n} - E(r_{t.n}) = \frac{\sigma_t s_{t,n} Z_{t,n}}{\sqrt{N}}, \tag{1}$$

where $\sigma_{t,n}$ is daily volatility factor, $s_{t,n}$ is periodicity factor and $Z_{t,n}$ is i.i.d. mean zero unit variance innovation term. The daily volatility component is measured as realized volatility, RV, which means it is a sum of squares of intraday returns, whereas periodicity component is estimated with flexible Fourier form regression:

$$x_{t,n} \equiv 2\log\left(\left|r_{t,n} - E(r_{t,n})\right|\right) - \log\sigma_t^2 + \log N = \log s_{t,n}^2 + \log Z_{t,n}^2, \tag{2}$$

$$x_{t,n} = f_{t,n} + \log Z_{t,n}^2 - E(\log Z_{t,n}^2) = f_{t,n} + u_{t,n}, \qquad (3)$$

$$f_{t,n} = \mu_0 + \mu_1 \frac{n}{N_1} + \mu_2 \frac{n^2}{N_2} + \sum_{p=1}^{P} \left(\gamma_p \cos \frac{2\pi p}{N} n + \delta_p \sin \frac{2\pi p}{N} \right), \qquad (4)$$

where $\mu_0, \mu_1, \mu_2, \gamma_p, \delta_p$ are estimated parameters and $N_1 = (N+1)/2$, $N_2 = (N+1)(N+2)/6$ are normalized constants (Andersen, Bollerslev, 1998). After some experimentation, we found that the order of expansion *P*=8 is sufficient to capture the basic shape of the series.

The estimator of periodic component on day *t* and interval *n*:

$$\hat{s}_{t,n} = \frac{T \exp(\hat{f}_{t,n}/2)}{\sum_{t=1}^{T} \sum_{n=1}^{N} \exp(\hat{f}_{t,n}/2)}. \qquad (5)$$

Finally we obtain periodically filtered series by dividing original series by the estimated seasonal pattern:

$$\tilde{r}_{t,n} = \frac{r_{t,n}}{s_{t,n}}. \qquad (6)$$

We show both the average absolute returns with periodical pattern of volatility in Figure 3. After periodicity filtering the intraday pattern for both series is removed, while the effects of macroeconomic announcements remain in the series.

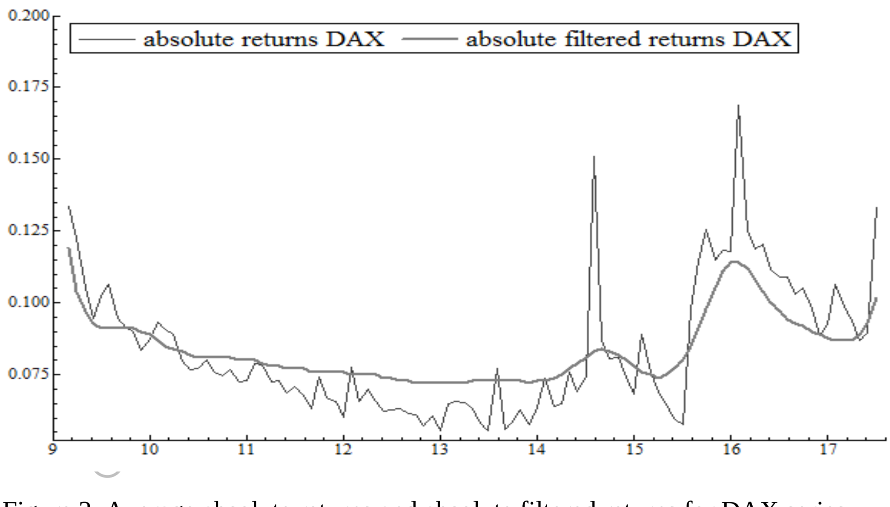

Figure 3. Average absolute returns and absolute filtered returns for DAX series

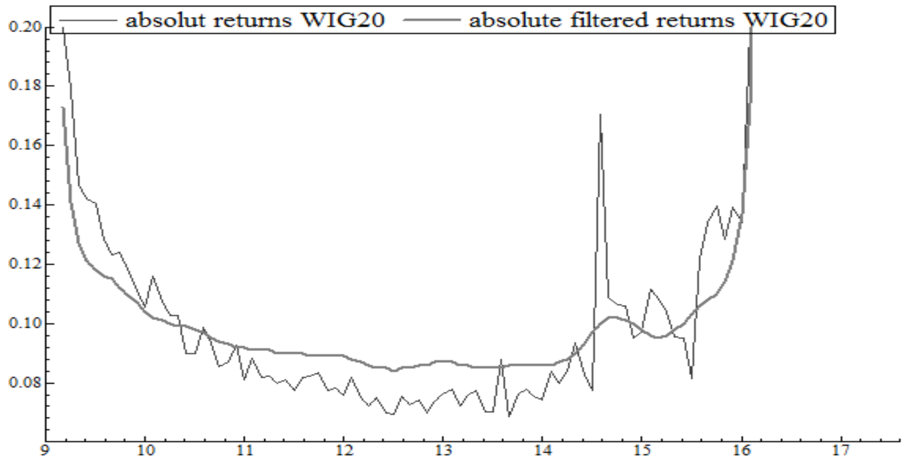

Figure 4. Average absolute returns and absolute filtered returns for WIG20 series

The descriptive statistics of series before and after filtering are presented in Table 3. The filtering of the data with FFF regression does not substantially change the descriptive statistics of the series.

Table 3. Descriptive statistics of DAX and WIG20 returns before and after periodicity removal

	DAX	DAX after FFF	WIG20	WIG20 after FFF
Mean	-0.0002	-0.0001	-0.0005	-0.0005
Standard deviation	0.1235	0.1224	0.1569	0.1506
Minimum	-1.8979	-1.9688	-1.9750	-1.4531
Maximum	1.1926	1.6331	1.9750	1.5642
Skewness	-0.2765	-0.2176	-0.2319	-0.2319
Excess kurtosis	7.0612	7.7792	11.1270	11.1270
Observations	51510		42755	

After filtering from periodicity we expect that the strong U-shaped autocorrelation observed previously in absolute returns is removed from the data. In fact, after filtering the periodical pattern is not observed in the series of absolute returns, but in both cases they are still characterized by long memory (Figure 5). This slow decay in autocorrelation function is typical for long memory process. Therefore we will model volatility in Section 5 with an appropriate GARCH model that allows for such a long memory.

3. The Intraday Effects of Macroeconomic Announcements on Volatility – FFF Regression

Our approach is aimed to study the influence of macroeconomic announcements of the same type from three markets on the volatility of two indices, the German and the Polish. The regression specification is than:

$$f_{t,n} = \mu_0 + \mu_1 \frac{n}{N_1} + \mu_2 \frac{n^2}{N_2} + \sum_{p=1}^{P} \left(\gamma_p \cos \frac{2\pi p}{N} n + \delta_p \sin \frac{2\pi p}{N} \right) + \lambda_i X_i, \quad (7)$$

where λ_i is the estimated coefficient and X_i is the time-stamped to the nearest 5-minute return announcements dummy variable. In some works it is suggested to filter series using only the control days – which means days without events under study (Conrad and Lamla 2007, Dominguez 2003). We rather agree with Boudt et al. (2010) that "conditioning on the days without any news, would lead to a too small sample". What is actually important is the difference between releases and the expected values – it is not the event itself, but the surprise that is causing the price change.

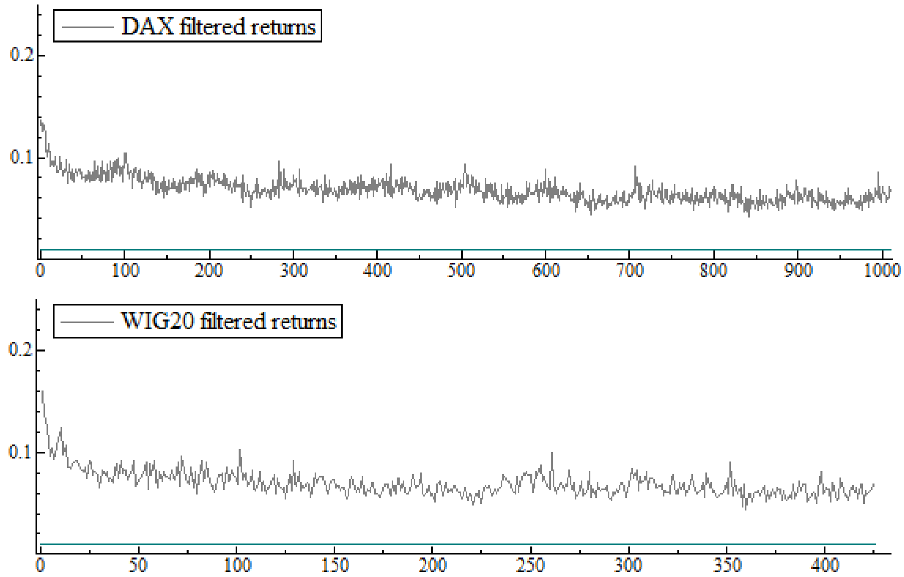

Figure 5. Sample autocorrelation function of the series of absolute filtered returns

In our approach the macroeconomic announcements take the value 1 if they were different from previously released forecasts and 0 otherwise. Additionally the dummies representing day-of-the-week effect are also included in the regression. The estimates of FFF regression are shown in Table 4 (DAX) and 5 (WIG20).

We consider the reaction in first 5 minutes after macro news releasing. For both series, DAX and WIG20, American announcements do increase volatility of returns in such a short period. In case of DAX the domestic announcements increase volatility (IP, ES, DGO), whereas in Poland domestic releases play no role in very short time interval. The neighbor-country announcements have no impact on volatility within first 5-minutes. The reaction to announcements on 14:35 which are clearly visible in average absolute returns (Figure 3) are now confirmed by the estimated parameters. The most powerful announcement in a short run is the American unemployment rate.

The estimated coefficients for day-of-the-week effect are omitted, however all of them are statistically significant. The considered announcements together with day-of-the-week dummies explain only 4% and 5% of intraday volatility in case of DAX and WIG20 respectively.

Table 4. Parameters estimated in FFF regressions for DAX

	United States		Germany		Poland	
GDP	3.1392	*(0.5588)*			1.2857	*(0.8425)*
CPI	1.7249	*(0.5462)*			0.7035	*(0.5504)*
PPI	1.4704	*(0.5020)*			0.1714	*(1.6936)*
UN	4.104	*(0.5446)*	-0.3629	*(0.5938)*	0.3127	*(1.6935)*
IP	1.3241	*(0.4947)*	1.4878	*(0.4957)*	-0.2941	*(0.9892)*
RS	2.5896	*(0.4932)*			0.1797	*(0.6346)*
ES	2.3163	*(0.4952)*	1.7297	*(0.4858)*	0.8400	*(0.6461)*
DGO	2.1283	*(0.4946)*	0.9873	*(0.4853)*		
TB	1.0291	*(0.4952)*			0.3455	*(0.5006)*
PMI	-0.1474	*(0.4949)*	0.4309	*(0.4857)*		
Observations	51510					
R^2	0.044905		0.0418		0.0415	
Adj. R^2	0.044312		0.0413		0.0409	

Note: The estimated parameters together with standard errors (in italics) are in the upper part. The bolded parameters are statistically significant at α=0.05.

5. Modeling with FIGARCH Models

For the purpose of modeling with FIGARCH models we filter the series again with FFF regression but this time including only the day-of-the-week dummies. The series filtered from periodicity with only day-of-the week dummies are introduced into FIGARCH models with dummy variables in the conditional variance equations. For these models the sample is restricted to 2009 only.

The conditional mean equations are modeled with the AR(2) process:

$$r_t = c_1 r_{t-1} + c_2 r_{t-2} + a_t. \quad (8)$$

Due to the long memory in series of absolute filtered returns, the innovations are modeled with FIGARCH (p, d, q) process with specification given by BBM's method (1999):

$$(1-L)^d \Phi(L) a_t^2 = \varpi + \mathrm{B}(L)(a_t^2 - \sigma_t^2), \quad (9)$$

where lag polonymials

$$\Phi(L) = 1 - \sum_{i=1}^{q} \phi_i L^i, \quad B(L) = 1 - \sum_{i=1}^{p} \beta_i L^i,$$

and $0 \le d \le 1$ being the fractional differencing parameter. Bollerslev and Mikkelsen (1996) define the sufficient condition of non-negative conditional variance in (9) as $\phi_1 < f_3$ with $f_j = (j-1-d)/j$. An extensive discussion of the properties of FIGARCH model can be found in Conrad and Haag (2006) where the necessary and sufficient conditions have been described in details.

Table 5. The parameters estimated in FFF regressions for WIG20

	United States		Germany		Poland	
GDP	2.7633	*(0.5358)*			0.4863	*(0.8511)*
CPI	0.5254	*(0.5520)*			0.3784	*(0.5558)*
PPI	1.4518	*(0.5076)*			-0.2171	*(1.7103)*
UN	4.0206	*(0.5504)*	0.8649	*(0.6000)*	1.2194	*(1.7103)*
IP	1.792	*(0.4999)*	0.2251	*(0.5011)*	-0.6301	*(0.9989)*
RS	2.2259	*(0.5093)*			0.7275	*(0.6411)*
ES	1.6942	*(0.5014)*	0.2867	*(0.4912)*	-0.1671	*(0.6526)*
DGO	2.2502	*(0.4999)*				
TB	1.4016	*(0.5004)*			-0.4574	*(0.4951)*
PMI	1.239	*(0.5005)*	-0.1594	*(0.5013)*		
Observations	42925		42925		42925	
R^2	0.0572		0.0535		0.0535	
Adj. R^2	0.0564		0.0529		0.0529	

Note: The estimated parameters together with standard errors (in italics) are in the upper part. The bolded parameters are statistically significant at α=0.05.

We introduce dummy variables into conditional variance equation:

$$\mathrm{B}(L)\sigma = \omega + \sum_{i=1}^{3} \varpi_i X_{t,i} + (\mathrm{B}(L) - (1-L)^d \Phi(L))a_t^2 . \qquad (10)$$

These dummy variables are defined in the way that they take the value of 1 at the time of macroeconomic surprise release on the particular market (American, German or Polish) and 0 otherwise.

Table 6. The estimates of AR(2)-FIGARCH(1, *d*, 1).

	DAX	WIG20
c_1	0.0052 (*0.0064*)	0.0011 (*0.0112*)
c_2	-0.0201 (*0.0082*)	-0.0312 (*0.0121*)
ω	0.0014 (*0.0005*)	0.0034 (*0.0010*)
φ	0.0997 (*0.1178*)	0.0791 (*0.0999*)
β	0.2936 (*0.1375*)	0.2599 (*0.1144*)
d	0.2681 (*0.0211*)	0.2425 (*0.0172*)
ω_1 (Germany)	0.0142 (*0.0051*)	0.0108 (*0.0074*)
ω_2 (Poland)	0.0032 (*0.0039*)	0.0084 (*0.0080*)
ω_3 (United States)	0.0936 (*0.0293*)	0.1540 (*0.0424*)

Note: The estimated parameters together with standard errors (in italics). The bolded parameters are statistically significant at α=0.05.

6. Results of AR-FIGARCH Estimations

We estimate AR(2)-FIGARCH(1,*d*,1) model including aggregated dummy variables standing for announcements. As can be seen in Table 6 the autoregressive parameters c_2 in conditional mean equation are statistically significant. In conditional variance equation ω, β and d are statistically significant and the values are reasonable according to suggestions in the literature (Bollerslev and Mikkelsen, 1996), but φ estimates are not statistically significant. It suggest that squares of previous shocks do not impact volatility. The estimated persistence parameters β are highly significant and around the value of 0.25. When we consider the aggregate dummy variables standing for announcements, it is visible that in Germany domestic announcements do increase volatility, but the parameter standing at the variable for American news is higher and that confirms our earlier findings. In case of Polish market only American announcements increase volatility and this impact is stronger than in Germany.

Conclusions

The periodical pattern in high frequency index returns on two European stock exchange markets, the German and the Polish, is very strong and might be successfully removed with flexible Fourier form (FFF). Our results of FFF regression indicate that US announcements have definitely stronger impact on volatility of both European indices, DAX and WIG20 than domestic and neighbor country macroeconomic news. It might be partly due to the fact that the number of German news released within the session is very limited. In Poland the only significant macro releases are those from America. In both countries, Germany and Poland, neighbor country news releases generally have no effect on volatility. The reaction to American announcements is immediate and recognized in first five minutes after announcements. If there is any cross-reaction to the announcements from the neighbor countries, it is not observable in such a short time.

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Wpływ ogłoszeń makroekonomicznych na zmienność rynków akcji

Z a r y s t r e ś c i. Celem artykułu jest zbadanie wpływu ogłoszeń makroekonomicznych z trzech krajów, Stanów Zjednoczonych, Niemiec i Polski na zmienność śróddziennych indeksów DAX i WIG20. Dla obu indeksów opisano wzorzec zmienności i zastosowano elastyczną postać Fouriera w modelowaniu szeregów. W stosunkowo krótkim przedziale czasowym pięciu minut w obu indeksach zaobserwowano silną reakcję na ogłoszenia ze Stanów, a w niemieckim indeksie DAX słabszą reakcję na ogłoszenia niemieckie. Dla polskiego WIG20 nie wychwycono w tak krótkim interwale czasowym reakcji na polskie ogłoszenia. Dodatkowo oba indeksy nie reagują na ogłoszenia z rynku kraju sąsiadującego.

S ł o w a k l u c z o w e: dane śróddzienne, ogłoszenia makroekonomiczne, elastyczna forma Fouriera, cykliczność śróddzienna, modelowanie zmienności.