THE REACTION OF ASSET PRICES TO MACROECONOMIC ANNOUNCEMENTS IN NEW EU MARKETS: EVIDENCE FROM INTRADAY DATA

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Abstract

We estimate the impact of macroeconomic news on composite stock returns in three emerging European Union financial markets (the Budapest BUX, Prague PX-50, and Warsaw WIG-20), using intraday data and macroeconomic announcements. Our contribution is twofold. We employ a larger set of macroeconomic data releases than used in previous studies and also use intraday data, an *excess impact* approach, and foreign news to provide more reliable inferences. Composite stock returns are computed based on five-minute intervals (ticks) and macroeconomic news are measured based on the deviations of the actual announcement values from their expectations. Overall, we find that all three new EU stock markets are subject to significant spillovers directly via the composite index returns from the EU, the U.S. and neighboring markets; Budapest exhibits the strongest spillover effect, followed by Warsaw and Prague. The Czech and Hungarian markets are also subject to spillovers indirectly through the transmission of macroeconomic news. The impact of EU-wide announcements is evidenced more in the case of Hungary, while the Czech market is more impacted by U.S. news. The Polish market is marginally affected by EU news. In addition, after decomposing pooled announcements, we show that the impact of multiple announcements is stronger than that of single news. Our results suggest that the impact of foreign macroeconomic announcements goes beyond the impact of the foreign stock markets on Central and Eastern European indices. We also discuss the implications of the findings for financial stability in the three emerging European markets.

Keywords: stock markets, intraday data, macroeconomic announcements, European Union, volatility, excess impact of news

JEL Classification: C52, F36, G15, P59

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Abstrakt

Analyzujeme dopad makroekonomických zpráv na výnosy akciových indexů na třech finančních trzích nových členských zemí EU (Budapešť-BUX, Praha-PX50, Varšava-WIG) za použití vysokofrekvenčních pětiminutových dat. Ve srovnání s jinými pracemi používáme rozsáhlejší soubor makroekonomických zpráv, pracujeme s vysokofrekvenčními daty, a metodologicky zohledňujeme rozsah zpráv vůči očekáváním trhu. Výnosy akciových indexů jsou počítány na základě pětiminutových intervalů a makroekonomické zprávy jako odchylky zpráv od jejich očekávání na trhu. Celkově jsou tři zkoumané trhy pod přímým vlivem trhů EU a USA, který se přelévá prostřednictvím tržních indexů. Nejsilnější přeliv zaznamenává Budapešť, poté Varšava a Praha. Český a maďarský trh je také zasažen nepřímými přelivy prostřednictvím makroekonomických zpráv. Maďarský trh je více citlivý na evropské zprávy, na českém trhu mají větší dopad zprávy americké. Polský trh je pouze marginálně pod vlivem evropských zpráv. Rozsah zpráv je rovněž důležitý: dopad zpráv, které přicházejí ve skupinách je silnější než u jednotlivých zpráv. Naše výsledky ukazují, že dopad zahraničních makroekonomických zpráv jde dál nad rámec přímého vlivu zahraničních trhů na tržní indexy středoevropských zemí. Naše výsledky vztahujeme také k finanční stabilitě na těchto trzích.

1. Introduction, Motivation and Related Literature

In this paper we analyze the impact of macroeconomic announcements on stock market returns using intraday data from the three most liquid emerging European Union markets: the Czech Republic, Hungary, and Poland. Our paper contributes to the related literature in several ways. First, to our knowledge, there are no studies investigating the direct impact of macroeconomic news on emerging EU stock markets using intraday data. Previous studies focus on advanced stock markets, especially on the German, U.S., and UK stock markets. Overall, a limited number of studies investigate stock markets in Central and Eastern Europe.[1] The only study that is closely related to ours is a recent work by Nikkinen, Omran, Sahlström and Äijö (2006) who analyze the behavior of volatilities around ten important scheduled U.S. macroeconomic announcements[2] on stock markets in several world regions, including the Czech Republic, Poland, Hungary, Slovakia, and Russia. Using cross-sectional monthly data, they find that these transition markets as a group are not affected by U.S. announcements. The monthly data they use, however, may not capture the true spillovers effects of foreign news announcements on local markets. We provide time series evidence and use intraday data to provide more precise findings.

Second, recent research accentuates the significance of using intraday data to reveal the importance of macroeconomic announcements on stock market activity. High-frequency studies include Anderson, Bollerslev and Cai (2000), Nikkinen and Sahlström (2004), Jones, Lin and Masih (2005), Erenburg, Kurov and Lasser (2005), and Rigobon and Sack (2006). In this paper, as an extension of this scant but growing literature, we use stock price data based on 5-minute intervals to provide more robust estimates of public information on stock returns. Although these studies focus on developed markets' stock prices, we use data from European emerging markets.

Third, the majority of studies focus only on a few macroeconomic announcements. In particular, most of them analyze only one event, namely the impact of monetary policy news

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[1] Zalewska-Mitura and Hall (1999) and Chun (2000) analyze efficiency issues in the Budapest stock market. Tse, Wu and Young (2003) investigate the transmission of shocks from the U.S. stock market to the Warsaw stock exchange. Mateus (2004) examines the sources of risk and the degree of predictability of returns in the stock markets of 13 EU accession countries. Korczak and Bohl (2005) investigate the changes in stock prices and trading volume around depositary receipts issuance on a sample of Czech, Hungarian, Polish, Russian, Slovak and Slovenian stocks. Serwa and Bohl (2005) investigate the contagion effects of several financial shocks in the stock markets of Central and Eastern Europe. The remaining studies discuss the development of stock markets in Central and Eastern Europe, including Fink, Haiss, Orlowski and Salvatore (1998), Hermes and Lensink (2000), Rockinger and Urga (2000), and Scholtens (2000).

[2] The announcements considered are consumer confidence, consumer price index, employment cost index, employment situation, gross domestic product, import and export price indices, manufacturing and non-manufacturing, producer price index, and retail sales.

on stock returns.[3] However, if there are other major announcements in the same time frame, then focusing only on monetary policy or only a few announcements may bias the estimated coefficients and hence may explain the poor performance of macroeconomic announcements in explaining asset returns. To our knowledge, Flannery and Protopapadakis (2002) have so far employed the most comprehensive set of local announcements, which includes 17 U.S. macroeconomic data releases.[4] However, we believe that financial markets react to *all* types of macroeconomic news; hence we use a larger set of macroeconomic releases than employed in previous studies. Our focus is on the overall impact of macroeconomic news, rather than their individual contributions.[5]

Fourth, previous studies mainly focus on local macroeconomic announcements. Investors may also react to foreign macroeconomic announcements if there are significant trade and financial linkages or institutional arrangements between countries. To our knowledge, there are only a few studies that investigate the impact of both local and foreign announcements on stock market returns. Nikkinen and Sahlström (2004) examine the relative importance of domestic and U.S. macroeconomic news in two European stock markets, Germany and Finland. They find that U.S. news moves both European markets while domestic news seems to be insignificant. Albuquerque and Vega (2006) investigate the impact of domestic and foreign (U.S.) news about economic fundamentals on the correlation of stock returns between the U.S. and Portugal. They find that cross-country correlations decline when domestic (Portuguese) news is released but unchanged when foreign (U.S.) news is released. Also, U.S. public information arrival influences Portuguese stock returns; however, this effect is much smaller when U.S. stock market returns are included in estimations. The latter finding suggests that only the macroeconomic news that impacts the U.S. stock market has an impact on the Portuguese stock market.

The limited evidence indicates that foreign news arrival may have important implications for stock valuation. We extend these studies to the case of three emerging EU markets. We use regional and foreign macro news, apart from local news. Local news is much less frequent than regional and foreign news, but more importantly the majority of local news

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[3] These studies include Jensen and Johnson (1995), Jensen, Mercer, and Johnson (1996), Patelis (1997), Thorbecke (1997), Siklos and Anusiewicz (1998), Bomfim (2001), Ehrmann and Fratzscher (2004, 2006), Gurkaynak, Sack and Swanson (2004), Mann, Atra and Dowen (2004), Rigobon and Sack (2006), Bredin, Hyde, and O'Reilly (2005), He (2006), and Wongswan (2006).

[4] They include balance of trade, consumer credit, construction, CPI, employment (non-farm) and unemployment, home sales, home starts, industrial production, leading indicators, M1, M2, personal consumption and personal income, producer price index, real GNP, and sales.

[5] Whether the individual impacts of different announcements are the same or different is an interesting empirical question, and we leave this issue to further study.

is released before trading begins; hence it cannot affect stocks during trading hours. In particular, we use news from other EU markets, mainly Germany, and the U.S. This set of news is interesting because Germany, apart from being an important trading partner, is part of the European monetary union. News from Germany may affect emerging EU markets substantially since the emerging markets aspire to join the monetary union, even if they have not yet determined when entry will occur (see Fidrmuc and Korhonen, 2003 and 2006). In addition, investors may also utilize information from neighboring markets and world markets (proxied by the U.S.). Overall, we provide a richer set of foreign news than is utilized in the literature, capturing institutional arrangements, trade and financial links through neighboring countries, and global market linkages.

Fifth, previous studies tend to investigate the impact of macro news only on conditional returns, assuming that stock returns do not exhibit time-varying volatility.[6] In this study, we model both conditional returns and the conditional variance of returns simultaneously in a time-varying (SUR-GARCH) framework to better capture the impact of macroeconomic announcements of stock returns and stock market volatility in the three emerging EU markets.

Finally, our paper is related to the literature on cross-market correlations between stock markets (e.g., Albuquerque and Vega, 2006). Our findings can shed light on the question of whether the source of any observed correlations among stock markets is due to economic fundamentals contained in public announcements rather than "contagion". For example, if U.S. macroeconomic announcements have explanatory power in the variations of stock prices in emerging EU markets, this would suggest that economic fundamentals are responsible for the co-movements between the U.S. and the emerging EU markets. The few studies summarized above on Central and Eastern European stock markets do not provide comprehensive evidence regarding cross market linkages between these markets and the rest of the world.

From a broader perspective, the current study should be of interest to investors and policymakers as the markets studied are relatively new and have been under the influence of dramatic reforms and privatization efforts since the early 1990s. In addition, they have been subject to global shocks due to opening up their economy to world trade and foreign direct investment. Furthermore, their recent efforts to enter the Exchange Rate Mechanism II of the

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[6] These studies include Jensen et al. (1996), Patelis (1997), Siklos and Anusiewicz (1998), Flannery and Protopapadakis (2002), Gurkaynak et al. (2004), Nikkinen and Sahlström (2004), Bredin et al. (2005), Albuquerque and Vega (2006), He (2006) and Ramchander et. al (2006). On the other hand, Kim and In (2002), Bomfim (2001), Kim et al. (2004), and Jones et al. (2005) utilize time-varying (GARCH) models.

European Monetary Union and hence the euro zone mean that they will be subject to further external shocks. In this process, it would be interesting to observe how these markets respond to the arrival of information from the EU and the U.S. Because such news from these foreign countries reflects underlying future economic shocks to local economies, our findings may provide a better understanding of investor behavior in these emerging markets in such an environment and allow us to observe whether they respond differently to macroeconomic news in emerging markets compared to those in advanced stock markets. The results are also useful for developing strategic investment decisions, as these markets are considered to be relatively larger, more open, and more liquid than others in the Central and Eastern European region. Hence, foreign investors are more likely to utilize these markets than others in the region for their portfolio decisions.

2. Data and Methodology

We analyze the impact of news on stock returns in new EU stock markets concentrating on the stock exchanges in Budapest, Prague, and Warsaw in particular.[7] These markets are the largest European emerging markets in terms of market capitalization as well as the extent of liquidity (Égert and Kočenda, 2007).

We analyze the impact of announcements by employing an augmented version of the generalized autoregressive conditional heteroskedasticity (GARCH) model attributed to Bollerslev (1986). Since the reasoning behind the augmentation of the model requires a knowledge of our approach with respect to announcements, we deviate from the standard sequencing and introduce our data prior to describing the model.[8]

2.1 Data Set: Stocks and News

We constructed our dataset from intraday data recorded by Bloomberg for the stock markets of three emerging EU markets. Stock exchange index quotes are available in five-minute intervals (ticks) for the stock markets in Budapest (BUX), Prague (PX-50), and Warsaw (WIG-20). The time period of our data starts on 2 June 2003 at 9:00 and ends on 29 December 2006 at 16:00 Central European Daylight Time (CEDT), which gives a total of 876 trading days after accounting for weekends and public holidays. A trading day is represented by the

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[7] Returns are stationary series. Results of stationarity tests not reported.
[8] A theoretical framework linking macro announcements to stock returns is underdeveloped. We refer readers to account of the bond pricing with announcement effects of Piazzesi (2001) and the equities modeling framework with announcements' effect of Mamaysky (2002).

trading window when the new EU markets are simultaneously in a trading session. Descriptive statistics of the stock indices are presented in Table 1.

The composition of the three indices is provided in Table A1 in the Appendix. The Budapest index BUX consists of 14 titles, with four forming the bulk of the index (92.3%): Magyar Telekom, MOL (oil and gas processing), OTP (banking), and Richter (pharmaceutical). The Prague index (PX-50) consists of 11 titles but 80.5% of it is formed by four titles: CEZ (electricity energy), Erste Bank (banking), Telefonica O2 (telecom), and Komerční banka (banking). The Warsaw index WIG-20 contains 20 titles and five titles form a majority (61.6%): PKO Bank Polski (banking), Bank PEKAO (banking), PKN Orlen (oil processing), TP SA (telecom), and KGHM (copper and silver mining and metallurgy). The Hungarian index contains only domestic issues while the Czech and Polish indices contain also foreign stocks. In the Polish index, foreign stocks constitute a negligible minority representing some energy companies from the Czech Republic and Hungary. All companies that are included in the three indices are obliged to report under international accounting standards and are, hence, not exposed to foreign economic conditions in a different way in terms of reporting activities. All three indices are composed of stocks representing a variety of economic sectors whose weights vary across the indices. The energy, banking and telecom industries dominate all three indices and specifically the banking industry is represented in similar proportions in the three markets. The index composition is then to a large extent representative of each country's economy without any strong concentration in a specific industry. If there is any bias towards banking, the index composition hints that at least it is consistent across the three countries. In the same spirit all three countries exhibit a similarly consistent trading pattern with respect to the U.S. and the old EU-15. International trade turnover with the U.S. ranges from 1 to 2.5% and is dwarfed by the turnover with the EU that ranges from 50 to 65% depending on the country. Therefore, among the three countries there is not one that would have closer economic ties with the EU or the U.S. than the others.

Further, we compiled an extensive data set on the macroeconomic announcements (news) in the above markets as well as announcements in the EU and the U.S. The news in our sample can be divided into five categories. These are announcements on nominal macroeconomic aggregates (consumer price index, labor costs), real economy (GDP, current account, production, sales, trade balance, unemployment, etc.), monetary policy (monetary aggregate and interest rate), fiscal policy (debt, deficit, expenditures), and economic confidence (consumer and industry confidence, business climate, etc.). In terms of the timing of news releases there is a major obstacle. Unfortunately, the vast majority of local news is

released intentionally before the market opening and thus they are absorbed by the market before trading begins as we document presently. For this reason, we are able to study chiefly the effect of foreign news. Altogether there are 1372 occasions at which announcements originating in the EU or the U.S. are released during the trading window common for all three new EU markets.

The announcements are defined in the following way. There is news i in the form of various macroeconomic releases or announcements that are known ahead of time to materialize on specific dates t.[9] The extent of such news is not known but expectations on the market form a forecast whose values are factored in. Thus, the impact of such news materializes through their difference from market expectations rather than from the extent of the news itself. Therefore, we define the news in our data set from the *excess impact* perspective. Since announcements are often reported in different units, news is standardized as the percentage deviation from the market expectation. The excess impact news variable is labeled as xn_{kt} and formally defined as $xn_{kt} = (100\,(sn_{kt} - E_{t-1}[sn_{kt}]) / E_{t-1}[sn_{kt}])$, where sn_{kt} stands for the value or extent of the scheduled announcement and $E_{t-1}[sn_{kt}]$ is the value expected by the market. For the purpose of our analysis we collected macroeconomic news for which there exists a Bloomberg or Reuters survey including a clearly defined calendar of releases with defined timing of news as well as their expectations. The vector xn_k contains all news pooled together but announcements may be released in groups or they are released as single announcements. The effects of multiple news (Mxn_k) are difficult to decompose and therefore we group multiple announcements into a specific category for the purpose of estimation. Single news (Sxn_k) are for the estimation also grouped in a separate vector.[10]

Table 2 provides information on the distribution of the news in all 876 trading days with respect to their origins. The proportion of days when no news is released is relatively high in the EU (70%) as the proportion for the U.S. is less than half the EU value (31%). The proportion of days when only a single news is released is roughly similar for both economies but the number of days with only multiple announcements is three times larger in the U.S. (18%) than in the EU (6%). The proportion of days when both single as well as multiple news are released does not reach a meaningful percentage in the EU but is one fifth of the days in

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[9] There is also news in the form of an unexpected announcement that can be understood as a truly exogenous shock or surprise. The number of such news that is recorded is negligible and we do not consider them in the present study.

[10] We acknowledge the referee's suggestion to consider multiple versus single news effects. At the estimation stage we do not differentiate among the various types of news. We have run preliminary regressions but learned that the division of the news into categories dilutes their effect as the majority of the obtained estimates were insignificant.

the U.S. Finally, we can see that the proportion of days when there is no announcement is very high for the new EU markets (above 90% for Prague and Budapest, and above 75% for Warsaw) as the vast majority of local news is released before the market opens. Only small proportions of days feature single news events during the trading session; this proportion is negligible for Prague and Budapest. Only Warsaw features small proportion of days (10%) when multiple news are released and a negligible proportion of combined releases.

From a practical perspective, we consider each new announcement within 5 minutes after release and account for its effect for another 10 minutes. Following the *excess impact* approach described above, we differentiate the positive (+) and negative (-) impact of the announcement in terms of its relation to market expectations. In the majority of cases the announcement has a positive (negative) impact if it is above (below) market expectations. However, there are some announcements where the impact direction is reversed. For example, a higher than expected unemployment rate has a negative impact as its consequence means lower tax collection, increased payments from state, etc. On the other hand, lower than expected inflation has a positive impact. Other variables whose announcement shows a reverse impact direction are, for example, debt, deficit, interest rate, and labor costs. Finally, an announcement has a zero impact if it is in line with the market.[11] The time difference between the markets is accounted for by setting the CEDT time for all news releases, which eliminates the time difference between the U.S. and continental Europe.

As a complement to the above news distribution we also provide information on the news from the excess impact perspective. The division is based on the number of events when news is released during the trading window. Out of 1372 occasions in which announcements originating in the EU and the U.S. are released, there is 42.06% positive news in terms of market expectations, 41.62% negative news, and 16.33% news that are in line with market expectations. It is evident that the distribution of surprises is almost 50/50 positive/negative as the number of positive news is only marginally higher. A finer distinction of the news categories is provided in Table 3. The total number of EU and U.S. announcements that are in line with expectations is about five times smaller than the total number of announcements that come as a negative or positive surprise. Further, the proportion of the positive and negative news originating in the U.S. is about four times higher than that of EU news, but only twice as large when news with no impact are considered. An even finer distinction can be made when

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[11] At the estimation stage we consider announcements that are exactly in line with market expectations compared to the wider set of news that deviates from market expectations by ±2% and thus can be still considered as being in line with the market. Both estimations yield identical results.

classifying news events into single and multiple categories. Both positive and negative surprises from the U.S. are several times more frequent than those coming from the EU. The feature is similar but less pronounced for multiple but reversed for single in-line-with-the-market news. Announcement events during the trading window and originating in the new EU markets are a fraction when compared to the EU and the U.S., and only Poland stands out somewhat.

2.2 Estimation Methodology

We employ the augmented generalized autoregressive conditional heteroskedasticity (GARCH) model attributed to Bollerslev (1986) to empirically test for stock market volatility. We augment the mean specification by parameters to account for the effect of macroeconomic news in the form of deviations of scheduled releases from market expectations, and the effects of spillovers from neighboring emerging markets as well as two major developed markets (Germany and the U.S.). In effect our model specification allows for intra-regional spillovers, as well as those from developed markets.[12] We use a GARCH-in-mean (GARCH-M) specification which includes a conditional variance in the mean equation so that we can analyze the process with the path-dependent rather than the zero-conditional mean. The baseline model is specified in the following form:

$$\Delta SI_{i,t}^E = \sum_{k \in \{EU,US\}} \sum_{j=1}^{q} \rho_k \Delta SI_{k,t-j}^D + \sum_{i=1}^{2} \sum_{j=1}^{p} \mu_i \Delta SI_{i,t-j}^E +$$
$$+ \sum_{k \in \{EU,US\}} \sum_{j \in \{+,-,0\}} \chi_{kj} xn_k^j + \theta \ln h_{i,t} + \varepsilon_t \tag{1.A}$$

$$\Delta SI_{i,t}^E = \sum_{k \in \{EU,US\}} \sum_{j=1}^{q} \rho_k \Delta SI_{k,t-j}^D + \sum_{i=1}^{2} \sum_{j=1}^{p} \mu_i \Delta SI_{i,t-j}^E +$$
$$+ \sum_{k \in \{EU,US\}} \sum_{j \in \{+,-,0\}} \gamma_{kj} Sxn_k^j + \sum_{k \in \{EU,US\}} \sum_{j \in \{+,-,0\}} \delta_{kj} Mxn_k^j + \theta \ln h_{i,t} + \varepsilon_t \tag{1.B}$$

$$h_{i,t} = \omega + \sum_{m=1}^{r} \alpha_m \varepsilon_{t-m}^2 + \sum_{m=1}^{s} \beta_m h_{i,t-m} . \tag{2}$$

The two mean equations are alternative specifications to account for the pooled announcements (1.A) and to distinguish between single and multiple news (1.B). The

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[12] The specification allows for both types of spillovers as we do not want to exclude the possibility that the impact of macroeconomic announcements could transmit via stock pricing in foreign (developed) markets instead of only a simple direct effect. The effect of these two channels is limited for the U.S. announcements that are released before the U.S. stock exchange opening hours, but can be stronger for the EU market. As there is an overlap of trading hours between the EU markets and the Czech, Hungarian and Polish markets, any EU macroeconomic releases analyzed in this paper are made during EU trading hours.

variables used are coded as follows. Our dependent variable $\Delta SI_{i,t}^{E}$ is return on a specific emerging (E) market stock index i (Budapest, Prague, Warsaw) at time t. The parameter $\Delta SI_{k,t-j}^{D}$ is the lagged return on a specific developed stock market index: as a proxy for Europe we employ the German DAX index from the Frankfurt stock exchange and for the U.S.A. we employ the Dow Jones Industrial Average of 30 stocks index. Coefficient ρ captures the effects of market spillovers from the two developed markets. The parameter $\Delta SI_{i,t-j}^{E}$ is the lagged return on a specific emerging market stock index other than that employed as a dependent variable and coefficient μ captures the effects of spillovers from the other two emerging markets (e.g., in the case of the Budapest index being the dependent variable, lagged indices from Prague and Warsaw are right-hand side variables). A vector of the pooled news defined in Section 2.1 is denoted as xn_k. Sxn_k is a vector of single news and Mxn_k is vector of multiple news. In all cases subscript k indexes the origin of the announcements, either Europe (EU) or the U.S.A. (US). Further, subscript j indexes the news entering our specification to reveal a different reaction to excess positive (+), excess negative (-) or no-impact (0) news expected from a behavioral point of view. Coefficients χ, γ and δ capture the contemporaneous effects of pooled, single and multiple news, respectively, on stock index returns. The numbers of lags p, q, r, and s are chosen by the lag selection information criteria. The log of the conditional variance in the mean equation, i.e., ln h_t, allows for an exponential rather than quadratic effect of observed volatility.

In the above conditional variance specification, the ARCH term, $\alpha \varepsilon_{t-1}^{2}$, primarily reflects the impact of news or surprises from previous periods that affect stock price volatility. A significant and positive value of α that is less than one characterizes the extent to which shocks do not destabilize volatility. When α is greater than one, shocks from the past are destabilizing. The GARCH term βh_{t-1} measures the impact of the forecast variance from previous periods on the current conditional variance or volatility. Hence, a significant value for β that is close to one indicates a high degree of persistence in stock price volatility. The sum of both coefficients, i.e., α plus β, indicates the speed of convergence of the forecast of the conditional volatility to a steady state. The closer its value is to one, the slower the convergence.

Finally, as behavior on these markets has been documented to follow periods of lower and higher activity during a trading day, our analysis is performed by using periods of lower volatility during a standard trading period and separating periods of high volatility during the

first 15 minutes after the opening, and the last 5 minutes before the closing, of the trading session.[13] This approach avoids mixing periods of varying volatility during the trading day and reflects the *U*-shape pattern documented for volatility in various markets (McMillan and Speight, 2002; Fan and Lai, 2006), including the three emerging markets under research (Égert and Kočenda, 2007).[14]

Based on the Akaike information criterion and the Schwarz-Bayesian information criterion and the significance of the coefficients, we select a specific version of the baseline model that corresponds best to the data on each stock index. The standardized residuals from such a specification are free from ARCH effects. Estimation of the model uses a log-likelihood function, $\ln L_t = -0.5(\ln(2\pi h_t) + \sum_{t=t_0}^{T} \varepsilon_t^2 / h_t)$, as in Bollerslev (1986). The maximum-likelihood estimates are obtained by using the numerical optimization algorithm described by Berndt et al. (1974). To avoid the risk of overestimating volatility, we do not impose the normality condition on the distribution of errors. Rather, we allow for generalized error distribution (GED) following Nelson (1991). The volatility of stock prices is likely to follow a leptokurtic data distribution that is reflected by an actual GED parameter considerably lower than 2, which is the value in the case of normal distribution. Leptokurtosis implies that daily stock price volatility tends to concentrate around the mean during tranquil market periods but that shocks to volatility are large during turbulent times.

The above specification accounts for the effect of various types of news on the firms' market value, hence the value of the market index. The emerging European stock markets are documented to be influenced by EU news but also by U.S. macroeconomic announcements at 14:30 CEDT and by the opening of the U.S. stock markets at 15:30 CEDT. The news from these two regions is hypothesized to exhibit the most direct influence on the new EU stock markets. The specification also accounts for the spillover effects through the lagged indices of neighboring emerging stock markets as well as lagged German and U.S. indices. Since trading hours in different markets span over different time periods we treat this difference by estimating the set of mean equations for each of the three emerging markets as seemingly unrelated regressions. This way we also allow for common features in the CEE markets to affect our estimates. Further, because of the time difference, there is a limited trading overlap between Europe and the U.S. Due to this short common window we estimate the U.S.

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[13] These times were chosen based on a sensitivity analysis. Further adjustments did not change results.
[14] Such a pattern could be explained by the arrival and incorporation of news during the beginning of the trading day or by intraday trading activity, implying the opening and closing of positions at the beginning and at the end of the trading session.

spillover effect in a separate regression. The coefficients of the volatility equation are estimated via maximum likelihood estimation.

3. Empirical Findings

To derive our empirical findings we first estimated the specification that includes the available local news. The estimation was performed with both pooled news announcements (specification 1.A) as well as single and multiple news (specification 1.B). We do not report those results for reasons given below, but the results are available upon request. In all three markets the overwhelming majority of the important news (e.g., GDP or inflation) is released before trading begins and therefore the markets have time to absorb the information prior to the trading session. This institutional arrangement means that the market opening already reflects the announcements to a large extent. Further, traders and market makers form expectations about the announcements in advance and these expectations are very accurate.[15] Most of the news then comes as no surprise and since they are processed even before trading begins, their effect is dampened dramatically. In particular, local Czech announcements during the day usually do not reach the magnitude of those made public before the trading starts and this is evidenced by the insignificant coefficients. In Hungary, about 80% of the scheduled announcements are released before the trading on the market begins and we have found that the vast majority is in line with market expectations. The absence of any domestic news impact is then quite sensible. Also in Poland the local announcements do not play a role despite the fact that Warsaw records the smallest proportion of days when no news occurs during the trading window. Announcements of key importance are usually released before trading starts. Moreover, market opening in Warsaw is quite late, at 10 a.m., which makes any announcement almost irrelevant at market opening. The absence of local news of essential importance during the trading window is evidenced by the insignificant coefficients (not reported).

Thus, our main empirical findings come from a specification that includes foreign news. First, we estimated specification 1.A with pooled foreign news announcements. The results are presented in Tables 4–6 for each of the three countries separately. They show considerable spillover effects reaching the new EU markets and the presence of the news impact on the index returns in general. However, the impact differs with respect to the extent

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[15] For example, central bank key interest rate announcements are released during the trading session but in an overwhelming majority of cases these announcements are fully in line with expectations on all three new EU markets.

and origin of the news as well as the impacted stock market. The Prague market is negatively affected by negative U.S. news (χ_3) and the U.S. news that is in line with the market (χ_5). The Budapest market is negatively affected by negative U.S. news (χ_3) and positively affected by negative EU news (χ_4). The Warsaw market seems to be unaffected by foreign news.

Then, we estimated specification 1.B with foreign news divided between single and multiple announcements in order to find which group of news drives the results. The effects of multiple announcements are difficult to decompose and the question is whether we should see a stronger or weaker impact of multiple events as opposed to single news. We show that by splitting the announcements we can provide incremental information on the effect of news on stock prices. Therefore, we report detailed results in additional columns in the tables and comment on those results in the three following subsections 3.1-3.3. On the Prague market we see a stronger impact of multiple news (δ_1, δ_3, δ_5), that drives our results. On the Budapest market again multiple news (δ_4 and δ_6) exhibits a stronger impact than single news (γ_3). On the Warsaw market the decomposition is not possible due to insignificant coefficients.

3.1. Czech Republic

The returns on the Czech stock index PX-50 are affected by the developments of both Hungarian and Polish indices (Table 4). The effect of Warsaw (μ_5 and μ_6) is about three to four times larger than that of Budapest (μ_1 and μ_2) but both effects are small relative to the spillover from Frankfurt (ρ_1 and ρ_2). Spillover from the U.S. (ρ_3 and ρ_4) is limited as the window of the common trading with Prague is very short and within it the effect of the U.S. and German indices is mixed together. Separate estimates show that there is a positive immediate spillover effect from the U.S. whose magnitude is about one third of the German spillover ($\rho_3 = 0.005$ when compared to $\rho_1 = 0.014$). Single announcements originating in the U.S. (γ_1, γ_3, γ_5) do not affect the stock returns at all but multiple announcements (δ_1, δ_3, δ_5) do. Positive multiple U.S. announcements exhibit a positive effect (δ_1) while negative announcements and those that are in line with market expectations exhibit a negative effect (δ_3, δ_5). The negative effect is about 50% stronger and this confirms multiple findings in the literature showing an asymmetric impact with negative news having a larger impact. News that is in line with the market has the strongest impact as if it is reflecting market disappointment with "no news". The impact of single positive EU news is negative (γ_2) and it is the only significant effect found. The fact that the effect of positive news is negative is surprising. However, in the European marketplace a positive news release related to the territory of the old EU members might be interpreted by the market as a signal to transfer

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funds from the new EU market to get higher gains. This interpretation has to be backed by large amounts of funds transferred and has to be paired with the heavy presence of foreign investors who tend to put more weight on foreign news. The presence of foreign investors on the Czech market is heavy and varies around 55-60% of the traded volume over time.[16] The path dependent behavior of the returns is confirmed by the significant coefficient of the conditional variance in the mean equation (θ). The impact of the lagged volatility should not be overestimated as its magnitude is much smaller than that of the combined effect of the news.

In our specification, the ARCH term $\alpha\varepsilon_{t-1}^2$ reflects the impact of news or surprises from previous periods that affect stock price volatility. We find a relatively small coefficient α, meaning that news are well accounted for in the mean equation, past news do not affect volatility to a great extent, and they do not destabilize volatility. On the other hand, the β coefficient in the GARCH term, βh_{t-1}, is quite large and indicates that no matter how large or small the effect of the news on volatility is, the impact of the forecast variance from previous periods on the current conditional variance, or volatility, is considerably persistent. Finally, the fact that the sum of both coefficients, i.e., α plus β, is close to one indicates that the convergence of the conditional volatility to a steady state is very slow.

3.2. Hungary

The Hungarian stock index exhibits considerable spillover effects from both neighboring markets, with the effect of the Prague market (μ_3 and μ_4) three to four times stronger than that of Warsaw (μ_5 and μ_6). The Warsaw effect is more stable in time, however (Table 5). The effect of the Frankfurt market (ρ_1 and ρ_2) lies between the former two. Separate estimates show that there is no spillover effect from the U.S. (ρ_3 and ρ_4). The Hungarian index is strongly and positively impacted by multiple negative announcements originating in the EU (δ_4) as well as those that are in line with market expectations (δ_6). In-line news is even stronger than multiple negative EU announcements, which means that the Budapest market reacts positively when expectations regarding EU news are below market expectations or are confirmed by actual releases. This is an interesting finding since Hungary has been having problems with inflation, fiscal discipline, deficit and other macroeconomic parameters for a considerable time. Below market and in-line with the market EU news may substitute for less

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[16] We are grateful to the Prague Stock Exchange (PSE) for the results of the analysis on the structure of investors and information on the proportion of foreign investors on the Czech capital market. We are also indebted to the PSE for facilitating similar information from Budapest and Warsaw stock exchanges.

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than optimal domestic performance. Alternatively, the negative or neutral old EU news having a positive impact may be interpreted by the market as a signal to transfer funds to the new EU market to get higher gains, which is an inverse parallel to the Czech market. Again, this interpretation calls for large amounts of funds transferred by foreign investors being significantly present on the market and their sensitivity to foreign news. The presence of foreign investors on the Hungarian market is heavy (about 75%) and dominated by investors from the old EU countries, according to the Budapest Stock Exchange.[17] The Budapest market also reacts strongly to single negative U.S. news (γ_3) and the effect is understandably negative.

The path dependence of the returns with respect to volatility is not confirmed as the volatility coefficient in the mean equation (θ) is insignificant. Further, past news (α) affect volatility to a moderate extent and they are not destabilizing. The volatility of the Hungarian stock index exhibits lower persistence (indicated by the value of the GARCH term βh_{t-1}) than the Czech one but more than the Polish index. Finally, the speed of the convergence of the forecast of the conditional variance to a steady state is very slow.

3.3. Poland

From Table 6 we see that the Polish stock index is moderately affected by spillovers from Prague (μ_3 and μ_4) and only a little from Budapest (μ_1 and μ_2). On the other hand, the effect of the Budapest market is more stable in time. The effect of the spillover from Frankfurt (ρ_1 and ρ_2) is about same as that of Prague, both in terms of extent as well as decay in time. Separate estimates show that there is no spillover effect from the U.S. (ρ_3 and ρ_4). From the perspective of news transmission, the Polish stock market represents the least affected market in the region under research. There is no effect of EU or U.S. news in any form since announcements are not found to leave a trace on the developments of the returns as none of the associated coefficients is significant. The single exception is a moderate negative effect of multiple announcements originating in the EU that are in line with market expectations (δ_6). This finding can be explained by the fact that the Polish stock market has the smallest participation of foreign investors among its regional counterparts; only about one third of the traded volume, as reported by the Warsaw Stock Exchange. We conjecture that for this reason foreign announcements do not have such a large impact as the foreign investors are a minority. The rest of the market is captured by local traders and pension funds. The domestic institutional investors are accustomed to maintaining relatively stable portfolios that exclude

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[17] National Bank of Hungary reports even higher proportion of the value of traded stocks by foreign investors that ranges between 77-79% for the period under research.

"overshooting" reactions to intraday news. An alternative explanation for the lack of significance of news announcements is that the information conveyed does not go beyond the information contained in foreign stock prices.

The path dependent behavior of the returns with respect to their own volatility is not present as the coefficient of the conditional variance in the mean equation (θ) is insignificant. In terms of volatility alone, we find that past news (α) affects volatility to the largest extent among all three markets, but it is not destabilizing. On other hand, the volatility of the Polish stock index exhibits the lowest persistence (β) with respect to its regional counterparts. Similar to the Prague and Budapest index returns, the speed of the convergence of the forecast of the conditional variance to a steady state is very slow.

3.4 Robustness Check

We have reported the estimated results for each country based on the full set of available single and multiple foreign announcements. We also explored the question whether there are any types of announcements that are more important than others with respect to market reaction. To accomplish the task we selected several major types of announcements that are documented in the literature to exhibit a larger impact on stock markets. These are announcements on GDP, inflation and interest rate. We then re-estimated our specification with a sub-sample of higher impact announcements and compared the results with those obtained during days where no announcement occurred as a control sub-sample.[18] Both sets of results were not materially different as no effect of the group of higher-impact announcements was found. Based on the results of our robustness estimations we conclude that our analysis truly captures the impact of specific news releases rather than a particular time-of-the-day pattern. The result of our robustness check is further corroborated by the fact that in our sample we have a large number of days when no announcements were released and this number is also quite high relative to the sum of the announcements during trading windows (see again Table 2).

4. Concluding Remarks

We estimate the impact of macroeconomic announcements on stock market returns and volatility in the three most liquid emerging European Union markets: the Czech Republic, Hungary, and Poland. Previous studies, mostly from developed markets, indicate that the

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[18] We are grateful to an anonymous referee for suggesting this extension. Detailed results are not reported but they are available upon request.

impact of macroeconomic announcements on stock market activity is either small or insignificant. Employing intraday data and the *excess impact* approach, and primarily foreign news, we provide more comprehensive evidence and reliable inferences on the impact of news in emerging markets. Our evidence indicates that the importance of macroeconomic news on stock returns may be sensitive to the institutional structures of the markets studied, as well as the presence of foreign investors. While we find the impact of foreign news is not overwhelming, it more frequently has an impact in countries with a larger proportion of foreign investors. Further, since the number of announcements that are in line with market expectations is about five times smaller than the total number of news that come as a surprise, the in-line news do not explain the limited impact of the announcements. In addition, we show that the impact of multiple announcements is stronger than that of single news. One important lesson for future studies is that institutional factors should be considered more seriously and given more weight in interpreting the significance of foreign macroeconomic news in emerging financial markets, especially with heavy foreign trading.

We find that deviations from expectations play an important role in the EU emerging stock markets. The finding validates the use of our *excess impact* approach, yielding important insights into the arguments of Rigobon and Sack (2006) who claim that the "detachment" of monetary policy expectations and asset prices from incoming economic news is partly related to the difficulties associated with measuring the surprise component of that news. Using the *excess impact* approach, we attempt to reduce the difficulties of measuring "news" correctly.

Regarding the relative impact of U.S. versus EU foreign macroeconomic announcements on stock returns, news originating in the EU affects the returns in Prague, Budapest and Warsaw markets, while U.S. announcements have an impact on the Prague and Budapest markets only. The results for the Czech stock market do reflect the fact that a very significant part of the traded volume is due to foreign investors. These market players put more weight on foreign announcements which shows in the direct impact of U.S. news releases on the Prague stock index. This finding is consistent with previous studies that find a reduced role for macroeconomic news when composite indices are included in regressions. Local macroeconomic news does not have immediate (intraday) effects on returns in all markets as the majority of scheduled announcements are released before trading on the market begins. This, however, does not rule out that domestic news affect the markets between subsequent trading sessions. In general, emerging markets with stronger dependence on

developed foreign stock markets react less to foreign macro announcements. This finding supports the notion that macro news can be transmitted by spillovers in asset prices.

In terms of volatility effects, stock returns show strong path-dependency on their own conditional variance (volatility) which is highly persistent in the Prague market but insignificant in the Budapest and Warsaw markets. This may reflect the higher degree of financial spillover effects to the Prague market originating from both the EU and U.S. markets directly through the composite index movements and indirectly via macroeconomic announcements. News affects volatility as the ARCH term in the conditional variance equation is statistically significant. News has a larger effect on volatility in the Budapest and Warsaw markets than the Prague market, indicating that the Prague market is calmer than the former markets. Perhaps this finding is due to more informed trading in the Czech market because of the large foreign investor presence.

Overall, we find that all three of these new EU stock markets are subject to significant spillovers directly via the composite index returns from the EU, the U.S. and neighboring markets among which Budapest exhibits the strongest spillover effect, followed by Warsaw and Prague. The Czech and Hungarian markets are also subject to spillovers indirectly through the transmission of macroeconomic news. The impact of EU-wide announcements is evidenced more in case of Hungary, while the Czech market is more impacted by U.S. news. The Polish market is marginally affected by EU news that is in line with expectations. We document that the impact of foreign macroeconomic announcements goes beyond the impact of the foreign stock markets on CEE indices.

The results have important implications for diversification and risk management strategies in these European emerging markets. As these countries prepare to enter the euro zone, we expect that their financial markets will be more sensitive to macroeconomic shocks, especially those originating from the European Union. This means that investors should price this expected higher future volatility (risk) when investing in these markets now. From a broader perspective, we find that the emerging markets in our sample countries seem to react similarly to macroeconomic news compared to those in advanced industrial markets. This finding suggests that the emerging European countries have made significant progress in terms of financial market development by successfully integrating their financial markets into the world economy in a relatively short period. Hence, the results provide incentives for the other emerging economies in the region to speed up economic reforms. This is also encouraging for lagging economies in the region, especially for the candidate EU countries.

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Table 1
Descriptive statistics for main composite indices.
[Time span selected according to the trading hours of Prague, Budapest and Warsaw, i.e., 9:00 a.m. to 4:00 p.m.]

	Number of observations	Mean	Std. Dev.	Minimum	Maximum
2003					
BUX	13172	8861	670	7693	9975
PX50	11398	601	37	529	661
WIG20	10437	1464	136	1188	1739
2004					
BUX	21745	11759	1434	9398	14806
PX50	18668	828	93	658	1034
WIG20	17174	1751	80	1577	1966
2005					
BUX	22980	19018	2408	14560	23831
PX50	19699	1253	124	1032	1482
WIG20	18727	2174	250	1809	2702
2006					
BUX	22253	22499	1279	18117	25513
PX50	18913	1480	90	1125	1632
WIG20	20437	2995	190	2453	3430

Table 2. Daily distribution of news events (percent of all trading days)

| Country/Region | Days with types of news events: | | | | |
	No news	Single news	Multiple news	Single and multiple news	Total
European Union	70,18	22,44	6,25	1,13	100,00
United States	31,15	29,20	18,85	20,80	100,00
Czech Republic	91,39	8,61	0,00	0,00	100,00
Hungary	95,70	4,30	0,00	0,00	100,00
Poland	75,20	13,73	9,94	1,13	100,00

Table 3. Daily distribution of news events that are released during trading window

| Country/Region | Classification and number of the news events: | | | |
	Positive	Negative	In-line	Total
All news				
European Union	121	104	114	339
United States	456	467	110	1033
Czech Republic	24	31	29	84
Hungary	8	5	29	42
Poland	110	84	71	265
Single news				
European Union	99	86	82	267
United States	295	285	32	612
Czech Republic	24	31	29	84
Hungary	8	5	29	42
Poland	60	52	43	155
Multiple news				
European Union	22	18	32	72
United States	161	182	78	421
Czech Republic	0	0	0	0
Hungary	0	0	0	0
Poland	50	32	28	110

Table 4. News and spillover effects: Prague Stock Exchange

Parameter	Coefficient	Specification (1.A)		Specification (1.B)	
		Estimate	Std. error	Estimate	Std. error
Stock index return					
DAX $_{t-1}$	ρ_1	0,015***	0,002	0,014***	0,001
DAX $_{t-2}$	ρ_2	0,002	0,002	0,006***	0,001
DowJones $_{t-1}$	ρ_3	0,005**	0,002	0,005**	0,002
DowJones $_{t-2}$	ρ_4	0,000	0,001	0,000	0,001
BUX $_{t-1}$	μ_1	0,002***	0,000	0,002***	0,000
BUX $_{t-2}$	μ_2	0,001**	0,000	0,001***	0,000
WIG20 $_{t-1}$	μ_5	0,007***	0,002	0,005***	0,001
WIG20 $_{t-2}$	μ_6	0.003**	0,001	0,006***	0,001
Pooled news announcement					
Positive US news	χ_1	0,011	0,038		
Positive EU news	χ_2	0,009	0,045		
Negative US news	χ_3	-0,060*	0,033		
Negative EU news	χ_4	0,090	0,128		
In-line US news	χ_5	-0,150*	0,092		
In-line EU news	χ_6	-0,032	0,065		
Single news announcement					
Positive US news	γ_1			-0,013	0,054
Positive EU news	γ_2			-0,154**	0,068
Negative US news	γ_3			-0,035	0,041
Negative EU news	γ_4			0,016	0,051
In-line US news	γ_5			0,002	0,122
In-line EU news	γ_6			-0,036	0,047
Multiple news announcement					
Positive US news	δ_1			0,057*	0,034
Positive EU news	δ_2			0,614	0,538
Negative US news	δ_3			-0,079*	0,041
Negative EU news	δ_4			0,800	0,513
In-line US news	δ_5			-0,334*	0,178
In-line EU news	δ_6			0,049	0,110
Path dependency					
Conditional variance	θ	0,023***	0,008	0,023***	0,006
Volatility equation parameters					
Constant	ω	0,000	0,000	0,001	0,000
ARCH term	α	0,022***	0,008	0,029**	0,010
GARCH term	β	0,977***	0,008	0,971***	0,010
Number of observations: 61, 680		DW: 1,71 SIC: 50962 Log Likelihood: -50875 Adjusted R^2 : 0,018		DW: 1,79 SIC: 55598 Log Likelihood: -55477 Adjusted R^2 : 0,023	

Notes: ***, **, * denote significant at 1%, 5%, 10% statistical test level, respectively. DW indicates the Durbin-Watson statistics and SIC stands for Schwarz-Bayesian information criteria.

Table 5. News and spillover effects: Budapest Stock Exchange

Parameter	Coefficient	Specification (1.A)		Specification (1.B)	
		Estimate	Std. error	Estimate	Std. error
Stock index return					
DAX $_{t-1}$	ρ_1	0,165***	0,018	0,161***	0,017
DAX $_{t-2}$	ρ_2	0,113***	0,019	0,108***	0,018
DowJones $_{t-1}$	ρ_3	-0,026	0,039	-0,026	0,039
DowJones $_{t-2}$	ρ_4	-0,009	0,022	-0,009	0,022
PX50 $_{t-1}$	μ_3	0,448***	0,128	0,454***	0,118
PX50 $_{t-2}$	μ_4	0,314**	0,126	0,266**	0,117
WIG20 $_{t-1}$	μ_5	0,103***	0,025	0,105***	0,024
WIG20 $_{t-2}$	μ_6	0,101***	0,025	0,095***	0,024
Pooled news announcement					
Positive US news	χ_1	-0,133	0,642		
Positive EU news	χ_2	0,126	0,849		
Negative US news	χ_3	-1,120*	0,598		
Negative EU news	χ_4	10,778***	3,908		
In-line US news	χ_5	0,274	1,387		
In-line EU news	χ_6	1,167	1,428		
Single news announcement					
Positive US news	γ_1			-0,235	0,772
Positive EU news	γ_2			1,660	1,228
Negative US news	γ_3			-1,517*	0,867
Negative EU news	γ_4			-0,830	1,163
In-line US news	γ_5			0,894	1,834
In-line EU news	γ_6			1,318	1,143
Multiple news announcement					
Positive US news	δ_1			-0,466	0,784
Positive EU news	δ_2			-2,698	9,658
Negative US news	δ_3			-0,765	0,774
Negative EU news	δ_4			4,408*	2,579
In-line US news	δ_5			0,147	1,678
In-line EU news	δ_6			7,232*	3,817
Path dependency					
Conditional variance	θ	0,001	0,004	0,004	0,004
Volatility equation parameters					
Constant	ω	0,012***	0,002	0,012***	0,002
ARCH term	α	0,089***	0,009	0,090***	0,008
GARCH term	β	0,909***	0,009	0,909***	0,008
Number of observations: 61, 680		DW: 1,76 SIC: 215764 Log Likelihood: -215677 Adjusted R^2 : 0,007		DW: 1,71 SIC: 245740 Log Likelihood: -245618 Adjusted R^2 : 0,013	

Notes: ***, **, * denote significant at 1%, 5%, 10% statistical test level, respectively. DW indicates the Durbin-Watson statistics and SIC stands for Schwarz-Bayesian information criteria.

Table 6. News and spillover effects: Warsaw Stock Exchange

Parameter	Coefficient	Specification (1.A)		Specification (1.B)	
		Estimate	Std. error	Estimate	Std. error
Stock index return					
DAX $_{t-1}$	ρ_1	0,071***	0,005	0,069***	0,004
DAX $_{t-2}$	ρ_2	0,022***	0,004	0,021***	0,004
DowJones $_{t-1}$	ρ_3	0,010	0,008	0,010	0,008
DowJones $_{t-2}$	ρ_4	-0,003	0,004	-0,003	0,004
BUX $_{t-1}$	μ_1	0,005***	0,001	0,005***	0,001
BUX $_{t-2}$	μ_2	0,004***	0,001	0,004***	0,001
PX50 $_{t-1}$	μ_3	0,052***	0,017	0,056***	0,016
PX50 $_{t-2}$	μ_4	0,030*	0,017	0,027*	0,016
Pooled news announcement					
Positive US news	χ_1	-0,163	0,230		
Positive EU news	χ_2	0,112	0,171		
Negative US news	χ_3	0,114	0,243		
Negative EU news	χ_4	-0,665	0,448		
In-line US news	χ_5	-0,029	0,177		
In-line EU news	χ_6	-0,228	0,234		
Single news announcement					
Positive US news	γ_1			0,000	0,269
Positive EU news	γ_2			0,035	0,237
Negative US news	γ_3			0,101	0,267
Negative EU news	γ_4			0,103	0,185
In-line US news	γ_5			0,160	0,542
In-line EU news	γ_6			-0,135	0,170
Multiple news announcement					
Positive US news	δ_1			-0,140	0,242
Positive EU news	δ_2			0,936	2,244
Negative US news	δ_3			0,107	0,307
Negative EU news	δ_4			0,688	1,037
In-line US news	δ_5			-0,160	0,230
In-line EU news	δ_6			-0,604*	0,376
Path dependency					
Conditional variance	θ	0,003	0,004	0,005	0,004
Volatility equation parameters					
Constant	ω	0,160***	0,018	0,154***	0,017
ARCH term	α	0,125***	0,008	0,123***	0,007
GARCH term	β	0,859***	0,009	0,861***	0,008
Number of observations: 61, 680		DW: 1,79 SIC: 55598 Log Likelihood: -55477 Adjusted R^2 : 0,016		DW: 1,86 SIC: 140351 Log Likelihood: -140230 Adjusted R^2 : 0,020	

Notes: ***, **, * denote significant at 1%, 5%, 10% statistical test level, respectively. DW indicates the Durbin-Watson statistics and SIC stands for Schwarz-Bayesian information criteria.

Composition of the stock market indices in Prague, Budapest and Warsaw

Stock Issuer	Stock Weight	Issuer Domicile
Budapest Stock Exchange Index (BUX)		
DANUBIUS	0.9%	D
ECONET	0.1%	D
EGIS	2.0%	D
ÉMÁSZ	0.4%	D
FHB	1.2%	D
FOTEX	1.1%	D
MAGYAR TELEKOM	13.1%	D
MOL	32.9%	D
OTP	31.9%	D
PANNONPLAST	0.7%	D
RÁBA	0.7%	D
RICHTER	14.4%	D
SYNERGON	0.3%	D
TVK	0.3%	D
Prague Stock Exchange Index(PX-50)		
ČEZ	26.7%	D
ERSTE BANK	23.5%	F
TELEFÓNICA O2 C.R.	15.8%	D
KOMERČNÍ BANKA	14.5%	D
CETV	5.6%	F
UNIPETROL	4.8%	D
ZENTIVA	4.1%	F
ORCO	2.3%	F
PHILIP MORRIS ČR	1.7%	D
PEGAS NONWOVENS	0.6%	F
ECM	0.5%	F
Warsaw Stock Exchange Index (WIG-20)		
PKOBP	15.7%	D
PEKAO	13.1%	D
PKNORLEN	12.7%	D
TPSA	10.3%	D
KGHM	9.8%	D
BANKBPH	4.9%	D
GTC	4.1%	D
BZWBK	4.0%	D
BRE	3.4%	D
PGNIG	3.3%	D
POLIMEXMS	3.1%	D
PBG	2.4%	D
TVN	2.3%	D
CERSANIT	2.0%	D
CEZ	1.9%	F
MOL	1.8%	F
LOTOS	1.6%	D
AGORA	1.6%	D
BIOTON	1.1%	D
PROKOM	1.1%	D

Note: Issuer domicile can be domestic (D) or foreign (F).