INTRADAY PRICE DISCOVERY IN EMERGING EUROPEAN STOCK MARKETS

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Jan Hanousek* and Evžen Kočenda**

Abstract

We characterize the price discovery in three emerging EU stock markets—the Czech Republic, Hungary, and Poland—by employing high-frequency five-minute intraday data on stock market index returns and four classes of EU and U.S. macroeconomic announcements during 2004–2007. We account for the difference of each announcement from its market expectation and we jointly model the volatility of the returns accounting for intra-day movements and day-of-the-week effects. Our findings show that real-time interactions on the new EU markets are strongly determined by matured stock markets as well as the macroeconomic news originating thereby. Monetary news has virtually no impact on stock returns while U.S. prices affect all three markets. The real economy announcements have varying effects but the news on the EU current account affects all three markets in a uniform manner. Only some EU economic climate and confidence announcements affect stock returns. In general, differences in results across markets are driven by differences in key market participants. Volatility of the returns is accounted for at the beginning and end of the trading session and it declines dramatically during the rest of the day. All three markets also show a decrease in volatility by the middle of the business week. Our findings yield insights into the process of stock market integration in the EU as well as portfolio allocation on the new EU markets.

Keywords: price discovery, stock markets, intra-day data, macroeconomic news, European Union, volatility, excess impact of news
JEL Classification: C52, F36, G15, P59

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Abstrakt

Analyzujeme proces tvorby cen na třech rozvíjejících se finančních trzích EU (České republice, Maďarsku a Polsku) při použití vysokofrekvenčních pětiminutových dat. Při analýze jsou použita data z období 2004-2007, která klasifikují makroekonomická oznámení do čtyř různých kategorií a analyzují jejich vliv na výnosy akciových indexů na těchto trzích. V naší analýze bereme jednak v potaz odchylky zpráv od jejich očekávání na trhu, při modelování volatility výnosů jsou zohledněny jak vnitro denní pohyby, tak i efekty na denní bázi (konec týdne apod.). Naše výsledky ukazují, že okamžité reakce nových EU trhů jsou silně určovány rozvinutými kapitálovými trhy, stejně tak jako makroekonomickými zprávami, které jsou s nimi spjaté. Zprávy monetárního charakteru nemají téměř žádný vliv na chování akciových výnosů, zatímco makroekonomické zprávy související s vývojem cenové hladiny v USA ovlivňují všechny tři trhy. Oznámeni charakterizující vývoj reálné ekonomiky mají různý efekt na jednotlivých trzích, ale zprávy o saldu běžného účtu v EU ovlivňují všechny sledované trhy stejným způsobem. Poznamenejme, že pouze některé EU oznámení o důvěře v ekonomiku („economic confidence „ a „economic climate“) ovlivňují vývoj akciových výnosů. Obecně se dá říci, že rozdíly mezi jednotlivými trhy, zejména co se týče výše zmíněných interakcí, mohou být vysvětleny rozdíly mezi hlavními hráči na trhu. Při analýze volatility výnosů zohledňujeme při estimaci specifický vývoj během začátku a konce obchodování kdy je voalitilta nejvyšší.Volatilita během zbývající části obchodního dne silně klesá. Všechny tři trhy také ukazují pokles volatility uprostřed týdne. Naše výsledky lze použít při hlubší analýze integrace kapitálových trhů a portfoliových investic v nových zemích EU.

1. Introduction, Motivation and Related Literature

Modern stock market research draws attention to the use of intraday data that are able to reveal the effect of macroeconomic announcements on stock market movements (Bollerslev and Cai, 2000; Nikkinen et al., 2006; Jones, Lin and Masih, 2005; Erenburg, Kurov and Lasser, 2005; Rigobon and Sack, 2006). In our paper we contribute to the related literature in several ways. Most of the literature targets the developed capital markets in the U.S. and Europe, while European emerging markets are still under-researched. Therefore we investigate new EU members: the Czech Republic, Hungary, and Poland. Further, as an extension to the above literature, we use stock price data based on 5-minute intervals to provide more robust estimates of public information on stock returns in the new EU markets, which is not covered in the literature.[1]

Further, 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 on stock returns.[2] 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.[3] Hence we use a larger set of macroeconomic releases than employed in previous studies; the announcements and their grouping are specified in the data section. In this respect we also differentiate between local and foreign announcements as the countries under research are small and highly open economies and as such they exhibit significant trade and financial linkages or institutional arrangements with respect to the EU.[4]

[1] Hanousek, Kočenda, and Kutan (2008) investigate the effect of single versus multiple announcements on the new EU stock markets using intraday data. Other literature deals with emerging markets in Europe but on a lower frequency and without the specific effect of macroeconomic announcements (see e.g. Korczak and Bohl, 2005 and Serwa and Bohl, 2005, among others).

[2] 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, Mann, Atra and Dowen (2004), Rigobon and Sack (2006), Bredin, Hyde, and O'Reilly (2005), He (2006), and Wongswan (2006).

[3] To our knowledge, exceptions are Flannery and Protopapadakis (2002) and Andersen et al. (2007) who employed 17 and 25 U.S. macroeconomic news announcements, respectively.

[4] To our knowledge, there are only a few studies that investigate the impact of both local and foreign announcements on stock market returns. See e.g. Nikkinen and Sahlström (2004) or Albuquerque and Vega (2006).

Finally, previous studies tend to investigate the impact of macro news only on conditional returns, assuming that stock returns do not exhibit time-varying volatility.[5] In this study, we model both conditional returns and the conditional variance of returns simultaneously in a time-varying (GARCH) framework to better capture the impact of macroeconomic announcements of stock returns and to assess intra-day and daily effects in stock market volatility at three new EU markets.

The rest of the paper is organized as follows. In Section 2 we introduce our modeling approach, data and definitions. Detailed empirical findings are presented in Section 3. A concluding summary follows.

2. Data and Methodology

We analyze the price discovery on the new EU stock markets and concentrate on the stock exchanges in Budapest, Prague, and Warsaw in particular. 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 macroeconomic announcements by employing an augmented version of the generalized autoregressive conditional heteroskedasticity (GARCH) model attributed to Bollerslev (1986). This approach allows us to assess the impact of news on stock returns and assess market volatility, as well as to account for the fact that errors from the mean equation are heteroskedastic. We deviate from the standard sequencing and introduce our data prior to describing the model since a description of the news announcements is needed to better describe our model.[6]

2.1 Data Set: Stocks and News

We constructed our dataset from intraday data on three emerging EU markets recorded by Bloomberg. Stock exchange index quotes ($I_{i,t}$) for market i are available in five-minute intervals at time t (ticks) for the stock markets in Budapest (BUX), Prague (PX-

[5] 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, Bomfim (2001), Kim et al. (2004), and Jones et al. (2005) utilize time-varying (GARCH) models.

[6] The theoretical framework linking macro announcements to stock returns is underdeveloped. We refer readers to the account of bond pricing with announcement effects of Piazzesi (2001), the equities modeling framework with announcements' effect of Mamaysky (2002), and an equilibrium asset pricing model with public announcements by Cenesizoglu (2007).

50), and Warsaw (WIG-20). In addition to these markets we also employ data from the Frankfurt stock exchange (the German DAX index) and the U.S. Dow Jones Industrial Average of 30 stocks index. Based on these quotes we construct a five-minute stock market index return $R_{i,t}$ ($R_{i,t} = \ln(I_{i,t} / I_{i,t-1})$) for each market i from time t-1 to time t. The time period of our data starts on 1 June 2004 at 9:00 and ends on 30 December 2007 at 16:30 Central European Daylight Time (CEDT). The beginning of our sample corresponds to the entry of the four countries to the European Union. After accounting for weekends and public holidays, the time span gives the following numbers of trading days for each of the three new EU markets: 878 (Budapest), 880 (Prague), and 879 (Warsaw). Descriptive statistics of the stock index returns are presented in Table 1.

The detailed composition of the three indices is provided in Table A1 in the Appendix. The Budapest index BUX consists of 16 titles, with four forming the bulk of the index (91.5%). The Prague index (PX-50) consists of 13 titles and 82.7% of it is formed by four titles. The Warsaw index WIG-20 contains 20 titles and five titles form a majority (64.0%). None of the companies that are included in the three indices are exposed to foreign economic conditions in a different way in terms of reporting activities as they are all obliged to report under international accounting standards. The energy, banking and telecom industries dominate all three indices and specifically the banking industry is represented in similar proportions in each of 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.

Further, we compiled an extensive data set on 15 different macroeconomic announcements (news) that are divided into four categories. These are announcements on prices, real economy (GDP, current account, production, sales, trade balance, unemployment, etc.), monetary policy (monetary aggregate and interest rate), and economic confidence (consumer and industry confidence, business climate, etc.). We provide details on the types and origin of the announcements later in this section.

The macroeconomic announcements we employ are surveyed by Bloomberg and Reuters with a clearly defined calendar and timing of the news releases; as publication

schedules of the releases is publicly available we do not report it for the sake of space. The available information also contains surveyed market expectations of the specific news that provide a market consensus on the expected values relevant for specific announcements. The surveyed values then constitute the best proxy for market expectation available. In our analysis we consider all scheduled macroeconomic announcements but for estimation purposes we employ only the major releases. A complete set of announcements from the Bloomberg database allows us to isolate the timing of other (i.e. not employed in the analysis) announcements and therefore minimize possible bias stemming from the fact that market expectations are formed and announced only for the major announcements.[7]

The above arrangement is particularly important since it enables us to analyze the effect of the news from its *excess impact* perspective. Because markets form expectations about scheduled important news, it is not the news itself that matters but its difference from what the market expects it to be (market consensus). The news deviation, or its excess, has then an impending impact on stock prices. Following this logic, we construct a data set of announcements. There is news associated with indicator i in the form of various macroeconomic releases or announcements that are known ahead of time to materialize on specific dates t.[8] The extent of such news is not known but expectations on the market form a forecast. The excess impact news announcement is then defined as a deviation of the news from the market expectation formed earlier. Further, announcements are often reported in different units and therefore they are standardized to allow their meaningful comparison (see e.g. Andersen et al., 2007). Formally, the excess impact news variable is labeled as xn_{it} and defined as $(sn_{it} - E_{t-1}[sn_{it}]) / \sigma_i$, where sn_{it} stands for the value or extent of the scheduled announcement i at time t and $E_{t-1}[sn_{it}]$ is the value of the announcement for time t expected by the market at time t-1, and σ_i is the sample standard deviation of the announcement i. The

[7] The classification of news as a major announcement is based on a survey of experts (Bloomberg) anticipating the given announcement. The survey works in this context as a market expectation for the particular announcement. By the same token we do not consider a time when no other macro announcement was made as "no news". Similarly like other researchers in the field, we are unable to account for announcements for which the market expectations are not formed and not made available.

[8] 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.

standardization does not affect the properties of the coefficients' estimates as the sample standard deviation σ_i is constant for any announcement indicator i.

From a practical perspective, we consider the immediate effect of each new announcement at the time of its release and account for its impact for 5 minutes because the significant differences in price discovery concentrate in transactions that immediately follow the news release (Greene and Watts, 1996). 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.[9] An announcement has a zero impact if it is exactly in line with the market or not further than 5% of the news sample standard deviation from market consensus.[10] The excess impact approach *per se* assumes that the difference of the announcement from its market expectation is in the form of a certain function (say linear or quadratic). Given the emerging character of the markets under research we simplify this assumption and consider only three types of impact: negative, in-line and positive. In this case our findings should be robust with respect to the particular excess impact response.

In our analysis we concentrate chiefly on foreign news originating in the Eurozone and the U.S.A. because the majority of local news is released intentionally before the market opening and thus they are absorbed by the market before trading begins and they are factored into stock prices without delay.[11] The time difference between the markets is accounted for by setting CEDT time for all news releases, which eliminates the time difference between the U.S. and continental Europe. The details on

[9] 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, empirics suggest that a lower-than-expected unemployment rate has a positive impact as its consequence means higher tax collection, decreased payments from the state, etc. On other hand, higher-than-expected inflation has a negative impact. Other variables whose announcement shows a reverse impact direction are, for example, debt, deficit, interest rate, and labor costs.

[10] As a robustness check, we consider a set of news that deviates from market expectations by ±10%. In this case estimates differ, though. We believe that the threshold of ±10% is too distant from the market consensus and the interval includes announcements with excess values that come as a true surprise and distort estimates as compared to an interval of ±5%.

[11] 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. Most of the news then comes as no surprise since they are in line with market expectations and because they are processed even before trading begins, their effect is dampened dramatically. Among the few local news that are released during the trading hours are the interest rate decisions made by central banks. In this case their values are virtually always in-line with market expectations and this type of news comes then as no surprise on the markets.

the announcements are introduced in Tables 2–4. The first category contains prices measured by Consumer and Industry Price Indices (items 1 and 2). News on the real economy (items 3 to 9) covers industrial production, GDP, factory orders, retail sales, trade balance, current account, and unemployment. Monetary indicators (items 10 and 11) are represented by the money aggregate and central banks' key interest rates. The category business climate and consumer confidence contains four measures (items 12 to 15). The first two are official indicators of the business climate and consumer confidence that provide an assessment of the current and expected business situation by surveying companies and the degree of optimism about the current and future state of the economy by surveying consumers. Then, there are two indices published by the Institute for Supply Management (ISM) in the U.S. and their equivalents for the Eurozone. These are the ISM index on business activities (non-manufacturing) and the Purchasing Managers' Index (PMI). Both indices are widely used by financial analysts and traders worldwide.[12]

In Table 2 we show the scope and distribution of news announcements entering the Czech stock market during trading hours in Prague (9:30–16:00 CEDT). There is total of 536 U.S. announcements for the period under research. News with negative, in line, and positive impact are roughly in a ratio of 3:1:3 in total, but proportions differ across news types. Announcements on unemployment are represented most frequently, followed by those on prices, real economy activities, and business confidence. The Eurozone news group is represented by 899 announcements and contrary to the U.S., all three types of news enter the market in almost equal proportions. News on business confidence, prices, and real economy are the most frequent. The Eurozone announcements are more evenly distributed among various types than U.S. news because the trading hours overlap with Central European markets is much larger.

In Table 3 we display information on news announcements entering the Hungarian stock market in Budapest that operates the longest trading session among the three new EU markets (9:00–16:30 CEDT). Budapest receives the broadest sample of news due to the longest span of the trading session. There are 700 announcements

[12] In our analysis we intentionally omit any type of news related to microeconomic foundations, such as company economic results, government regulation changes pertaining to major companies, etc. This is done for practical reasons. The availability of this type of data and the exact timing of the information releases are extremely difficult.

originating in the U.S. and those with negative/positive impact are equal in number (307/307). Only about 11% of announcements are in line with market expectations. The distribution of the announcements is similar to that in Prague. Unemployment announcements is the single most frequent category, followed by prices. Representation of Eurozone news totals 934 announcements, with negative and positive impacts carrying almost equal weights (315/320).

Finally, Table 4 provides data on news announcements at the Polish stock market. The trading session in Warsaw is the shortest among the countries (10:00–16:00 CEDT) and that is why the number of foreign news announcements is also the smallest. The numbers of the announcements originating in the U.S. and Eurozone are 535 and 731, respectively. Their division among various types is naturally similar to that in Prague and Budapest.

2.2 Estimation Methodology

We employ the augmented generalized autoregressive conditional heteroskedasticity (GARCH) model attributed to Bollerslev (1986) to empirically test for the effect of macroeconomic announcements on stocks and to assess 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.). The volatility equation is augmented by a set of dummy variables to capture intraday and daily effects. Thus, our model effectively captures the effect of news and market spillovers on stock returns and the effect of trading patterns on stock volatility. The baseline model is specified in the following form:

$$R_{i,t}^{E} = \sum_{y=2004}^{2007} \lambda_y + \sum_{k\in\{EU,US\}} \sum_{j=1}^{p} \pi_k R_{k,t-j}^{M} + \sum_{i=1}^{2}\sum_{j=1}^{q} \gamma_i R_{i,t-j}^{E} + \sum_{j=1}^{n}\sum_{l=1}^{3} \delta_{l,j} xn_{EU}^{j} + \sum_{j=1}^{n}\sum_{l=1}^{3} \kappa_{l,j} xn_{US}^{j} + \varepsilon_t \quad (1)$$

$$h_{i,t} = \omega + \sum_{m=1}^{r} \alpha_m \varepsilon_{t-m}^{2} + \sum_{m=1}^{s} \beta_m h_{i,t-m} + \sum_{\tau\in T} \mu_\tau D_\tau + \sum_{d=1}^{4} \psi_d W_d \quad . \quad (2)$$

The variables in the mean equation (1) are coded as follows. Our dependent variable $R_{i,t}^{E}$ is the return on a specific emerging (*E*) market stock index *i* (Budapest,

Prague, Warsaw) at time t. The parameter $R^{M}_{k,t-j}$ is the lagged return on a specific mature and developed (M) stock market index in the European Union (EU) and the United States (US). As a proxy for the Eurozone 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.[13] Coefficients π_k capture the effects of market spillovers from the two developed markets. The parameter $R^{E}_{i,t-j}$ is the lagged return on a specific emerging market stock index other than that employed as a dependent variable and coefficients γ_i capture the effects of spillovers from emerging markets (e.g., in the case of the Prague index being the dependent variable, lagged indices from Budapest and Warsaw are right-hand side variables). Coefficients λ represent a set of year-specific dummy variables that provide information on stock index returns in a specific year during the period 2004–2007.

A vector of the news announcements defined in section 2.1 is denoted as xn^{j}_{EU} for the announcements originating in the Eurozone (EU) and xn^{j}_{US} for those originating in the U.S.A. (US). Further, subscript j indexes news announcements according to their type or class that we described in section 2.1 and classified in Tables 2–4. Finally, subscript l indexes the three qualities of the news entering our specification. This way we are able to disclose a different reaction expected from a behavioral point of view to announcements that are below market expectations (excess negative news, $\delta_{1,j}$), announcements that are in-line with market assessment (news with no-impact, $\delta_{2,j}$), or announcements above market expectations (excess positive news, $\delta_{3,j}$). Thus, coefficients $\delta_{l,j}$ capture the contemporaneous effects of various types of news on stock index returns. The numbers of lags p, q, r, and s are chosen by the lag selection information criteria. Intercepts in different years captured by λ_y are allowed to vary for the sake of filtering away effects of potentially different means during the consecutive years.

In the above conditional variance $h_{i,t}$ specification (2), the ARCH term, $\alpha\varepsilon^{2}_{t-1}$, 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

[13] Germany is the most important trading partner for the three new EU countries under research. Using a composite Stoxx 50 or EuroStoxx 50 index is not feasible as these are not available historically at the desired intra-day frequencies.

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 the convergence of the forecast of the conditional volatility to a steady state. The closer its value is to one, the slower the convergence.

Further, behavior on stock markets has been documented to follow periods of lower and higher activity during a trading day in the form of a *U*-shape pattern (e.g. McMillan and Speight, 2002; Fan and Lai, 2006; Égert and Kočenda, 2007). Such a pattern can be explained by the arrival and incorporation of news during the beginning of the trading session or by intraday trading activity, implying the opening and closing of positions at the beginning and at the end of the trading session. In order to avoid mixing periods of varying volatility our specification includes a dummy variable D_τ associated with five-minute intraday intervals (ticks) at the beginning and end of the trading day. The associated coefficients μ_τ capture intraday volatility whose presence has been documented in the literature for quite a time (see Andersen and Bollerslev, 1998). The volatility at the beginning and end of the trading session is considerably higher than during the rest of the trading day and this decline in volatility is captured by the constant ω. The range of the intra-day-effect dummies (T) was selected based on the results of a standard *F*-test. Finally, dummy variable W_d allows accounting for the effect of specific days during a business week. Four coefficients ψ_d capture these day-of-the-week effects well documented in the empirical literature including European markets (see e.g. Tonchev and Kim, 2004; Chang, Pinegar and Ravichandran, 1993; Kiymaza and Berument, 2003). To sum up, the volatility specified by equation (2) represents a simple yet comprehensive specification allowing for assessment as well as the influence of trading patterns on volatility.

Based on the Akaike information criterion, 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 market at 15:30 CEDT. The news announcements from these two regions are hypothesized to exhibit the most direct influence on the new EU stock markets. The specification also accounts for the spillover effects through the lagged index returns of neighboring emerging stock markets as well as lagged German and U.S. returns. Since trading hours in different markets span over different time periods we treat this difference by estimating the set of mean and volatility equations for each of the three emerging markets separately.

3. Empirical Findings

The results of our analysis are presented in Tables 5–7 for each of the three countries separately. Each table is divided into two panels. Panel A displays the estimates of the spillover effects in the mean equation as well as estimates from the volatility equation. The effects of specific news in the mean equation are then summarized in panel B. Each effect of an announcement is clearly identified by the associated coefficients $\delta_{l,j}$ and $\kappa_{l,j}$ for Eurozone and U.S. news, respectively. For example, coefficient $\delta_{3,1}$ shows the effect of the industrial production announcement (subscript 3) originating in the Eurozone whose value is below market expectations (subscript 1), and coefficient $\kappa_{1,2}$ shows the effect of an announcement of the consumers prices (subscript 1) originating in the U.S.A. that is in line with market expectations (subscript 2).

Our results show substantial spillovers affecting the new EU markets together with the news impact on the index returns in general. The German DAX exhibits the strongest spillover effects, followed by the Dow-Jones and regional indices whose impact varies. The impact of announcements differs with respect to the extent and origin of the news as well as the impacted stock market. We credit these differences to the varying extent of foreign, mostly institutional, investors on the three markets and their shares on traded volumes. The presence of foreign investors on the Czech and Hungarian markets is heavy and varies around 55–60% and 75% of the traded volume, respectively, over time. The Hungarian market is dominated by investors from the old EU while U.S. investors prevail on the Czech market. This is in sharp contrast to the Polish market where only about one third of the traded volume is due to foreign investors. Different perceptions and sensitivity to news origin are conjectured as reasons behind the differences in our results.[14]

The general finding is that the three markets are not efficient in the sense of efficient market theory because numerous significant coefficients associated with the impact of the news testify that news is not absorbed by the market immediately and reflected instantaneously in prices. Announcements originating in the Eurozone exhibit more effects than U.S. news. In terms of specific news, EU current account, consumer confidence and PMI affect all three markets while U.S. prices are the only news of the same reach. The volatility of the returns is accounted for at the beginning and end of the trading session and it declines dramatically during the rest of the day. The differences in the extent of volatility at the three markets should be credited to differences in trading hours on these markets. This finding is consistent with results of French and Roll (1986) and Banko and Flannery (2008).[15]

3.1. Czech Republic

The returns on the Prague stock index PX-50 (Table 5.A) reflect most heavily spillovers from Frankfurt (π_1 and π_2) whose impact is double that of Dow-Jones (π_3 and π_4).

[14] We rule out the different trading hours as the cause of the different results across the markets. When constraining the data sample to the common trading window as in Hanousek, Kočenda, and Kutan (2008) the differences remained of the same extent.

[15] French and Roll (1986) show that volatility is not fixed across calendar time intervals but varies with trading time. The variability of trading hours has increased since the mid-1980s. Banko and Flannery (2008) find that permanent changes in the available trading hours on the U.S. stock market can fully account for the increase in volatility from 1962 to 2004.

Regional spillovers are smaller but comparable to the U.S. spillovers and they come from Budapest (γ_1 and γ_2) as coefficients on the Polish index are either insignificant (γ_5) or small (γ_6). All spillovers are positive and hint at the market being efficient but this finding is contested by the multiple effects of news announcements (Table 5.B). Among these the effects of prices and real economic indicators from the Eurozone stand out. A positive outcome of consumer price development has a positive effect on the stock index return ($\delta_{1,3}$), while less favorable announcements below market expectations on industrial production ($\delta_{3,1}$), current account ($\delta_{8,1}$), and unemployment ($\delta_{9,1}$) all exhibit negative effects on stock returns.[16] Further, the effect of a consumer confidence release that is in line with the market shows a negative impact ($\delta_{13,2}$). Higher-than-expected growth in the Purchasing Managers' Index (PMI) exhibits a positive impact ($\delta_{15,3}$) on stock returns while a value that is in line with the market assessment shows negative impact of similar extent ($\delta_{15,2}$). While the positive impact of positive news does not pose an intellectual challenge, the negative impact of the in-line outcome of consumer confidence and PMI is not clear. A possible interpretation is that markets expect a specific value of a particular indicator but hope for a better result, which turns an in-line outcome into negative news. This interpretation also fits with the empirical facts that negative news impacts stocks more than positive news of the same caliber; the same result is found by Kaminsky and Schmukler (1999) on Asian emerging markets.

The only announcements originating in the U.S. that impact index returns are consumer and producer prices. A favorable development in producer prices has a positive impact ($\kappa_{2,3}$) while consumer prices that are in line with expectations exhibit a negative impact ($\kappa_{1,2}$). The findings show that the market index is affected by spillovers from other markets as well as specific news where most of the announcements exhibit an intuitively correct impact on the return. This finding rules out market efficiency in the sense of the strict theoretical definition.

The above results are complemented by the volatility equation estimates (Table 5.A). The ARCH term $\alpha\varepsilon_{t-1}^2$ reflects the impact of news or surprises from previous periods that affect stock price volatility. The size of the coefficient α indicates that past

[16] The finding of the negative effect of unemployment goes against the results of Boyd, Hu and Jagannathan (2005) who find that on average, an announcement of rising unemployment is good news for stocks during economic expansions and bad news during economic contractions. During the period under research the Czech Republic as well as Hungary and Poland were in an expanding period of the business cycle. For this reason we also do not adjust our estimation to account for different stages of business cycle.

announcements affect volatility to an extent but they do not destabilize volatility. On the other hand, the β coefficient in the GARCH term, βh_{t-1}, is quite small and indicates that the impact of the forecast variance from previous periods on the current conditional variance, or volatility, is not persistent. Finally, the fact that the sum of both coefficients, i.e., α plus β, is way below one indicates that the convergence of the conditional volatility to a steady state is very fast. A large negative constant (ω) in conjunction with significant coefficients of the intra-day volatility dummies ($\mu_1 - \mu_{10}$) illustrate the sizable decrease of the volatility during the middle of the trading day. Intra-day volatility dummies capture increased volatility during the beginning and end of the trading session and their inclusion accounted for the differences in volatility during the trading day. Day-of-the-week dummies contribute to the volatility in relatively even proportions (ψ_1, ψ_2, ψ_4) but its extent decreases by the middle of the week (ψ_3).

3.2. Hungary

The Hungarian stock index exhibits considerable spillover effects (Table 6.A) from the other two regional markets; the spillovers are of unequal magnitudes and the effect of the Prague market dominates that of Warsaw. In the first lag the Prague effect (γ_3) is about five times stronger than that of Warsaw (γ_5), but their second lags' effects are equal (γ_4 and γ_6). On the contrary, the first lag impact of the Frankfurt and New York markets are of equal caliber (π_1 and π_3) but only Frankfurt retains further influence (π_2).

The Hungarian index is also impacted by the number of announcements whose majority originates in the Eurozone and they generate the following impacts. In terms of news from the real economy, announcements on GDP and trade balance that are in line with market expectations prompt positive ($\delta_{4,2}$) and negative ($\delta_{7,2}$) effects on stock market index returns, respectively. Better-than-market announcements on current account development generate a positive effect ($\delta_{8,3}$), while lower-than-market results on unemployment are reflected in a negative impact on stock returns ($\delta_{9,1}$). Survey indicators on the climate and confidence regarding the EU economy provide unambiguous interpretations. A lower-than-expected consumer confidence indicator triggers a negative effect ($\delta_{13,1}$) while in-line or better-than-market developments of the Purchasing Managers' Index (PMI) yield positive effects ($\delta_{15,2}$ and $\delta_{15,3}$).

Further, past news (α) affects volatility to a moderate extent and they are not destabilizing. The volatility of the Hungarian stock index exhibits the highest persistence (indicated by the value of the GARCH term βh_{t-1}) among the three indices. Finally, the speed of the convergence of the forecast of the conditional variance to a steady state is very slow. The change in intra-day volatility is fully accounted for ($\mu_1 - \mu_{10}$) and its decline is substantial (ω), similarly as in the other two markets. Intra-week volatility increases only in the middle of the week (ψ_3), otherwise it stays comparably low (ψ_1, ψ_2, ψ_4).

3.3. Poland

From Table 7.A we see that the Polish stock index is affected by spillovers from key world as well as regional markets. The effect of the Frankfurt market (π_1 and π_2) is larger and more prolonged than that of the U.S. (π_3). In a similar manner the effect of Prague (γ_3) is smaller and less extended than that of Budapest (γ_1 and γ_2). The impact of spillovers is complemented by numerous effects of news (Table 7.B). In terms of prices, there is no effect from the Eurozone but an important and intuitively meaningful effect of U.S. announcements. Below-market development in consumer prices is reflected by a negative impact ($\kappa_{1,1}$) while movement in producer prices better than market expectations impacts stock returns positively ($\kappa_{2,3}$). At the same time, producer prices in-line with market assessment impact the stock index negatively ($\kappa_{2,2}$), a sign of the tendency of markets to undervalue positive changes. The impact of real economy announcements on stock returns depends on the region of origin. Above-market progress in industrial production ($\delta_{3,3}$) and currency account ($\delta_{8,3}$) in the EU results in a positive effect ($\delta_{3,3}$ and $\delta_{8,3}$). In-line announcements on retail sales and trade balance in the U.S. are reflected in a strong and positive effect ($\kappa_{6,2}$ and $\kappa_{7,2}$) while in-line unemployment brings a negative impression ($\kappa_{9,2}$) on the index return. Survey indicators produce adequate reactions no matter in which region they originate but the impact of U.S. news is less frequent than that of the Eurozone. The EU consumer confidence announcements that are below and above market expectations produce negative ($\delta_{13,1}$) and positive ($\delta_{13,3}$) effects of comparable extent, respectively. Further, lower-than-expected growth in the Purchasing Managers' Index (PMI) from the U.S. negatively impacts ($\kappa_{15,1}$) stock returns while its above-EU market outcome shows a positive effect

($\delta_{15,3}$). Finally, in-line movement in the Eurozone monetary aggregate is echoed by a negative influence on stock returns ($\delta_{10,2}$).

In terms of volatility (Table 7.A), from the value of the coefficient associated with the ARCH term (α) we find that past news affects volatility to the lowest extent among all three markets and also in a non-destabilizing manner. Further, the volatility of the Polish stock index exhibits the middle persistence (β) with respect to its regional counterparts. Similarly to the Budapest index returns, the speed of the convergence of the forecast of the conditional variance to a steady state is relatively fast but much slower than in the case of Prague. Intra-day volatility dummies account well for the volatility during peak trading periods ($\mu_1 - \mu_7$, $\mu_9 - \mu_{10}$) and a sizable negative value of constant (ω) reflects a dramatic decline in volatility during the trading session. Day-of-the-week dummies contribute to the volatility in relatively even proportions (ψ_1, ψ_2, ψ_4), with a decrease by the middle of the week (ψ_3).

3.4 Robustness Check

As a robustness check we also performed estimations with local news originating at the three markets. These announcements are intentionally made before trading begins in most cases. For example there is only a single announcement emerging during trading hours at the Budapest stock market. More local news is present during trading at markets in Prague and Warsaw but their extent is marginal when compared to those coming from the Eurozone and the U.S. In any event, the effect of local news is mostly insignificant and for that reason we do not report them. Additionally, by not employing a handful of the local news we further minimize the bias and improve the identification of the effect of the Eurozone and the U.S. announcements on the stock returns.

4. Concluding Summary

We analyze price discovery on three emerging EU stock markets: the Czech Republic, Hungary, and Poland. In our analysis we employ high-frequency five-minute intraday data of stock market index returns. We analyze the effect of the four classes of Eurozone and U.S. macroeconomic announcements from the *excess impact* perspective, e.g. we account for the difference of each announcement from its market expectation.

Further, we jointly model the volatility of the returns accounting for its intra-day movements as well as day-of-the-week effects.

Despite varied effects inferred from estimates we can draw some generalizations specific to all three countries. The effects of other stock markets are dominated by spillovers from Frankfurt stock exchange while reaction to the New York market is smaller. The findings are sensible given the ongoing process of European integration that also affects financial markets and the narrow time window during which trading at the U.S. and European markets overlap. Spillovers from the neighboring markets are smaller or comparable in cumulative magnitudes to the effect of New York. Among them the Budapest stock market produces the strongest spillover effects, followed by Prague, and the smallest effect is from Warsaw.

The effects of macroeconomic announcements need more detail to summarize. Among the four classes of macroeconomic announcements, monetary news has virtually no impact on stock returns. The reason might rest in the relative detachment of monetary policy figures from stock market developments. Rigobon and Sack (2006) 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. Since we account for the surprise component our findings show that the detachment might be due to the low value stock markets place on monetary announcements.

Prices on the other hand affect all three markets, mostly in a very intuitive manner: worse (better) than expected results bring negative (positive) effects on stock returns. This result upholds the market's ability to effectively incorporate inflation into stock prices. The interesting trait in the price effect findings is the dominating influence of U.S. prices while the Eurozone announcements pass nearly unnoticed.[17] The possible and sensible explanation might be credited to the well-mapped expectations of the European Central Bank's operations that in the integrating Europe pose little challenge to financial market assessment.

The real economy class of announcements offers varied results from which the news on the EU current account stand out as it affects all three markets in the same manner without exception: better-than-expected results prompt a positive reaction and

[17] The importance of the consumer and producer price information on the U.S. market found by Kim, McKenzie and Faff (2004) is in line with our findings.

worse-than-expected results prompt a negative one. This finding should be paired with the heavy dependency of the three economies on foreign trade with other EU countries, the presence of EU firms in these markets, the similarity of supply and demand shocks (Fidrmuc and Korhonen, 2003), and a relatively high degree of business cycle correlation (Fidrmuc and Korhonen, 2006) between the old and new EU members. Needless to say that the most important companies present in the new EU economies as owners or co-owners of the major local firms and banks are also often quoted on the local stock markets. Other real economy announcements are limited in their reach to one or two markets. Industrial production influences Prague and Warsaw, while announcements on trade balance and unemployment are echoed in Prague and Budapest. Announcements on factory orders and retail sales do not provoke any market reactions. Real economy announcements originating in the U.S. bring only scarce evidence of their effects on stock returns. Many announcements are simply not available during the Europe-U.S.A. trading window. The Prague stock market is not affected by U.S. news at all while Budapest and Warsaw are only sparingly.

Finally, business climate and confidence announcements provide valuable insights to the previous categories. Practically no effect of the U.S. survey announcements has been found in any of the three markets and the effect of those originating in the Eurozone is limited. Only the news on consumer confidence and the Purchasing Manager's Index (PMI) impact all three markets in an intuitive manner common to developed markets: a worse-than-expected outcome provokes a negative effect on stock returns and better-than-expected results prompt a positive one. All the above results thus validate the *excess impact* approach that highly reduces difficulties in measuring "news" correctly.

News affects the volatility of the stock return indices in a similar manner but specific features vary across the three markets. The volatility of the Prague index is affected by the past announcements most but in no market is the effect destabilizing. The Budapest index exhibits the highest persistence of volatility. The volatility of the Warsaw index shows the slowest convergence to the steady state. In terms of the intra-day features the Budapest market exhibits the highest volatility at the beginning and end of the trading sessions while Prague records the lowest volatility during the two periods. Volatility declines dramatically on the three markets during the rest of the trading day

and its extent is comparable across the markets. All three markets also show a decrease in volatility by the middle of the business week.

Our findings show that real-time interactions on the new EU markets are strongly determined by matured stock markets as well as the macroeconomic news originating thereby. The differences in results across the three markets seem to be driven by differences in the composition and origin of the key market participants. The discovered detailed effects are complemented by a characterization of market volatility. Our findings yield insights into the process of stock market integration in the EU as well as portfolio allocation on the new EU markets.

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Table 1
Descriptive statistics of the new EU stock market index returns (2004-2007).

	Number of observations	Mean	Std. Dev.	Minimum	Maximum
2004					
BUX	11,904	0.0010194	0.0899766	-0.875302	0.8673481
PX50	10,182	0.0024305	0.0642685	-0.6283482	0.7893682
WIG20	9,542	0.0003562	0.1062148	-1.055499	0.9226493
2005					
BUX	22,089	0.0001499	0.1259988	-1.125185	0.8984209
PX50	19,180	0.0010761	0.0846787	-1.934051	1.927916
WIG20	17,608	0.0011976	0.1027598	-0.7934296	1.513824
2006					
BUX	21,169	-0.0010376	0.1314166	-1.45375	1.41399
PX50	18,257	-0.0006988	0.0961222	-3.546999	3.549172
WIG20	16,956	-0.0005537	0.135886	-1.14298	1.125542
2007					
BUX	21,299	-0.0015563	0.10846	-3.437372	3.550318
PX50	18,868	0.0002218	0.0793367	-1.141195	1.120969
WIG20	17,318	-0.0010011	0.1203231	-1.140243	1.406999

Table 2
Macroeconomic Announcements recorded in Prague stock market

Announcements	Impact							
	Negative		In-line		Positive		Total	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Eurozone								
Prices								
1 - CPI	13	(21.7)	32	(53.3)	15	(25.0)	60	(100)
2 - PPI	17	(41.5)	19	(46.3)	5	(12.2)	41	(100)
Economy								
3 - Industrial Production	36	(43.9)	6	(7.3)	40	(48.8)	82	(100)
4 -GDP	8	(19.5)	21	(51.2)	12	(29.3)	41	(100)
5 - Factory orders	32	(41.0)	1	(1.3)	45	(57.7)	78	(100)
6 - Retail Sales	22	(55.0)	3	(7.5)	15	(37.5)	40	(100)
7 - Trade balance	5	(7.5)	59	(88.0)	3	(4.5)	67	(100)
8 - Current account	20	(60.6)	0	(0.0)	13	(39.4)	33	(100)
9 - Unemployment	14	(20.9)	18	(26.9)	35	(52.2)	67	(100)
Monetary								
10 - Money	27	(71.0)	2	(5.3)	9	(23.7)	38	(100)
11 -Interest rate	0	(0.0)	39	(100)	0	(0.0)	39	(100)
Business climate and consumer confidence								
12 - Business climate	77	(32.5)	59	(24.9)	101	(42.6)	237	(100)
13 - Consumer confidence	12	(33.3)	14	(38.9)	10	(27.8)	36	(100)
14 - ISM Index	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15 - PMI	13	(32.5)	21	(52.5)	6	(15.0)	40	(100)
Total	296	(32.9)	294	(32.7)	309	(34.4)	899	(100)
U.S.A.								
Prices								
1 - CPI	17	(40.5)	13	(31.0)	12	(28.5)	42	(100)
2 - PPI	40	(46.5)	10	(11.6)	36	(41.9)	86	(100)
Economy								
3 - Industrial Production	22	(53.7)	4	(9.8)	15	(36.5)	41	(100)
4 -GDP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5 - Factory orders	0	(0.0)	0	(0.0)	1	(100)	1	(100)
6 - Retail Sales	19	(45.2)	2	(4.8)	21	(50.0)	42	(100)
7 - Trade balance	19	(44.2)	1	(2.3)	23	(53.5)	43	(100)
8 - Current account	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9 - Unemployment	78	(36.1)	46	(21.3)	92	(42.6)	216	(100)
Monetary	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Business climate and consumer confidence								
12 - Business climate	28	(53.8)	2	(3.8)	22	(42.4)	52	(100)
13 - Consumer confidence	1	(100)	0	(0.0)	0	(0.0)	1	(100)
14 - ISM Index	1	(100)	0	(0.0)	0	(0.0)	1	(100)
15 - PMI	5	(45.5)	0	(0.0)	6	(54.5)	11	(100)
Total	230	(42.9)	78	(14.6)	228	(42.5)	536	(100)

Table 3
Macroeconomic Announcements recorded in Hungarian stock market

Announcements	Impact							
	Negative		In-line		Positive		Total	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Eurozone								
Prices								
1 - CPI	20	(28.2)	33	(46.5)	18	(25.3)	71	(100)
2 - PPI	17	(41.5)	19	(46.3)	5	(12.2)	41	(100)
Economy								
3 - Industrial Production	38	(44.7)	6	(7.1)	41	(48.2)	85	(100)
4 -GDP	8	(19.0)	22	(52.4)	12	(28.6)	42	(100)
5 - Factory orders	32	(39.5)	1	(1.2)	48	(59.3)	81	(100)
6 - Retail Sales	23	(54.8)	3	(7.1)	16	(38.1)	42	(100)
7 - Trade balance	5	(7.2)	61	(88.4)	3	(4.4)	69	(100)
8 - Current account	20	(62.5)	0	(0.0)	12	(37.5)	32	(100)
9 - Unemployment	22	(27.2)	19	(23.5)	40	(49.3)	81	(100)
Monetary								
10 - Money	28	(71.8)	2	(5.1)	9	(23.1)	39	(100)
11 -Interest rate	0	(0.0)	41	(100)	0	(0.0)	41	(100)
Business climate and consumer confidence								
12 - Business climate	78	(33.1)	59	(25.0)	99	(41.9)	236	(100)
13 - Consumer confidence	12	(32.4)	14	(37.8)	11	(29.8)	37	(100)
14 - ISM Index	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15 - PMI	12	(32.4)	19	(51.4)	6	(16.2)	37	(100)
Total	315	(33.7)	299	(32.0)	320	(34.3)	934	(100)
U.S.A.								
Prices								
1 - CPI	17	(40.5)	13	(31.0)	12	(28.5)	42	(100)
2 - PPI	38	(45.2)	10	(11.9)	36	(42.9)	84	(100)
Economy								
3 - Industrial Production	23	(54.8)	4	(9.5)	15	(35.7)	42	(100)
4 -GDP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5 - Factory orders	17	(44.7)	1	(2.6)	20	(52.7)	38	(100)
6 - Retail Sales	19	(45.2)	2	(4.8)	21	(50.0)	42	(100)
7 - Trade balance	19	(44.2)	1	(2.3)	23	(53.5)	43	(100)
8 - Current account	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9 - Unemployment	82	(37.3)	46	(20.9)	92	(41.8)	220	(100)
Monetary	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Business climate and consumer confidence								
12 - Business climate	43	(53.8)	3	(3.8)	34	(42.4)	80	(100)
13 - Consumer confidence	17	(43.6)	0	(0.0)	22	(56.4)	39	(100)
14 - ISM Index	17	(51.5)	6	(18.2)	10	(30.3)	33	(100)
15 - PMI	15	(40.5)	0	(0.0)	22	(59.5)	37	(100)
Total	307	(43.9)	86	(12.3)	307	(43.8)	700	(100)

Table 4
Macroeconomic Announcements recorded in Polish stock market

Announcements	Impact							
	Negative		In-line		Positive		Total	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Eurozone								
Prices								
1 - CPI	13	(21.7)	32	(53.3)	15	(25.0)	60	(100)
2 - PPI	17	(44.7)	17	(44.7)	4	(10.6)	38	(100)
Economy								
3 - Industrial Production	38	(45.2)	6	(7.1)	40	(47.7)	84	(100)
4 -GDP	8	(20.0)	21	(52.5)	11	(27.5)	40	(100)
5 - Factory orders	33	(40.2)	1	(1.2)	48	(58.6)	82	(100)
6 - Retail Sales	23	(54.8)	3	(7.1)	16	(38.1)	42	(100)
7 - Trade balance	6	(8.6)	61	(87.1)	3	(4.3)	70	(100)
8 - Current account	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9 - Unemployment	5	(12.8)	17	(43.6)	17	(43.6)	39	(100)
Monetary								
10 - Money	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11 -Interest rate	0	(0.0)	41	(100)	0	(0.0)	41	(100)
Business climate and consumer confidence								
12 - Business climate	67	(34.0)	53	(26.9)	77	(39.1)	197	(100)
13 - Consumer confidence	13	(34.2)	14	(36.8)	11	(28.9)	38	(100)
14 - ISM Index	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15 - PMI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	223	(30.5)	266	(36.4)	242	(33.1)	731	(100)
U.S.A.								
Prices								
1 - CPI	18	(42.9)	12	(28.6)	12	(28.6)	42	(100)
2 - PPI	40	(47.6)	10	(11.9)	34	(40.5)	84	(100)
Economy								
3 - Industrial Production	22	(55.0)	3	(7.5)	15	(37.5)	40	(100)
4 -GDP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5 - Factory orders	0	(0.0)	0	(0.0)	1	(100)	1	(100)
6 - Retail Sales	20	(46.5)	2	(4.7)	21	(48.8)	43	(100)
7 - Trade balance	19	(44.2)	1	(2.3)	23	(53.5)	43	(100)
8 - Current account	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9 - Unemployment	81	(37.5)	46	(21.3)	89	(41.2)	216	(100)
Monetary	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Business climate and consumer confidence								
12 - Business climate	29	(54.7)	2	(3.8)	22	(41.5)	53	(100)
13 - Consumer confidence	1	(100)	0	(0.0)	0	(0.0)	1	(100)
14 - ISM Index	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15 - PMI	5	(41.7)	0	(0.0)	7	(58.3)	12	(100)
Total	235	(43.9)	76	(14.2)	224	(41.9)	535	(100)

Table 5.A
Spillover effects and volatility: Prague stock market

Mean Equation					Volatility Equation				
Parameter	Coeff.			Std.err.	Parameter	Coeff.			Std.err.
Stock index return					*Volatility terms*				
DAX_{t-1}	π_1	0,110	a	(0,003)	Constant	ω	-5,373	a	(0,003)
DAX_{t-2}	π_2	0,050	a	(0,003)	ARCH term	α	0,342	a	(0,004)
DJI_{t-1}	π_3	0,050	a	(0,008)	GARCH term	β	0,019	a	(0,001)
DJI_{t-2}	π_4	0,019	a	(0,006)	*Intraday volatility dummies*				
BUX_{t-1}	γ_1	0,039	a	(0,002)	D_1	μ_1	0,937	a	(0,049)
BUX_{t-2}	γ_2	0,027	a	(0,002)	D_2	μ_2	0,810	a	(0,030)
PX_{t-1}	γ_3	n/a			D_3	μ_3	0,580	a	(0,037)
PX_{t-2}	γ_4	n/a			D_4	μ_4	0,531	a	(0,039)
WIG_{t-1}	γ_5	0,002		(0,002)	D_5	μ_5	1,099	a	(0,031)
WIG_{t-2}	γ_6	0,010	a	(0,002)	D_{T-5}	μ_6	-0,451	a	(0,033)
Year dummies					D_{T-4}	μ_7	-0,265	a	(0,031)
year 2004	λ_1	0,003		(0,001)	D_{T-3}	μ_8	-0,363	a	(0,028)
year 2005	λ_2	0,003		(0,001)	D_{T-2}	μ_9	-0,146	a	(0,029)
year 2006	λ_3	0,001	a	(0,001)	D_{T-1}	μ_{10}	-0,115	a	(0,031)
year 2007	λ_4	0,002		(0,001)	***Day of the week dummies***				
					W_1	ψ_1	0,210	a	(0,005)
					W_2	ψ_2	0,217	a	(0,004)
					W_3	ψ_3	-0,040	a	(0,005)
					W_4	ψ_4	0,101	a	(0,005)

Number of observations	65955	Wald statistics	4564
Log likelihood	72017	Chi-square	76

Table 5.B
Effects of Macroeconomic Announcements: Prague stock market

Announcements	Impact								
	Negative			In-line			Positive		
	Coeff.		Std.err.	Coeff.		Std.err.	Coeff.		Std.err.
Eurozone									
Prices									
1 - CPI	$\delta_{1,1}$	-0,012	(0,029)	$\delta_{1,2}$	-0,011	(0,024)	$\delta_{1,3}$	0,053 a	(0,017)
2 - PPI	$\delta_{2,1}$	-0,013	(0,027)	$\delta_{2,2}$	0,000	(0,024)	$\delta_{2,3}$	-0,005	(0,023)
Economy									
3 - Industrial Production	$\delta_{3,1}$	-0,022 b	(0,010)	$\delta_{3,2}$	-0,033	(0,063)	$\delta_{3,3}$	0,012	(0,012)
4 - GDP	$\delta_{4,1}$	-0,006	(0,016)	$\delta_{4,2}$	0,015	(0,015)	$\delta_{4,3}$	0,028	(0,030)
5 - Factory orders	$\delta_{5,1}$	0,009	(0,023)	$\delta_{5,2}$	-0,062	(59,09)	$\delta_{5,3}$	0,008	(0,017)
6 - Retail Sales	$\delta_{6,1}$	-0,025	(0,024)	$\delta_{6,2}$	0,005	(0,066)	$\delta_{6,3}$	-0,007	(0,071)
7 - Trade balance	$\delta_{7,1}$	-0,008	(0,126)	$\delta_{7,2}$	-0,005	(0,010)	$\delta_{7,3}$	0,043	(0,100)
8 - Current account	$\delta_{8,1}$	-0,042 c	(0,023)	$\delta_{8,2}$	n/a		$\delta_{8,3}$	0,026	(0,020)
9 - Unemployment	$\delta_{9,1}$	-0,094 a	(0,010)	$\delta_{9,2}$	0,018	(0,020)	$\delta_{9,3}$	0,005	(0,012)
Monetary									
10 -Money	$\delta_{10,1}$	0,001	(0,018)	$\delta_{10,2}$	n/a		$\delta_{10,3}$	0,010	(0,102)
11 - Interest rate	$\delta_{11,1}$	n/a		$\delta_{11,2}$	0,002	(0,026)	$\delta_{11,3}$	n/a	
Business climate and consumer confidence									
12 - Business climate	$\delta_{12,1}$	-0,004	(0,007)	$\delta_{12,2}$	0,000	(0,024)	$\delta_{12,3}$	0,000	(0,009)
13 - Consumer confidence	$\delta_{13,1}$	-0,011	(0,028)	$\delta_{13,2}$	-0,032 c	(0,017)	$\delta_{13,3}$	-0,014	(0,023)
14 - ISM Index	$\delta_{14,1}$	n/a		$\delta_{14,2}$	n/a		$\delta_{14,3}$	n/a	
15 - PMI	$\delta_{15,1}$	0,004	(0,022)	$\delta_{15,2}$	-0,077 a	(0,013)	$\delta_{15,3}$	0,078 a	(0,016)
U.S.A.									
Prices									
1 - CPI	$\kappa_{1,1}$	-0,008	(0,016)	$\kappa_{1,2}$	-0,039 a	(0,009)	$\kappa_{1,3}$	0,022	(0,029)
2 - PPI	$\kappa_{2,1}$	-0,006	(0,009)	$\kappa_{2,2}$	-0,009	(0,071)	$\kappa_{2,3}$	0,038 a	(0,008)
Economy									
3 - Industrial Production	$\kappa_{3,1}$	-0,019	(0,014)	$\kappa_{3,2}$	-0,003	(0,174)	$\kappa_{3,3}$	0,004	(0,069)
4 - GDP	$\kappa_{4,1}$	n/a		$\kappa_{4,2}$	n/a		$\kappa_{4,3}$	n/a	
5 - Factory orders	$\kappa_{5,1}$	n/a		$\kappa_{5,2}$	n/a		$\kappa_{5,3}$	-0,001	(7,254)
6 - Retail Sales	$\kappa_{6,1}$	-0,021	(0,018)	$\kappa_{6,2}$	-0,024	(0,131)	$\kappa_{6,3}$	0,006	(0,018)
7 - Trade balance	$\kappa_{7,1}$	-0,001	(0,022)	$\kappa_{7,2}$	-0,005	(123,1)	$\kappa_{7,3}$	0,008	(0,018)
8 - Current account	$\kappa_{8,1}$	n/a		$\kappa_{8,2}$	n/a		$\kappa_{8,3}$	n/a	
9 - Unemployment	$\kappa_{9,1}$	0,007	(0,009)	$\kappa_{9,2}$	-0,013	(0,011)	$\kappa_{9,3}$	0,005	(0,010)
Monetary									
10 -Money	$\kappa_{10,1}$	n/a		$\kappa_{10,2}$	n/a		$\kappa_{10,3}$	n/a	
11 - Interest rate	$\kappa_{11,1}$	n/a		$\kappa_{11,2}$	n/a		$\kappa_{11,3}$	n/a	
Business climate and consumer confidence									
12 - Business climate	$\kappa_{12,1}$	-0,011	(0,015)	$\kappa_{12,2}$	0,006	(0,101)	$\kappa_{12,3}$	0,008	(0,018)
13 - Consumer confidence	$\kappa_{13,1}$	-0,247	(29,37)	$\kappa_{13,2}$	n/a		$\kappa_{13,3}$	n/a	
14 - ISM Index	$\kappa_{14,1}$	n/a		$\kappa_{14,2}$	n/a		$\kappa_{14,3}$	n/a	
15 - PMI	$\kappa_{15,1}$	-0,005	(0,026)	$\kappa_{15,2}$	n/a		$\kappa_{15,3}$	0,003	(0,033)

Note: ISM stands for Institute for Supply Management; PMI stands for Purchasing Managers' Index.
The signs a, b, and c denote statistical significance at 1, 5, and 10%, respectively.

Table 6.A
Spillover effects and volatility: Budapest stock market

Mean Equation					Volatility Equation				
Parameter	Coeff.			Std.err.	Parameter	Coeff.			Std.err.
Stock index return					*Volatility terms*				
DAX_{t-1}	π_1	0,084	a	(0,004)	Constant	ω	-5,287	a	(0,007)
DAX_{t-2}	π_2	0,074	a	(0,004)	ARCH term	α	0,291	a	(0,004)
DJI_{t-1}	π_3	0,085	a	(0,011)	GARCH term	β	0,303	a	(0,003)
DJI_{t-2}	π_4	0,002		(0,012)	*Intraday volatility dummies*				
BUX_{t-1}	γ_1	n/a			D_1	μ_1	2,259	a	(0,426)
BUX_{t-2}	γ_2	n/a			D_2	μ_2	2,132	a	(0,153)
PX_{t-1}	γ_3	0,028	a	(0,003)	D_3	μ_3	2,157	a	(0,035)
PX_{t-2}	γ_4	0,016	a	(0,002)	D_4	μ_4	1,334	a	(0,046)
WIG_{t-1}	γ_5	0,006	b	(0,003)	D_5	μ_5	0,883	a	(0,088)
WIG_{t-2}	γ_6	0,015	a	(0,003)	D_{T-5}	μ_6	0,487	a	(0,054)
Year dummies					D_{T-4}	μ_7	0,488	a	(0,035)
year 2004	λ_1	0,001	b	(0,001)	D_{T-3}	μ_8	-0,162	b	(0,073)
year 2005	λ_2	0,001	a	(0,001)	D_{T-2}	μ_9	0,112		(0,069)
year 2006	λ_3	-0,001	b	(0,001)	D_{T-1}	μ_{10}	0,394	a	(0,063)
year 2007	λ_4	-0,003	b	(0,001)	***Day of the week dummies***				
					W_1	ψ_1	-0,026	a	(0,008)
					W_2	ψ_2	-0,039	a	(0,010)
					W_3	ψ_3	-0,110	a	(0,009)
					W_4	ψ_4	-0,027	a	(0,009)

Number of observations	72180	Wald statistics	1458
Log likelihood	62001	Chi-square	82

Table 6.B
Effects of Macroeconomic Announcements: Budapest stock market

Announcements	Impact								
	Negative			In-line			Positive		
	Coeff.		Std.err.	Coeff.		Std.err.	Coeff.		Std.err.
Eurozone									
Prices									
1 - CPI	$\delta_{1,1}$	-0,016	(0,029)	$\delta_{1,2}$	0,014	(0,017)	$\delta_{1,3}$	0,005	(0,024)
2 - PPI	$\delta_{2,1}$	-0,019	(0,026)	$\delta_{2,2}$	-0,026	(0,033)	$\delta_{2,3}$	0,029	(0,045)
Economy									
3 - Industrial Production	$\delta_{3,1}$	-0,005	(0,019)	$\delta_{3,2}$	0,019	(0,066)	$\delta_{3,3}$	0,002	(0,013)
4 - GDP	$\delta_{4,1}$	-0,014	(0,020)	$\delta_{4,2}$	0,085 a	(0,022)	$\delta_{4,3}$	0,030	(0,037)
5 - Factory orders	$\delta_{5,1}$	-0,014	(0,030)	$\delta_{5,2}$	-0,011	(35909)	$\delta_{5,3}$	0,009	(0,017)
6 - Retail Sales	$\delta_{6,1}$	-0,012	(0,032)	$\delta_{6,2}$	-0,115	(0,138)	$\delta_{6,3}$	0,016	(0,016)
7 - Trade balance	$\delta_{7,1}$	-0,022	(0,060)	$\delta_{7,2}$	-0,026 b	(0,012)	$\delta_{7,3}$	0,034	(0,136)
8 - Current account	$\delta_{8,1}$	-0,038	(0,040)	$\delta_{8,2}$	n/a		$\delta_{8,3}$	0,059 b	(0,028)
9 - Unemployment	$\delta_{9,1}$	-0,025 b	(0,012)	$\delta_{9,2}$	0,019	(0,020)	$\delta_{9,3}$	0,009	(0,011)
Monetary									
10 -Money	$\delta_{10,1}$	-0,023	(0,023)	$\delta_{10,2}$	n/a		$\delta_{10,3}$	0,005	(0,018)
11 - Interest rate	$\delta_{11,1}$	n/a		$\delta_{11,2}$	0,012	(0,019)	$\delta_{11,3}$	n/a	
Business climate and consumer confidence									
12 - Business climate	$\delta_{12,1}$	-0,006	(0,006)	$\delta_{12,2}$	-0,016	(0,013)	$\delta_{12,3}$	0,005	(0,010)
13 - Consumer confidence	$\delta_{13,1}$	-0,042 b	(0,020)	$\delta_{13,2}$	-0,008	(0,036)	$\delta_{13,3}$	0,003	(0,028)
14 - ISM Index	$\delta_{14,1}$	n/a		$\delta_{14,2}$	n/a		$\delta_{14,3}$	n/a	
15 - PMI	$\delta_{15,1}$	-0,005	(0,034)	$\delta_{15,2}$	0,084 a	(0,025)	$\delta_{15,3}$	0,069 b	(0,038)
U.S.A.									
Prices									
1 - CPI	$\kappa_{1,1}$	-0,016	(0,028)	$\kappa_{1,2}$	0,029 c	(0,015)	$\kappa_{1,3}$	0,032	(0,037)
2 - PPI	$\kappa_{2,1}$	-0,002	(0,018)	$\kappa_{2,2}$	-0,020	(0,028)	$\kappa_{2,3}$	0,002	(0,014)
Economy									
3 - Industrial Production	$\kappa_{3,1}$	-0,025	(0,022)	$\kappa_{3,2}$	0,038	(0,086)	$\kappa_{3,3}$	0,044	(0,030)
4 - GDP	$\kappa_{4,1}$	n/a		$\kappa_{4,2}$	n/a		$\kappa_{4,3}$	n/a	
5 - Factory orders	$\kappa_{5,1}$	-0,031	(0,085)	$\kappa_{5,2}$	n/a		$\kappa_{5,3}$	0,033	(0,069)
6 - Retail Sales	$\kappa_{6,1}$	-0,001	(0,026)	$\kappa_{6,2}$	0,002	(2,629)	$\kappa_{6,3}$	0,016	(0,018)
7 - Trade balance	$\kappa_{7,1}$	-0,019	(0,030)	$\kappa_{7,2}$	0,027	(0,499)	$\kappa_{7,3}$	0,006	(0,014)
8 - Current account	$\kappa_{8,1}$	n/a		$\kappa_{8,2}$	n/a		$\kappa_{8,3}$	n/a	
9 - Unemployment	$\kappa_{9,1}$	-0,007	(0,012)	$\kappa_{9,2}$	0,047 a	(0,010)	$\kappa_{9,3}$	0,004	(0,014)
Monetary									
10 -Money	$\kappa_{10,1}$	n/a		$\kappa_{10,2}$	n/a		$\kappa_{10,3}$	n/a	
11 - Interest rate	$\kappa_{11,1}$	n/a		$\kappa_{11,2}$	n/a		$\kappa_{11,3}$	n/a	
Business climate and consumer confidence									
12 - Business climate	$\kappa_{12,1}$	-0,012	(0,022)	$\kappa_{12,2}$	0,033	(0,073)	$\kappa_{12,3}$	0,003	(0,024)
13 - Consumer confidence	$\kappa_{13,1}$	-0,031	(0,040)	$\kappa_{13,2}$	n/a		$\kappa_{13,3}$	0,032	(0,038)
14 - ISM Index	$\kappa_{14,1}$	-0,077 a	(0,026)	$\kappa_{14,2}$	0,041	(0,068)	$\kappa_{14,3}$	0,061	(0,078)
15 - PMI	$\kappa_{15,1}$	-0,014	(0,022)	$\kappa_{15,2}$	n/a		$\kappa_{15,3}$	0,031	(0,071)

Note: ISM stands for Institute for Supply Management; PMI stands for Purchasing Managers' Index.
The signs a, b, and c denote statistical significance at 1, 5, and 10%, respectively.

Table 7.A
Spillover effects and volatility: Warsaw stock market

Mean Equation					Volatility Equation				
Parameter	Coeff.			Std.err.	Parameter	Coeff.			Std.err.
Stock index return					*Volatility terms*				
DAX_{t-1}	π_1	0,176	a	(0,005)	Constant	ω	-5,058	a	(0,009)
DAX_{t-2}	π_2	0,071	a	(0,006)	ARCH term	α	0,261	a	(0,004)
DJI_{t-1}	π_3	0,124	a	(0,016)	GARCH term	β	0,253	a	(0,003)
DJI_{t-2}	π_4	-0,025		(0,020)	*Intraday volatility dummies*				
BUX_{t-1}	γ_1	0,024	a	(0,003)	D_1	μ_1	1,016	a	(0,061)
BUX_{t-2}	γ_2	0,041	a	(0,003)	D_2	μ_2	0,834	a	(0,048)
PX_{t-1}	γ_3	0,017	a	(0,004)	D_3	μ_3	1,527	a	(0,054)
PX_{t-2}	γ_4	-0,001		(0,003)	D_4	μ_4	1,836	a	(0,027)
WIG_{t-1}	γ_5	n/a			D_5	μ_5	0,460	a	(0,067)
WIG_{t-2}	γ_6	n/a			D_{T-5}	μ_6	0,345	a	(0,038)
Year dummies					D_{T-4}	μ_7	0,470	a	(0,042)
year 2004	λ_1	0,004		(0,001)	D_{T-3}	μ_8	-0,006		(0,054)
year 2005	λ_2	0,005	c	(0,001)	D_{T-2}	μ_9	0,195	a	(0,054)
year 2006	λ_3	0,005	c	(0,001)	D_{T-1}	μ_{10}	0,398	a	(0,062)
year 2007	λ_4	0,003		(0,002)	*Day of the week dummies*				
					W_1	ψ_1	0,134	a	(0,011)
					W_2	ψ_2	0,120	a	(0,012)
					W_3	ψ_3	0,055	a	(0,011)
					W_4	ψ_4	0,132	a	(0,012)

Number of observations	64090	Wald statistics	2791
Log likelihood	46511	Chi-square	81

Table 7.B
Effects of Macroeconomic Announcements: Warsaw stock market

Announcements	Impact											
	Negative				In-line				Positive			
	Coeff.			Std.err.	Coeff.			Std.err.	Coeff.			Std.err.
Eurozone												
Prices												
1 - CPI	$\delta_{1,1}$	0,031		(0,033)	$\delta_{1,2}$	0,029		(0,025)	$\delta_{1,3}$	-0,019		(0,026)
2 - PPI	$\delta_{2,1}$	-0,035		(0,032)	$\delta_{2,2}$	-0,012		(0,027)	$\delta_{2,3}$	0,067		(0,044)
Economy												
3 - Industrial Production	$\delta_{3,1}$	-0,003		(0,027)	$\delta_{3,2}$	-0,048		(0,044)	$\delta_{3,3}$	0,036	c	(0,021)
4 - GDP	$\delta_{4,1}$	0,057		(0,040)	$\delta_{4,2}$	0,047		(0,030)	$\delta_{4,3}$	0,012		(0,051)
5 - Factory orders	$\delta_{5,1}$	0,015		(0,023)	$\delta_{5,2}$	-0,013		(0,625)	$\delta_{5,3}$	-0,025		(0,016)
6 - Retail Sales	$\delta_{6,1}$	0,003		(0,030)	$\delta_{6,2}$	0,050		(0,073)	$\delta_{6,3}$	0,000		(0,026)
7 - Trade balance	$\delta_{7,1}$	-0,065		(0,069)	$\delta_{7,2}$	0,003		(0,012)	$\delta_{7,3}$	0,055		(0,136)
8 - Current account	$\delta_{8,1}$	0,036		(0,066)	$\delta_{8,2}$	n/a			$\delta_{8,3}$	0,147	b	(0,059)
9 - Unemployment	$\delta_{9,1}$	0,000		(0,041)	$\delta_{9,2}$	0,007		(0,021)	$\delta_{9,3}$	-0,007		(0,025)
Monetary												
10 -Money	$\delta_{10,1}$	0,023		(0,049)	$\delta_{10,2}$	-0,494	a	(0,061)	$\delta_{10,3}$	0,050		(0,153)
11 - Interest rate	$\delta_{11,1}$	n/a			$\delta_{11,2}$	-0,017		(0,019)	$\delta_{11,3}$	n/a		
Business climate and consumer confidence												
12 - Business climate	$\delta_{12,1}$	-0,008		(0,010)	$\delta_{12,2}$	-0,018		(0,015)	$\delta_{12,3}$	0,018		(0,014)
13 - Consumer confidence	$\delta_{13,1}$	-0,056	b	(0,024)	$\delta_{13,2}$	-0,012		(0,046)	$\delta_{13,3}$	0,068	a	(0,017)
14 - ISM Index	$\delta_{14,1}$	n/a			$\delta_{14,2}$	n/a			$\delta_{14,3}$	n/a		
15 - PMI	$\delta_{15,1}$	0,017		(0,083)	$\delta_{15,2}$	0,053		(0,124)	$\delta_{15,3}$	0,187	a	(0,069)
U.S.A.												
Prices												
1 - CPI	$\kappa_{1,1}$	-0,064	a	(0,021)	$\kappa_{1,2}$	0,013		(0,020)	$\kappa_{1,3}$	0,033		(0,027)
2 - PPI	$\kappa_{2,1}$	-0,019		(0,017)	$\kappa_{2,2}$	-0,055	a	(0,016)	$\kappa_{2,3}$	0,037	b	(0,019)
Economy												
3 - Industrial Production	$\kappa_{3,1}$	-0,018		(0,029)	$\kappa_{3,2}$	0,066		(0,057)	$\kappa_{3,3}$	0,005		(0,032)
4 - GDP	$\kappa_{4,1}$	n/a			$\kappa_{4,2}$	n/a			$\kappa_{4,3}$	n/a		
5 - Factory orders	$\kappa_{5,1}$	-0,060		(0,040)	$\kappa_{5,2}$	n/a			$\kappa_{5,3}$	0,008		(0,096)
6 - Retail Sales	$\kappa_{6,1}$	-0,015		(0,020)	$\kappa_{6,2}$	0,290	a	(0,023)	$\kappa_{6,3}$	0,036		(0,026)
7 - Trade balance	$\kappa_{7,1}$	-0,033		(0,022)	$\kappa_{7,2}$	0,116	b	(0,049)	$\kappa_{7,3}$	0,018		(0,023)
8 - Current account	$\kappa_{8,1}$	n/a			$\kappa_{8,2}$	n/a			$\kappa_{8,3}$	n/a		
9 - Unemployment	$\kappa_{9,1}$	-0,005		(0,012)	$\kappa_{9,2}$	-0,024	b	(0,011)	$\kappa_{9,3}$	-0,002		(0,013)
Monetary												
10 -Money	$\kappa_{10,1}$	n/a			$\kappa_{10,2}$	n/a			$\kappa_{10,3}$	n/a		
11 - Interest rate	$\kappa_{11,1}$	n/a			$\kappa_{11,2}$	n/a			$\kappa_{11,3}$	n/a		
Business climate and consumer confidence												
12 - Business climate	$\kappa_{12,1}$	-0,013		(0,018)	$\kappa_{12,2}$	0,039		(0,283)	$\kappa_{12,3}$	0,014		(0,022)
13 - Consumer confidence	$\kappa_{13,1}$	-0,024		(0,029)	$\kappa_{13,2}$	n/a			$\kappa_{13,3}$	0,021		(0,043)
14 - ISM Index	$\kappa_{14,1}$	n/a			$\kappa_{14,2}$	n/a			$\kappa_{14,3}$	n/a		
15 - PMI	$\kappa_{15,1}$	-0,136	a	(0,021)	$\kappa_{15,2}$	n/a			$\kappa_{15,3}$	0,028		(0,048)

Note: ISM stands for Institute for Supply Management; PMI stands for Purchasing Managers' Index.
The signs a, b, and c denote statistical significance at 1, 5, and 10%, respectively.

Table A1: Composition of the Stock Indices

Stock Issuer	Stock Weight	Issuer Domicile
Budapest Stock Exchange Index (BUX)		
MOL	33,09%	D
OTP	29,22%	D
RICHTER	16,21%	D
MTELEKOM	12,94%	D
FHB	2,07%	D
EGIS	1,87%	D
FOTEX	0,94%	D
PANNERGY	0,74%	D
RABA	0,71%	D
DANUBIUS	0,59%	D
EMASZ	0,50%	D
ANY	0,31%	D
SYNERGON	0,29%	D
TVK	0,24%	D
ECONET	0,16%	D
PHYLAXIA	0,10%	D
Prague Stock Exchange Index (PX-50)		
ERSTE BANK	28.98%	F
ČEZ	25.09%	D
TELEFÓNICA O2 C.R.	14.51%	D
KOMERČNÍ BANKA	14.10%	D
CETV	5.26%	F
UNIPETROL	4.36%	D
ZENTIVA	3.51%	F
ORCO	1.21%	F
VIG	1.20%	F
PHILIP MORRIS ČR	0.95%	F
PEGAS NONWOVENS	0.38%	F
ECM	0.30%	F
AAA	0.15%	F
Warsaw Stock Exchange Index (WIG-20)		
PKOBP	16.82%	D
PEKAO	14.57%	D
PKNORLEN	11.65%	D
KGHM	11.25%	D
TPSA	9.71%	D
GTC	4.15%	D
GETIN	3.66%	D
PGNIG	3.43%	D
BRE	3.42%	D
BZWBK	3.31%	D
ASSECOPOL	2.95%	D
PBG	2.65%	D
POLIMEXMS	2.51%	D
TVN	2.32%	D
CEZ	1.91%	F
LOTOS	1.47%	D
AGORA	1.43%	D
CERSANIT	1.26%	D
BIOTON	0.99%	D
POLNORD	0.52%	D

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