Intra- and Inter-regional Spillovers between Emerging Capital Markets around the World*

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Abstract

In this paper, returns and volatility spillovers between emerging capital markets of Central and Eastern Europe, Latin America, and South-East Asia are investigated. We distinguish between spillovers from countries located in one region (intra-regional) and in different regions (inter-regional) after controlling for shocks originating at home and on the global market. Both intra- and inter-regional spillovers are significant, with the former being more pronounced than the latter. Our findings indicate that linkages between emerging markets are not solely due to their common dependence on the global capital market and highlight the importance of common factors in intra-regional interdependencies.

JEL-Classification: C32, F30, F36, G15
Keywords: Return and volatility linkages, emerging markets, financial integration

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1. Introduction

In this paper, we analyze the nature of return and volatility spillovers between emerging capital markets from Central and Eastern Europe, Latin America, and Southeast Asia. Specifically, we are interested in the question of whether contemporaneous and lagged linkages in returns and volatility between emerging markets are independent from the impact of the world market (i.e. global linkages) and local (domestic) effects. Further, we investigate whether financial spillovers are more pronounced between emerging markets in a given region than between countries located on different continents. On the one hand, we expect strong cultural links, common business conditions, and trade relations within a given region to encourage intra-regional integration. On the other hand, the global trend in technological progress and towards liberalization should give rise to inter-regional spillovers (Kaminsky and Reinhart, 2000; Pritsker, 2001; Gelos and Sahay, 2001; Pericoli and Sbracia, 2003). In addition, we analyze how quickly foreign news is assimilated by local markets.

The study of spillovers between emerging capital markets deserves special attention because of several important effects resulting from international integration. The most striking phenomena are decreasing, but still considerable, average returns, increasingly correlated international stock price movements, and rising beta factors of the national markets with the world market. Although these developments mirror the decreasing risk of investing on emerging markets, they also reduce the scope of international portfolio diversification (Bekaert and Harvey, 2000, 2003).

The interest for return causality and, hence, predictability, is obviously motivated by profit considerations of market participants. However, return and volatility spillovers also allow insights into the nature of cross-border flows of information (e.g. King and Wadhwani, 1990). From the investors' point of view, analyzing volatility sheds light onto asset risk (Merton, 1980), facilitates the valuation of financial products and the development of hedging techniques (Ng, 2000), allows for accurate modeling of the error variance, and improves the

forecasts of time-varying confidence intervals and the efficiency of estimators (Poshakwale and Murinde, 2001). For academics, changes in volatility reveal the arrival of information, its assessment and degree of disagreement among traders concerning the news' impact on asset prices, as well as the magnitude of the news' assimilation by the market (Ross, 1989; Engle et al., 1990).

In this paper, we extend the existing empirical evidence in several respects. First, many previous studies focused either only on the impact of mature markets on emerging ones (global spillovers) or only on the inter- or intra-regional interdependencies between emerging markets, without controlling for the impact of mature markets. In contrast, we take into account both phenomena and control for the impact of global factors when analyzing linkages in returns and volatility between emerging markets. Second, unlike most previous studies, we explicitly account for the observed return spillovers in the volatility-spillover analysis, since omitting the spillover effects in returns might cause biased inference in the volatility-spillover tests (Cheung and Ng, 1996). Third, this study attempts to measure a delay with which news from abroad is absorbed by the local markets due to the low availability or quality of information, presence of investors pursuing feedback strategies, high transaction costs, and other factors. Fourth, in contrast to the previous studies analyzing emerging markets from one or at best two regions, we focus on emerging countries from three regions simultaneously. Hence, applying an uniform methodology makes it possible for us to directly compare returns and volatility spillovers around the world.

In our study, the methodology developed by Cheung and Ng (1996) is applied to explore causality effects between the investigated markets. Most importantly, it allows assessing the speed of adjustment of markets to foreign news. The test of Cheung and Ng has also several advantages over other methods, which are discussed in section 3. Our main finding based on this methodology is that co-movements between emerging markets are not due solely to these countries' similar reactions to global shocks, but that emerging markets are

also directly related to each other. Spillovers are more pronounced between markets located in one region (intra-regional) than between markets from different regions (inter-regional).

The remainder of this paper is organized as follows. In section 2, we present the relevant literature on emerging market spillovers. Section 3 describes the methodology. Data and empirical results are presented and discussed in section 4. Section 5 summarizes.

2. Financial Spillovers: Theory and Evidence

In this section, we present theoretical arguments for the existence of cross-border financial spillovers, with special focus on two core issues of this paper. First, what are the characteristics of the impact of global and regional markets on the domestic market, and second, what factors determine inter- versus intra-regional spillovers? In addition, we review empirical studies on return and volatility spillovers in light of our research questions.

2.1 Theoretical Foundations of Spillovers

The co-movements of financial markets has long drawn the attention of academics and practitioners alike. Markets follow each other, both in return and variance, due to the emergence of and reaction to information originating abroad. However, for news to travel across borders, transmission channels are required. Finance-related news transmission often occurs due to correlated information, i.e. macroeconomic news arrival in one country influences the value of domestic and foreign assets as far as there are real linkages between countries. Liquidity shocks, forcing market participants experiencing them to liquidate their portfolios also in other countries, represent another transmission channel. This effect is often strengthened by a wide application of portfolio strategies like cross-market feedback trading.

Further, investors are motivated to rebalance their global portfolios due to shifts in relative risk aversion driven by changes in asset prices (wealth effect), and cross-country hedging policies which reveal their reaction to foreign news. Additionally, real economic linkages between countries (due to foreign trade or investment) and common lenders

constitute further potential channels for financial spillovers (Kaminsky and Reinhart, 2000; Kodres and Pritsker, 2002; Pritsker, 2001, among others).

One research question is whether linkages between emerging markets are to some extent independent from the world market. Obviously, these countries trade more with the developed world than with their developing counterparts. Also, substantial funds flow from banks and institutional investors located in the few global financial centers. All this implies emerging markets' strong dependence on the global market. On the other hand, similarities in regional economic structure and economic policy, common bank lenders, and the simultaneous actions of portfolio investors holding emerging markets' assets might give rise to interdependencies between these countries' financial markets (Kaminsky and Reinhart, 2000; Pericoli and Sbracia, 2003). Hence, arguments can be brought forth both in favor and against the direct linkages between emerging markets and this question has to be answered empirically.

Another issue investigated here is whether inter-regional spillovers between emerging markets are stronger than intra-regional ones. Again, economic theory is inconclusive. On the one hand, stronger intra-regional trade relations, more pronounced real and financial linkages with the closest developed market (the US, the EU, and Japan for Latin American, European, and Asian emerging markets, respectively), regional economic integration, and the tendency of portfolio investors to view countries in one region as an entity, speak in favor of stronger intra-regional dependencies. However, technological progress lowering information and transaction costs for international investment, liberalization, direct competition on third countries' product markets, and similarities in risk-return characteristics of emerging markets' assets might result in significant spillovers between emerging markets located on different continents, i.e. inter-regional spillovers. Again, the problem of the relative magnitude of intra- vs. inter-regional spillovers has to be resolved empirically.

Even if local markets can fully incorporate the price-relevant information originating abroad, a temporary under- or overreaction due to information asymmetries and actions of specific investors like feedback traders is possible. Results of this study indicate that indeed factors such as limited access to and low quality of information, existence of feedback traders or chartist investors, investors' behavior patterns such as herding and momentum trading, as well as non-trading, stale limit orders, or high transaction costs most likely contribute to extending the time needed by local emerging markets to fully absorb foreign news (e.g. Mech, 1993; De Long et al., 1990; Hong and Stein, 1999).

2.2 Empirical Evidence on Spillovers

Substantial literature exists on returns and volatility spillovers from mature to emerging markets (e.g. Bekaert and Harvey, 1997; Hu et al., 1997; Ng, 2000; Hashmi and Tay, 2001; Bekaert, Harvey, and Ng, 2005). Most importantly, Harvey (1995) reports that emerging market returns are, compared to their mature counterparts, more influenced by local (domestic) rather than global information. Bekaert and Harvey (1997) also find a weak, but increasing, impact of global factors on domestic volatility on emerging markets, indicating a progressive integration of these markets into the world market. Applying GARCH methodology, Ng (2000) finds for six Pacific Basin countries that foreign factors explain only a small fraction of stock market volatility in each country, indicating the prevailing role of country-specific shocks. Also Chelley-Steeley (2004) shows that markets in the Asia-Pacific region are more integrated with each other than with the world, and that regional integration develops faster than the worldwide one. However, Karolyi (2004) argues that the speed of integration of emerging markets with the world is also remarkable, e.g. due to dual-listing of stocks in both developing and developed countries. Also, the results reported in Kim (2005) show substantial impact of the U.S. on Asian markets.

Some papers focus on direct linkages between emerging markets situated in one region. For the Czech, Hungarian, and Polish markets, Scheicher (2001), relying on a

multivariate GARCH setting, finds domestic returns to depend on local (domestic), regional, and global factors, but volatility to be independent from the global market. Kasch-Haroutounian and Price (2001) apply a multivariate GARCH setting for to four Central European countries and find some evidence for contemporaneous and lagged spillovers in variance, mostly from Hungary. However, the impact of the global market is not accounted for in this study. Voronkova (2004) reports existence of a time-varying long-run relationship between the CEE countries and with the developed markets. Applying an AR-GARCH model with time-varying conditional skewness for six Asian markets, Hashmi and Tay (2001) find the influence of regional and global factors on return volatility to be small and regional linkages to became stronger in the late 1990s. Bekaert, Harvey, and Ng (2005) model time-varying interdependence between markets within a GARCH framework and find regional and global effects to account for a minor component of return volatility on the Asian and Latin American stock markets. Tai (2004) argues for some Asian countries that intra-regional interdependencies during the 1997 Asian crisis might have been originated in the Thai banking sector, and Caporale et al. (2005) find that regional spillovers intensify during turbulent periods.

Another branch of literature distinguishes between the intra- and inter-regional linkages between emerging markets without accounting for global factors. For instance, Edwards and Susmel (2001), employing a switching ARCH model, analyze volatility spillovers within a group of emerging stock markets. They report strong regional interdependencies within Latin America, but at best only weak linkages with the Asian markets. Sola, Spagnolo, and Spagnolo (2002) apply a bivariate Markov switching model for a set of emerging markets and find strong evidence for intra-regional volatility spillovers, but only weak evidence for inter-regional ones. However, how the world market affects these linkages remains a question which we investigate in this paper.

In a recent study, Fujii (2005) analyzes Asian and Latin American countries and reports evidence in favor of intra- and inter-regional linkages in both returns and volatility. Our investigation is more comprehensive in many respects. First, we analyze a lager set of countries, including European emerging markets which are an important part of the international financial system. Second, we estimate simultaneously the impact of the global market and the parameters measuring the spillover effects, while the two-step procedure employed in Fujii might result in efficiency losses. Our optimal control variable for the global market is chosen for each country individually, whereas in Fujii (2005) the U.S. market is imposed as a global proxy. Also, Fujii (2005) does not control for causality in variance while estimating causality in returns, which may lead to biased results as argued by Cheung and Ng (1996). Further, we estimate the relevant models that account for the day of the week effects and sluggish adjustment to news, opposed to the one-lag model employed in Fujii (2005). We also control for possible cointegration between indices.

3. Methodology

In this section we describe the two-step procedure developed by Cheung and Ng (1996) to detect patterns of financial spillovers between markets. This approach consists of, first, estimating models of national index returns and, second, applying standardized innovations from these models to test for causality-in-mean and causality-in-variance effects between national markets. Causality in mean (variance) is interpreted here as return (volatility) spillovers between markets.

The approach of Cheung and Ng has a considerable power against causality in mean and causality in variance alternatives. The testing procedure does not depend on a specific model selection and is robust to asymmetric and leptokurtic errors. Therefore, it is less vulnerable to the misspecification problem that reduces the power of tests based on multivariate GARCH models (e.g. Hafner and Herwartz, 2004). The method involves

estimating univariate models and applying test statistics with standard asymptotic distributions under the null hypothesis. In contrast to Markov switching models, this methodology enables us not only to assess the existence, but also to measure the magnitude of, any spillover effects. It also yields interpretable results on how quickly markets assimilate new information and provides insight on the dynamics of market returns, which is useful for building econometric models of stock price changes (Cheung and Ng, 1996, Hu et al., 1997).

Hong (2001) extends the Cheung-Ng test and argues that the latter suffers from lower power for large lag values, i.e. causation effects with a large delay. However, we test for a maximum of five lags (five-day delay), which he shows reducing the test's power only marginally. Also, van Dijk, Osborn and Sensier (2005) show that the power of the Cheung-Ng test may decrease if specific breaks in the volatility series are present. Therefore, as a robustness check in our empirical study we divide our sample into a number of sub-samples (e.g. excluding crisis periods) and find that our general results remain unaffected.

We begin by modeling index returns on each emerging market. Changes in returns are described by an autoregressive process with generalized autoregressive heteroscedasticity (GARCH) in disturbances, as in Bollerslev (1986). Additionally, some explanatory variables, representing external shocks, are included at different lags into the mean and variance equation. The model, employed to approximate index return movements of all investigated emerging markets, is defined by

$$R_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i R_{t-i} + \sum_{i=0}^{n} \phi_i X_{t-i} + \lambda C_{t-1} + z_t , \tag{1}$$

$$z_t = \varepsilon_t h_t^{1/2} , \qquad \varepsilon_t \sim NID(0,1) , \tag{2}$$

$$h_t = \beta_0 + \sum_{i=1}^{p} \beta_i h_{t-i} + \sum_{i=1}^{q} \delta_i \varepsilon_{t-i}^2 + \sum_{i=0}^{v} \eta_i X_{t-i}^2 , \tag{3}$$

where R_t is the index log-return on the selected emerging market and X_t is a measure of external global shocks to the emerging market index returns. These shocks are represented by index returns from one or many developed markets. The choice of this external shock measure

is discussed in more detail in the next section.[1] Shocks originating at home are captured by lagged values of local (domestic) stock index returns, R_{t-i} ($i = 1,...m$). We include an optional lagged error correction term, C_{t-1}, from the possible cointegration relationship between the log values of the global and local market indices into the mean equation (1) only when these two indices are cointegrated. α_i ($i = 0,...m$) and ϕ_i ($i = 0,...n$) are structural parameters in the mean equation (1); β_i ($i = 1,... p$), δ_i ($i = 1,...q$), and η_i ($i = 0,... v$) are structural parameters in the variance equation (3). The disturbance, z_t, is fitted to an autoregressive conditional heteroscedastic process with conditional variance h_t. The standardized disturbances, ε_t, may be interpreted as excess index returns or unpredictable shocks to index returns on the selected market. It is assumed that they are independently, identically, and normally distributed with zero mean and unit variance.[2]

The second step of the procedure is a test of causality linkages between returns on indices from emerging capital markets. The models of national index returns, satisfying equations (1) – (3), are estimated, and standardized innovations, ε_t, are derived for each emerging market. For index returns $R_{1,t}$ and $R_{2,t}$ from two selected emerging markets innovations $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ represent unpredictable shocks on these markets and are termed ξ_t and ζ_t, respectively. If we define squared innovations on both markets as $U_t \equiv \xi_t^2$ and $V_t \equiv \zeta_t^2$, it is possible to calculate spillover effects in both returns and volatility by applying

[1] Similar to other studies, we assume that global shocks are exogenous (e.g. Ng, 2000; Forbes and Rigobon, 2002), because emerging markets usually have a small impact on international developed markets (e.g. Hu, Chen, Fok, and Huang, 1997). "Endogenizing" external shocks would make the model intractable.

[2] Even if the true distribution of standardized innovations is not normal, the quasi-maximum likelihood estimation, consisting of the maximization of a conditional normal likelihood function, provides asymptotically consistent results under some regularity conditions; see e.g. discussion in Bollerslev, Engle, and Nelson (1994). Moreover, the causality test applied in this paper is robust against the non-normality of error terms.

the shocks ξ_t, ζ_t, U_t, and V_t to tests of causality. The test of Cheung and Ng (1996), based on estimations of the cross-correlation function, is employed here to verify the presence of causality-in-mean and causality-in-variance effects between index returns on different emerging markets. Under the null hypothesis no causality between the two selected markets is present. Specifically, there is no causality in mean when unpredictable returns from the first market, ξ_t, are independent of shocks from the second market, ζ_{t-i}, at all leads and lags ($i = 0, \pm 1, \pm 2, \ldots$). Causality in variance is not present when squared shocks, U_t and V_{t-i}, are independent at all leads and lags ($i = 0, \pm 1, \pm 2, \ldots$). We test the hypothesis of no causality at all lags from j to k, using the test statistic defined by

$$S_{\xi\zeta}(j,k) = T\sum_{i=j}^{k} r_{\xi\zeta}(i)^2 \tag{4}$$

against the alternative hypothesis of causality-in-mean at some lag *i*, and the statistic

$$S_{UV}(j,k) = T\sum_{i=j}^{k} r_{UV}(i)^2 \tag{5}$$

to test against the alternative hypothesis of causality-in-variance at some lag *i*. *T* is sample size; sample cross-correlation functions $\hat{r}_{\xi\zeta}(i)$ and $\hat{r}_{UV}(i)$ are used as estimates of $r_{\xi\zeta}(i)$ and $r_{UV}(i)$, respectively. The selection of j and k is discussed in section 4.2. Under the null hypothesis presented above both statistics (4) and (5) have asymptotic χ^2 distributions with $(k - j + 1)$ degrees of freedom (Cheung and Ng, 1996).

Additionally, statistics $S_{\xi\zeta}(i,i)$ and $S_{UV}(i,i)$, i.e. *S(j,k)* for *j=k=i*, are used to test for causality at a certain lag *i.*The alternative hypothesis for causality in mean at the selected lag i is that $R_{1,t-i}$ causes $R_{2,t}$ in mean when $i > 0$ and $R_{2,t}$ causes $R_{1,t-i}$ in mean when $i < 0$. This is true when the correlation between ζ_{t-i} and ξ_t, $r_{\xi\zeta}(i)$ is significantly different from zero, i.e. the statistic $S_{\xi\zeta}(i,i)$ exceeds its critical value for a selected lag i. Analogously, if the statistic

$S_{UV}(i,i)$ exceeds its critical value for a selected lag i, then $R_{1,t-i}$ causes $R_{2,t}$ in variance if $i > 0$ and $R_{2,t}$ causes $R_{1,t-i}$ in variance when $i < 0$.

The causality in mean (in variance) indicates that changes in returns (volatility of returns) on one market are transferred to returns (volatility) on the other market at some lag i. For both tests, contemporaneous causality occurs when the alternative hypothesis is true for $i = 0$ and a feedback relationship exists when both markets cause each other at some lags. For markets with overlapping opening hours contemporaneous causality indicates that news is absorbed by these markets at the same time. For markets with different opening hours, the market that operates later replicates some behavior of the market that operates earlier.

4. Data and Empirical Results

In this section we present empirical results from tests of inter- and intra-regional spillover patterns between emerging capital markets around the world. We begin by estimating standardized innovations from those markets and continue by applying the causality tests to explore possible return and volatility spillovers between emerging markets.

4.1 Data

Since the empirical analysis of financial spillovers between capital markets may be sensitive to different types of national market indices, we employ the standard broad national equity indices from the MSCI database in our study for the period from April 1, 1998 to January 4, 2006. The series are daily returns of indices from selected emerging markets in Asia (Malaysia, South Korea, Taiwan, and Thailand), Central and Eastern Europe (the Czech Republic, Hungary, Poland, and Russia), and Latin America (Argentina, Brazil, Chile, and Mexico).

Our choice of countries is motivated by their importance for and integration into the global economy, especially during periods of financial crises. First, these countries represent the biggest economies among emerging markets in the respective regions, as measured by

their GDP or GNI per capita. Further, they are regional leaders as far as capitalization or liquidity of the stock markets is concerned. Moreover, these countries are best integrated into the global economy among emerging markets worldwide and, hence, object of cross-border spillovers. This integration is established by strong real economic linkages in foreign trade and foreign direct investment. Also, statistics on international portfolio investment and bank lending reveal a high degree of interdependence between the global financial market and the countries analyzed in this study. Therefore, we expect transmission channels for information among these countries to be especially strongly pronounced. In addition, the regional similarities due to common history, business conditions, cultural links, and economic as well as political integration make these countries particularly suitable for a comparative study of inter- versus intra-regional spillovers. These countries have also been broadly investigated so far (Kaminsky and Reinhart, 2000; Pritsker, 2001; Gelos and Sahay, 2001; Pericoli and Sbracia, 2003, among others).

National capital markets are often affected by common global or regional shocks. Therefore, we also investigate index returns from four large national markets (Germany, Japan, the UK, and the US), returns from three international indices in different regions (AMERICA, EUROPE, and PACIFIC), and returns from two global indices of developed markets (G7 and WORLD) as possible proxies of the global shock X_t. All indices come from the MSCI database and are denominated in US dollars (www.msci.com). Employing indices denominated in one currency enables us to formulate conclusions that are important for international investors (Chen, Firth, and Rui, 2002). By doing this, we also take into account the foreign exchange markets which are, as channels of capital flows, affected by international spillovers. Hence, using one currency implicitly adjusts for the foreign exchange risk associated with investing in foreign assets.

4.2 Financial Spillovers between Emerging Markets

Testing of causality in returns and in volatility follows a two-step procedure described in section 3. First, we employ models given by equations (1)-(3) to estimate innovations from individual emerging markets, z_t. Including one of the variables corresponding to index returns from developed markets (PACIFIC, EUROPE, AMERICA, G7, WORLD, Germany, Japan, UK, and US) controls for external global shocks, X_t. The selection of the variable approximating external shocks is conducted for each country separately and is based on the criterion of minimizing the standard deviation of residuals, but similar results are also obtained after maximizing the likelihood function and the coefficient of determination R^2 from the estimated models. Minimizing residual standard deviation is equivalent to minimizing the Schwarz (1978) and the Akaike (1973) information criteria, because the number of parameters does not change in alternative models. We prefer the statistical criterion to the one of geographical proximity or of trade linkages because we intend to choose a variable, X_t, capturing most of the external impact on local (domestic) stock market returns. This approach also shows (see below) that indices covering a set of developed markets are superior to national indices (including the US one) as global market proxies.

Five lags are utilized for all explanatory variables in the mean and variance equations to control for possible day-of-the-week effects, serial correlation, and serial heteroscedasticity in index returns. A longer lag structure is preferred to a GARCH(1,1) specification because past returns may reflect important information about future index returns, since emerging markets are considered to be less efficient than developed ones (Kasch-Haroutounian and Price, 2001). In the context of financial spillovers between capital markets, five lags were adopted by Cheung and Ng (1996) and Forbes and Rigobon (2002), among others.

[Table 1 about here]

Standard statistics from estimated equations are presented in Table 1. The first column lists the abbreviated names of the national markets for which the models (1)-(3) are estimated. Variables optimally representing global shock X_t employed in the respective model are

displayed in the second column. Interestingly, the returns of the regional indices EUROPE and PACIFIC are the best variables approximating global shocks for emerging markets in Central and Eastern Europe and in Southeast Asia, respectively. The global index WORLD best approximates external shocks to the Latin American markets.

According to the unit root tests, results from two of which are reported in Table 1, all investigated market return variables are stationary. The cointegration tests of Johansen (1991) indicate that the WORLD and Chilean stock market indices are the only two cointegrated (results are not presented, but are available upon request). Thus, we include the error correction term, C_{t-1}, into the mean equation (equation (1)) for only the Chilean market.

In the second step we employ standardized innovations from the estimated equations to compute the statistics for causality in mean and in variance between all pairs of emerging markets. All presented test results are based on the 5% level of significance, but applying the 1% significance level does not affect the general conclusions. We start by calculating the statistics for causality in mean and the most important results are presented in Table 2. For every pair of emerging markets we report the value of correlation coefficients, ρ, between innovations from different markets as well as the lag numbers corresponding to the significant values of the statistics $S_{\xi\zeta}(i,i)$, where $i = 0,1,...5$, and $S_{\xi\zeta}(1,5)$, i.e. for j=1 and k=5.

Both statistics $S_{\xi\zeta}(i,i)$ and $S_{\xi\zeta}(1,5)$ are employed to test for the causality in mean at lags 1 to 5. Significant estimated $S_{\xi\zeta}(i,i)$ statistic value indicates that spillover effects from one market to the other are present at lag i. When the statistic $S_{\xi\zeta}(1,5)$ is significant, indicated by the entry "1-5," the spillover effect exists for at least one lag between 1 and 5. For instance, for spillovers from Russia to Poland, the correlation between innovations to returns is 0.196, significant return spillovers are present at lags 0 and 1, and the hypothesis of no causality at any lag between 1 and 5 can be rejected (indicated by the entry "1-5").

[Table 2 about here]

Some interesting results are presented in Table 2. First, the values of the correlation coefficient reveal that in most cases, as indicated by a '0' entry for the $S_{\xi\zeta}(i,i)$ statistic, significant contemporaneous relationships between markets are present even after controlling for external shocks from developed markets. This interdependence between countries is stronger between markets in each region than between markets in different regions. The coefficient values for the CEE markets range from 0.19 to 0.34, in Asia they range from 0.07 to 0.31 and in Latin America they are between 0.19 and 0.37. The correlation between innovations from markets on different continents is weaker, but usually significant as well.

Furthermore, one can observe that the $S_{\xi\zeta}(i,i)$ statistic for the lag $i=0$ is significant for almost all pairs of emerging markets, which can be interpreted as evidence of contemporaneous causation between the markets. Contemporaneous financial spillovers in returns are present regardless of the location and geographical proximity between the emerging markets. Again, more incidences of instantaneous spillovers can be observed between markets in the same region.

Whereas the analysis of contemporaneous interdependencies between markets has a long tradition in financial research, interpreting these results as evidence for a causal relationship earned severe critique. Two points can be made: first, the correlation coefficient shows no causality but only a linear relationship between two variables and, second, the revealed correlation might be due to the dependence of both variables to a third factor. As a consequence, it is argued, one can neither distinguish between simple co-movements and causality, nor detect the direction of causality.

However, our research settings largely overcome these problems. First, we control for the impact of the global capital market on each of the emerging markets analyzed. Hence, the correlation found is not due to the simultaneous reaction of the markets to global shocks. Second, concerning inter-regional spillovers, significant contemporaneous relationships do indicate causality, since emerging capital markets operate in different time zones (see

Appendices 1 and 2).[3] Asian markets open and close first, and are followed by the European markets, which are in turn followed by Latin American markets. Thus, the significant value of the $S_{\xi\zeta}(i,i)$ statistic at lag 0 for the markets in different time zones can be interpreted as evidence that a market located in the East leads a market located in the West. For example, Asian markets lead European and American markets, and European markets lead American on the same day. More generally, we can conclude that information is transmitted in both directions between two emerging markets in one region, but information from one market cannot be transmitted on the same day to another market in a different region when the other market closes first due to time zone differences.[4]

The causation statistics at higher lags demonstrate plausible patterns of financial spillovers. According to the $S_{\xi\zeta}(i,i)$, $0<i\leq 5$, and $S_{\xi\zeta}(1,5)$ statistic values most news originates in Latin American markets and spills over to the European and Asian emerging markets. Spillovers in the opposite direction are relatively seldom. Moreover, European markets seem to be most sensitive to news originating on other continents. Again, these findings for spillovers at lag 1 is associated with different opening hours of capital markets around the world. The returns on the emerging American markets cause returns on the Asian

[3] For spillovers between countries located in different regions, by contemporaneous we mean the quickest possible reaction of the market open later to news originating on the markets open earlier.

[4] Several studies argued that correlations of daily close-to-close returns in presence of non-synchronous trading hours are biased (Kahya, 1997; Burns, Engle, and Mezrich, 1998). However, adjustment methods proposed so far failed to deliver correct values, since they add noise to the data and are sensitive to model specification. Using weekly data might reduce the biases but, first, it causes a decrease in sample size and, hence, in efficiency of estimates and, second, low frequency data cannot capture daily spillover dynamics. Studies using open-to-close and close-to-open returns (Hamao, Masulis, and Ng, 1990; Koutmos and Booth, 1995) cannot distinguish between contemporaneous and lagged interdependencies, and the results are reported to be similar to those obtained from close-to-close returns. See Martens and Poon (2001) for the discussion on this issue. Given these arguments, we follow the main branch of spillovers literature and use unadjusted close-to-close returns.

and European markets the next day because the latter markets start to operate on the day after the American markets closed. Numerous instances of significant causation at lag 1 from the Latin American markets illustrate this phenomenon.

Most lagged spillovers are due to the differences in opening hours between continents, but there is also some evidence for lagged causality resulting from the sluggish adjustment of markets to news originating abroad. Causation effects at higher lags are present mostly within regions and from Latin America to Asia, but some moderate spillovers are found between all pairs of regions. Interestingly, from four CEE countries the main source of inter-regional causation is Russia, while in Asia and America all markets tend to cause some other. Patterns of lagged causation suggest that emerging markets may need more days to absorb foreign news, which could be explained by the limited number of informed traders and the presence of feedback traders which stimulates herding behavior. Alternatively, this effect could be driven by nontrading, stale limit orders, or high transaction costs. Some thinly-traded stocks included in the broad MSCI indices adjust to new information with a delay, providing rationale for their lagged adjustment.

Continuing the investigation, we test for the presence of causality in variance between the emerging markets in America, Asia, and Europe, controlling for idiosyncratic and global shocks. Cheung and Ng (1996) argued that results from tests of causality in variance between two different markets are affected when there is evidence of causality in mean. Our approach to control for this phenomenon is to remove any potentially remaining causality in mean from inter-market linkages by including present and lagged returns from the second market as explanatory variables into the first market's mean equation, as has been suggested by Cheung and Ng (1996). These authors also argue that any causality in variance has no effect on potential causality in mean when a model analogous to ours is used. Hence, after returns from the first market are included as explanatory variables into the mean equation of the second market, the new innovations for both models are estimated. Next, the statistics $S_{UV}(i,i)$ and

$S_{UV}(1,5)$ are calculated to test the null hypothesis of no causality in variance at lag i ($i = 0, 1, \ldots 5$) and at all lags from 1 to 5, respectively, independently of the causality in mean.

[Table 3 about here]

Table 3, which demonstrates results of correlation and causality tests between the squared innovations on different emerging markets, is constructed analogously to Table 2. As discussed previously, non-lagged spillovers can be interpreted here as causality between markets since we control for the impact of external factors and due to different opening hours. Correlation coefficients between markets in the same region are always positive and on average higher than between markets from different regions. The correlation coefficient values range from 0.05 to 0.16 in Europe, from 0.04 to 0.18 in Asia, and from 0.10 to 0.28 in America.

Similar to the standardized innovations, the squared innovations proxying volatility of country-specific shocks are most strongly correlated in Latin America. Generally, the squared innovations (volatility) are less correlated than the standardized innovations (returns) regardless of the geographical region. Moreover, contemporaneous causation in volatility between the markets is less common than the causation in mean. According to the results from causality-in-volatility tests based on the $S_{UV}(i,i)$ statistic for $i = 0$, the highest number of contemporaneous volatility spillovers is present among markets in the same region. Significant interdependence in volatility of returns is apparent between the European and Latin American emerging markets. If we consider the time difference between opening hours of capital markets in these regions, we can assume unidirectional volatility spillovers from Europe to Latin America.

Inter-regional volatility spillovers at higher lags are more frequent than contemporaneous interdependencies (again, one should keep in mind that spillovers from Europe and America to Asia at lag 1 indicate "contemporaneous" causality and are equivalent to those from Asia and from Europe to America at lag 0). The $S_{UV}(i,i)$ and $S_{UV}(1,5)$ statistics

indicate that volatility spillovers from Asia to Latin America, between markets in the Asian region, and between emerging markets in America at lags higher than 0 are less apparent, but there exists causality in variance from Europe to all regions and from all regions to Europe. These results reveal the existence of feedback relationships between European and American (and Asian) markets. According to the $S_{UV}(i,i)$ test results, 7 out of 16 possible cases of causation in volatility from Latin American to Asian markets are significant, also at lags higher than 1. However, the $S_{UV}(1,5)$ statistics indicate that only 5 out of 16 cases are significant.

The main finding after examining the causality in variance between emerging markets is that after controlling for global shocks and for causality in mean, volatility feedback linkages are present between all studied regions, although the spillovers between Asian and Latin American markets are less frequent. Moreover, volatility spillovers are generally more common between markets in the same region than between different regions.

To summarize, spillovers result from both instantaneous and lagged causation. The possible interpretation is that due to the lack of well-informed traders, emerging markets need time to assess the risk related to foreign news and the news' general impact on asset prices. Linkages in volatility are also most likely caused by the disagreement of local investors in interpretation of news originating abroad.

Additionally, we compare the results on causality in returns and volatility when global shocks from developed markets are controlled for, as reported above, and when no external shocks from mature markets are taken into account (details are available upon request). Significant additional patterns of causation found in this exercise indicate that it is important to account for global shocks when studying financial linkages between emerging markets. Those studies that did not control for this important factor could point to too many cases of inter-market linkages.

As a robustness check, we also analyze whether causality in returns and in variance is present in different sub-samples. First, we conduct a year-by-year analysis of spillovers to assess the dynamic behavior of linkages between markets. For both returns and volatilites this detailed analysis confirms our findings for the whole sample: contemporaneous spillovers are more pronounced than lagged ones and intra-regional effects are stronger than inter-regional ones. Linkages in volatility are weaker than those in returns. Moreover, the number of observed causality effects seems to be generally stable over time, with some exceptions. First, contemporaneous intra-regional correlation in returns is less frequent in 1999, most likely due to the country-specific character of events such as the Brazilian Real's devaluation and the presidential elections in Argentina. Second, contemporaneous intra-regional correlation in variance is above average in 2001, which we attribute to the impact of the political and economic crises in Argentina and Brazil on stock markets in that region. Third, lagged spillovers in variance are time-varying and reveal no clear behavior pattern.

We also divide our investigation period into two sub-periods of equal length. In each sub-sample, after controlling for global shocks, we still find significant causality effects in both returns and volatility which are rather stable and reveal patterns found for the entire period. A slight increase in the contemporaneous and a decrease in lagged return spillovers indicate an increased speed of the markets' adjustments to news originating in other emerging markets. Further, we test for possible changes in causality patterns due to major economic and political events. For instance, excluding the first year of the Russian crisis does not change the general intensity of spillovers between markets. The results also show that the markets' responses to the terrorist attacks in September 2001 and to the Iraqi war lead to a slight decrease in interdependencies, after controlling for the impact of global shocks. Hence, after investigating the dynamic effects in spillover patterns our general conclusions remain: contemporaneous causation is more frequent than lagged spillover effects, and intra-regional linkages are stronger than inter-regional.

4.3 Some Implications for Investors and Policy Makers

The presented results for causality in returns are important for international investors because they indicate that emerging markets are dependent not only on the global developed markets, but also on other emerging markets. Although it might be impossible to capitalize on non-lagged causality, profits could be obtained given sluggish adjustment of some markets to news originating abroad. Also, the knowledge of the complex causality patterns helps to improve the forecasting power of models for domestic returns. For the purpose of international portfolio diversification, the results presented here indicate that the scope of risk reduction is larger for traders splitting their capital among emerging markets from different regions compared to investment on the markets located in the same region, due to weaker inter-regional links. Also, cross-border linkages in variance are shown to be an important determinant of domestic assets' volatility, which highlights their relevance for forecasting, hedging, and valuation of domestic assets. The finding of intertemporal stability in spillovers implies that, although international portfolio diversification might fail to reduce risk due the short run contagion effects, in the medium and long run spreading capital worldwide is effective.

Furthermore, the causality patterns in mean and variance reveal the channels and structure of cross-border information flows among emerging markets, underscoring that news stemming from other continents is less important for domestic assets than news originating from neighboring markets. Causality in volatility also reveals that risk, understood as variance of returns and resulting from the disagreement about asset valuation, spills over across borders.

Our findings on the existence of financial spillovers between emerging markets have important implications for policy makers. Any policies affecting financial markets should account for the impact of shocks from other mature and emerging markets. Our results and evidence of inter-regional crises (South-East Asia in 1997, Russia in 1998, Brazil in 1999

etc.) suggest that policies concerning financial markets should take into account international spillovers because shocks from abroad may influence domestic financial stability. For example, international cooperation of supervisory and regulatory institutions, coordination of monetary and fiscal policies as well as administrative measures to control international capital flows can be employed with the aim to protect the domestic financial market from shocks spilling over from other emerging markets. However, any such measures to stop contagious crises should be applied with caution since recent research shows them to be rather ineffective and even possibly harmful to the local economy (Kaminsky and Schmuckler, 2001; Forbes, 2002).

5. Summary and Conclusions

In this study we investigate whether linkages between emerging markets from a given region (intra-regional) and from different regions (inter-regional) result solely from these countries' common dependence on global shocks originating on the world market, or whether interdependencies between emerging markets are partially independent from these global factors. Moreover, we ask whether countries located in one region are more closely related to each other than with countries from other regions.

The existence of spillovers indicates that investors extract information about domestic assets from foreign returns (King and Wadhwani, 1990). We confirm the findings of the majority of previous studies conducted for individual regions that a certain amount of return and volatility spillovers among emerging markets can be explained by their common reaction to shocks originating on the global capital market. However, we also show that linkages between emerging markets remain significant after controlling for global and local (domestic) effects. This indicates that the widely-observed co-movements between emerging markets are not only due to the countries' common reaction to global shocks. Apparently, factors discussed above such as similarities in economic structure and economic policy, competition

of countries' products on the third markets, common bank lenders, and simultaneous actions of portfolio investors establish real interrelations between emerging capital markets worldwide. Our finding that both global and regional linkages are relevant is in line with the results of Bekaert and Harvey (1997), Ng (2000), and Bekaert, Harvey, and Ng (2005), among others.

We also find that intra-regional spillovers are more frequent than inter-regional ones, as reported by Edwards and Susmel (2001) and Sola et al. (2002) for a smaller set of countries. This illustrates the relative strength of intra-regional linkages between capital markets from Central and Eastern Europe, Latin America, and South-East Asia, respectively. This finding is in line with the theoretical literature arguing that stronger intra-regional trade relations (both direct and via competition on the third markets), common creditors and portfolio investors from the closest developed market, regional economic integration, and similar macroeconomic policy induce strong financial linkages within a region. We confirm the existence of spillovers in both returns and volatility, with the former being more pronounced than the latter. The analysis of inter-temporal changes in the causation patterns between the markets reveals that the effects found for the entire sample hold also in various sub-samples, indicating at least medium term stability in spillovers.

In general, our findings indicate that economists and most importantly investors have to account for local, regional, and global shocks as well as different time zones when analyzing the interdependencies between emerging capital markets around the world.

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Table 1: Estimated index return models for the 12 emerging markets

MARKET	EXTERNAL SHOCKS	LOG LIKELIHOOD	S.D.	R^2	ADF	KPSS
CZE	EUROPE	5731.88	0.0150	0.17	-40.88*	0.5242
HUN	EUROPE	5572.47	0.0171	0.18	-41.61*	0.4953
POL	WORLD	5476.54	0.0174	0.18	-40.75*	0.3173
RUS	EUROPE	4624.64	0.0311	0.10	-40.81*	0.2589
KOR	PACIFIC	5126.10	0.0222	0.20	-42.55*	0.0907
MAL	PACIFIC	5780.24	0.0188	0.08	-11.33*	0.1080
TAI	PACIFIC	5534.07	0.0172	0.12	-43.15*	0.1280
THA	PACIFIC	5328.89	0.0192	0.17	-36.94*	0.2270
ARG	WORLD	5080.12	0.0248	0.08	-14.87*	0.1005
BRA	WORLD	5288.45	0.0208	0.21	-44.48*	0.4337
CHI	WORLD	6545.60	0.0102	0.25	-40.31*	0.4436
MEX	WORLD	5983.71	0.0144	0.35	-36.21*	0.3520

Note: EXTERNAL SHOCK is the name of the additional explanatory variable describing return spillovers from developed international markets to the emerging market; S.D. is the standard deviation of residuals from the estimated model; ADF is the augmented Dickey-Fuller (1979) test for the null hypothesis indicating nonstationarity of returns, KPSS is the Kwiatkowski-Phillips-Schmidt-Shin (1992) test for the null hypothesis of stationarity of returns; * indicates significance at the 1% level.

Note to Table 2: Correlation values between market returns, adjusted for internal and global shocks, are presented in the first row for each pair of markets. The lag numbers i from the significant causality-in-mean statistic values, $S_{\xi\zeta}(i,i)$, are presented in the second row. The lag numbers from the significant causality statistic $S_{\xi\zeta}(1,5)$ are presented in the third row. For instance, for spillovers from Russia to Thailand, the correlation between adjusted returns is 0.109, significant return spillovers are present at lags 0 and 3, and the hypothesis of no causality at any lag between 1 and 5 can be rejected (indicated by the entry '1-5'). Regional linkages are surrounded with a thick line.

Note to Table 3: Correlation values between market squared returns, adjusted for internal and global shocks, are presented in the first row for each pair of markets. The lag numbers i from the significant causality-in-variance statistic values, $S_{UV}(i,i)$, are presented in the second row. The lag numbers from the significant causality statistic $S_{UV}(1,5)$ are presented in the third row. For instance, for spillovers from Russia to Thailand, the correlation between adjusted volatilities is 0.035, significant volatility spillovers are present at lag 2, and the hypothesis of no causality at any lag between 1 and 5 cannot be rejected (indicated by the missing entry '1-5'). Regional linkages are surrounded with a thick line.

Table2: Return spillovers, corrected for global and local shocks

Spillover to		Spillover from											
		CZE	HUN	POL	RUS	KOR	MAL	TAI	THA	ARG	BRA	CHI	MEX
CZE	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	X	0.334 0,2,3,4 1-5	0.271 0,2 1-5	0.215 0	0.043 1	0.063 0,4	0.031	0.031	0.034 1,4 1-5	0.026 1 1-5	0.068 0,5	0.036 1
HUN	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.334 0	X	0.331 0	0.199 0	0.127 0	0.063 0	0.011	0.052 0	0.087 0,1 1-5	0.041 1 1-5	0.082 0,1	0.095 0,1 1-5
POL	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.271 0,1	0.331 0,1 1-5	X	0.196 0,1 1-5	0.113 0	0.058 0,1	0.062 0,4	0.128 0	0.055 0,1 1-5	0.073 0,1 1-5	0.138 0,1 1-5	0.062 0,1 1-5
RUS	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.215 0,1	0.199 0	0.196 0,1	X	0.074 0,3	0.090 0	0.066 0	0.109 0,4	0.121 0,1 1-5	0.101 0,1 1-5	0.088 0,1	0.120 0 1-5
KOR	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.043	0.127 0	0.113 0	0.074 0	X	0.111 0	0.310 0,	0.221 0,1 1-5	0.042	0.082 0,1	0.087 0,1	0.130 0,1
MAL	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.063 0	0.063 0,2	0.058 0	0.090 0,3	0.111 0	X	0.071 0	0.183 0	0.035	0.036	0.044 0	0.072 0
TAI	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.031 3	0.011	0.062 0	0.066 0,4	0.310 0,1	0.071 0,1,5 1-5	X	0.142 0	0.034 3,4 1-5	0.039 4 1-5	0.095 0,3,5 1-5	0.038 3,4 1-5
THA	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.031	0.052 0	0.128 0	0.109 0,3 1-5	0.221 0	0.183 0,4	0.142 0	X	0.091 0,1 1-5	0.084 0	0.126 0,2 1-5	0.097 0,1 1-5
ARG	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.034	0.087 0	0.055 0	0.121 0,5 1-5	0.042	0.035	0.034	0.091 0	X	0.331 0,1 1-5	0.194 0	0.231 0,1
BRA	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.026	0.041 1	0.073 0	0.101 0	0.082 0	0.036	0.039 1	0.084 0	0.331 0	X	0.337 0	0.370 0
CHI	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.068 0	0.082 0	0.138 0	0.088 0,3	0.087 0	0.044 0	0.095 0	0.126 0	0.194 0,1 1-5	0.337 0,3	X	0.208 0
MEX	ρ $S_{\xi\zeta}(i,i)$ $S_{\xi\zeta}(1,5)$	0.036	0.095 0	0.062 0,2	0.120 0	0.130 0	0.072 0,3	0.038	0.097 0	0.231 0,1 1-5	0.370 0,1	0.208 0	X

Table 3: Volatility spillovers, corrected for global and local shocks

Spillover to		Spillover from											
		CZE	HUN	POL	RUS	KOR	MAL	TAI	THA	ARG	BRA	CHI	MEX
CZE	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	X	0.152 0,3,4 1-5	0.149 0,5	0.056 0,4	-0.003 1 1-5	0.021 1	-0.005 1	0.000	-0.008 2	0.017	-0.003 2	0.028 1,2,3 1-5
HUN	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.152 0	X	0.151 0,2,5 1-5	0.074 0,5 1-5	0.026	0.029 3	0.034	0.025 2	-0.012	0.066 0,2,5 1-5	0.047 0,1,2 1-5	0.042 1,2,5 1-5
POL	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.149 0,	0.151 0,1,3,5 1-5	X	0.055 0,1,3,5 1-5	0.038	0.042	0.011	0.053 0,1	0.021 3 1-5	0.056 0,1	0.047 0	0.059 0,2 1-5
RUS	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.056 0,1 1-5	0.074 0	0.055 0	X	0.005 4	0.019 1,4 1-5	-0.004 4	0.035	0.057 0,2	0.021	0.050 0	0.077 0
KOR	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	-0.003	0.026	0.038	0.005 1,2 1-5	X	0.046 0	0.174 0	0.079 0	-0.018	0.029	0.046 0,1,2 1-5	0.048 0
MAL	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.021 3 1-5	0.029 4	0.042	0.019 4,5 1-5	0.046 0	X	0.048 0,4	0.135 0	-0.041	0.007	0.005 5 1-5	0.011
TAI	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	-0.005	0.034	0.011 5	-0.004 2 1-5	0.174 0	0.048 0	X	0.058 0	0.041 2	0.042 1	0.001	0.043 1 1-5
THA	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.000	0.025	0.053 0	0.035 2	0.079 0,1 1-5	0.135 0	0.058 0	X	0.051 0,2 1-5	-0.009	0.011	0.044 0,1 1-5
ARG	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	-0.008	-0.012 1,5	0.021	0.057 0	-0.018	-0.041 5	0.041	0.051 0	X	0.275 0	0.107 0	0.105 0
BRA	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.017	0.066 0,1,2,5 1-5	0.056 0,5 1-5	0.021	0.029 1	0.007	0.042	-0.009	0.275 0	X	0.160 0,2 1-5	0.130 0,1
CHI	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	-0.003	0.047 0,2	0.047 0,2,3 1-5	0.050 0	0.046 0	0.005	0.001	0.011 1,3,4 1-5	0.107 0,1,5 1-5	0.160 0	X	0.163 0
MEX	ρ $S_{UV}(i,i)$ $S_{UV}(1,5)$	0.028	0.042 1 1-5	0.059 0,3	0.077 0	0.048 0	0.011	0.043	0.044 0	0.105 0	0.130 0,2,4 1-5	0.163 0	X

Appendix 1: Trading hours of emerging markets stock exchanges

COUNTRY	LEADING STOCK EXCHANGE	LOCAL TIME	LOCAL TRADING HOURS
CZECH REPUBLIC	PRAGUE STOCK EXCHANGE	GMT + 1 h (+2 h)*	7:30 – 16:00 (20:00)
HUNGARY	BUDAPEST STOCK EXCHANGE	GMT + 1 h (+2 h)*	9:00 – 16:30
POLAND	WARSAW STOCK EXCHANGE	GMT + 1 h (+2 h)*	9:00 – 16:10
RUSSIA	MOSCOW STOCK EXCHANGE	GMT + 3 h (+4 h)*	11:00 – 17:15
KOREA	KOREA STOCK EXCHANGE	GMT + 9 h	8:00 – 16:00
MALAYSIA	KUALA LUMPUR STOCK EXCHANGE	GMT + 8 h	9:00 – 17:00
TAIWAN	TAIWAN STOCK EXCHANGE	GMT + 8 h	9:00 – 16:00
THAILAND	STOCK EXCHANGE OF THAILAND	GMT + 7 h	9:55 – 16:40
ARGENTINA	BUENOS AIRES STOCK EXCHANGE	GMT – 3 h	10:30 – 17:00
BRAZIL	BRAZIL STOCK EXCHANGE (BOVESPA)	GMT – 3 h (-2 h)*	9:45 – 17:00
CHILE	CHILEAN STOCK EXCHANGE	GMT – 4 h (-3 h)*	9:00 – 16:30
MEXICO	MEXICO STOCK EXCHANGE	GMT – 6 h (-5 h)*	8:30 – 15:00

Note: GMT is Greenwich Mean Time; * indicates Summer Time (there is Summer Time in Europe when there is Winter Time in South America); some additional or special trading may take place after normal trading hours (stock indices are not computed during that time) – this is indicated in parentheses in the last column. Source: the internet web pages of stock exchanges.

Appendix 2: Trading hours of emerging markets stock exchanges