Dynamic Volatility Spillover Effects

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ABSTRACT

This paper investigates the dynamic nature and determinants of returns and volatility spillovers from the developed European region and the world to the five emerging European equity markets that are not members of the European Monetary Union. Using a multi-factor model with time-varying loadings estimated in three stages, we find the regional effect on volatility is stronger than the world effect, however, the return spillover from the world is stronger than that from the region. Economic growth and exchange rate can predict the volatility spillover intensities. We also find that the return spillover effect from the world to the developed European region is stronger during a recession.

INTRODUCTION

Over the last few decades, liberalization and integration of the financial markets have increased the co-movements of international capital markets. Particularly, stock returns in emerging markets that are characterized by high volatility are usually influenced by developed markets. However, Binswager (1999) indicates that the markets exert a strong influence on international linkages and uncertainty with respect to the direction and size of price changes. Under the efficient markets hypothesis, the movements of stock markets reflect the transmission of information between markets. Accordingly, an examination of the volatility spillover process also enhances the understanding of information transmission for the emerging markets. Understanding the origins and drivers of volatility in emerging markets is important for pricing securities, determining the cost of capital, implementing global hedging strategies, and making asset allocation decisions (Bekaert and Harvey, 1997). Recently, a large number of empirical studies attempted to investigate how financial market shocks were transmitted across Asian countries (see, e.g., Ng, 2000; Gallo and Velucchi, 2009) and developed European economies (Baele, 2005); however, attempts to analyze the volatility spillover effect related to economic conditions in emerging European markets have been few. Therefore, much research remains to be undertaken.

The essential topic of international market efficiency is often viewed in terms of international market integration or segmentation. In financial market theory, the integration of capital markets is tackled from the perspective of asset pricing theory. Early research on integration made one of the following three assumptions: perfectly integrated, perfectly segmented, or partially integrated with the degree of integration being constant. Furthermore, Bekaert and Harvey (1995, 1997) combined both extremes in a model and found that some emerging markets exhibit time-varying world integration. Building on their work, Ng (2000) and Baele (2005) added the regional factor to the pricing model and tested volatility spillover effects in emerging Asian and developed European markets, respectively. Thus far, the drivers of volatility in emerging European markets have not been fully examined.
If the degree of integration is truly time varying, it is important to understand the economic determinants of shock spillover intensity. Chambet and Gibson (2008) state that regional economic instability may influence foreign investors’ pricing of risk. Financial variables incorporate the market’s reaction to macroeconomic news; furthermore, international spillovers may be related to the internal situation of a country or regional (world) economic growth, although it has long been established that business cycle conditions are intricately linked with asset returns (see, e.g., Fama and French, 1989) and international equity correlations (Kim and Lee, 2008). Thus, there is considerable evidence that equity market correlation and volatility are higher during recession than during growth periods, yet it is not clear whether shock spillover intensities also exhibit this asymmetry. A number of studies have examined the importance of economic growth for international market linkages (see, e.g., Bekaert et al., 2007; Ragunathan et al., 1999). However, very few papers focus on the relationship between economic conditions and the volatility effects driven by the world and the region, with the exception of Baele (2005). Although Baele (2005) studied the issue for European Monetary Union (EMU) countries, the results were mixed. Therefore, we investigate whether there are business cycle components in the shock spillover intensities.

The first objective of this study is to determine the degree to which globalization and increasing regional integration affect the interdependence of emerging European equity markets, and the second objective is to test whether there are economic growth and exchange rate components in the shock spillover intensities. This paper claims that the increasing impact of world and regional factors on volatility in emerging European markets is consistent with increased global and regional integration. A comparison between our research and previous studies is given below.

Firstly, this paper focuses on emerging European markets. A sizable increase in the capital flows to emerging economies is one of the most prominent features of international financial markets today. Other emerging markets such as those in Asia have been extensively studied, but evidence of stock market integration in Central and Eastern Europe remains relatively scarce (Babetskii et al., 2007). In practice, financial market behavior of emerging European markets can be different from other emerging markets. Therefore, it would be interesting to gain an insight into the working of these countries’ financial markets.

Secondly, from a methodological point of view, the European situation provides an excellent case study for regional analysis owing to the differences in culture, economy, geography, and polity compared with Asia. The method in this paper allows for time-varying parameters and further gives us the possibility to address world effect and regional (developed Europe) effect on emerging European markets. Previous studies on international market linkages in emerging European markets focused mainly on the effects of a single international market (see, e.g., Chelley-Steeley, 2005) or on the influence of the EMU (see, e.g., Baele, 2005; Babetskii et al., 2007). However, in the case of emerging European markets, very few papers discuss the volatility spillover effects from both the world and the region (Bekaert et al., 2005).

Unlike previous studies, our model nests two models that are composed of a pricing formula by extending the framework of Bekaert et al. (2005) in three stages, with the world equity returns and the European regional portfolio as the benchmarks.¹ By combining the local factors, we also examine the asset pricing descriptions using univariable generalized autoregressive conditional heteroscedasticity

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¹ We extend the framework of Bekaert et al. (2005) and further allow for different impacts on the size and pattern between the mean and volatility driven by world (European region).
(GARCH) processes with asymmetry,\(^2\) provided by Glosten et al. (1993). Then, negative news from the world or the region may increase the volatilities of the equity returns in emerging European markets. We add economic instruments to local and regional information sets that contain additional information on excess returns as the proxies for local and regional risk factors. The empirical model in this paper, allowing volatility spillover effects from the world to Europe and avoiding orthogonalization, suits the simultaneous analysis of world and regional integration in emerging markets and allows for time-varying parameters, latent factors, and a GJR-GARCH structure for the residuals.

Finally, this paper tests the economic circumstances that have an impact on the spillover effects from the world and the European region. With the degree of international correlation changing over time, a more appropriate method of investigating the behaviors of return and volatility spillovers is to allow the spillover weight parameters to be driven by certain local information variables that might capture the time variation in correlations (Ng, 2000). Our research focuses on the impact of the components of economic growth and exchange rate on equity returns and volatility spillovers. The impact of the level of economic activity on stock returns is widely documented, and research results generally indicate that the macroeconomic variables can explain the relationship between risk and returns and predict the excess returns.\(^3\) Moreover, previous studies show the importance of currency effects on equity prices and volatility (see, e.g., Francis et al., 2006; Cumperayot et al., 2006). Investors focus more on the movements of exchange rates during large shocks, which may propagate across markets. Accordingly, we hypothesize that both exchange rate and expected economic growth have an impact upon the degree of spillover in emerging European markets. Thus far, to our knowledge, the existing literature has focused primarily on world market integration; however, regional integration on the basis of economic growth conditions in emerging European markets has hardly been analyzed. Our analysis is therefore a first look on this issue.

Our result suggests that foreign shocks from the world and the region are both important. The volatility spillover intensities from the European region seem to be stronger than those from the world. In contrast, the mean spillover effects from the world are greater than those from the European region. Furthermore, this paper provides some evidence of exchange rate and economic growth effects on the degrees of spillover in emerging European markets and the European region.

**METHODOLOGY**

**The Model**

This paper intends to test the time-varying effects of return and volatility spillovers from the world and the European region to five emerging European markets. Considering that the degree of international correlation is unstable, we assume that the spillover effects change over time. We extend the two-factor model of Bekaert et al. (2005) by allowing for different degrees of spillover effects on mean and volatility. Thus, the model takes the following general form:

\[
R_{t,i} = \delta_t Z_{t,i-1} + \beta_{t,i-1}^{\text{world}} u_{\text{world},t-1} + \beta_{t,i-1}^{\text{reg}} u_{\text{reg},t-1} + \gamma_{i,t-1}^{\text{world}} e_{\text{world},t} + \gamma_{i,t-1}^{\text{reg}} e_{\text{reg},t} + e_{t,i} ,
\]

\[
\sigma_{t,i}^2 = E(e_{t,i}^2 | I_{t-1}) = \theta_i + \phi_i \sigma_{i,t-1}^2 + \varphi_i \sigma_{i,t-1}^2 + \zeta_i \eta_{i,t-1}^2 + \xi_{i,t-1}, \quad i = 1,2,..N
\]

\(^2\)Koutmos and Booth (1995) found that volatility transmission is asymmetric. Spillovers are more pronounced in the case of bad news than good news.

\(^3\)For instance, Fama (1981) provides the evidence of a negative relationship between inflation and stock returns.

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where $R_{i,t}$ represents the stock index returns in excess of the 30-day Eurodollar rate on market $i$ in US dollars, and $u_{\text{world},t-1}$ and $u_{\text{reg},t-1}$ denote the conditional expected excess returns on the world and European regional stock markets, respectively. The vector $Z_{i,t-1}$ includes a constant term, security transactions per GDP, the ratio of total trade to GDP, exchange rate components, business cycle components, and the stock indices for market $i$, all of which are lagged by one month. The variance of the idiosyncratic return shock $\epsilon_{i,t}$ follows a GARCH process in eq. (1b) with asymmetric effects in the conditional variance, similar to those of Glosten et al. (1993). Finally, we let $\eta_{i,t}$ represent the negative shock of market $i$.

Parameterizations for Mean and Volatility Spillovers

This section provides two different parameterizations for the mean and volatility spillover effects. We initially assume that the effects are constant over time and then relax this assumption. We allow the spillover effects to be influenced by economic situation. Hence, the model can be expressed as

$$
\beta_{\text{world},t-1} = a_i \chi_{\text{world},t-1}, \quad \beta_{\text{reg},t-1} = b_i \chi_{\text{reg},t-1}, \quad \beta_{\text{world},t} = c_i \chi_{\text{world},t-1},
$$

$$
\gamma_{i,t-1} = d_i \chi_{i,t-1}, \quad \gamma_{i,t-1} = v_i \chi_{i,t-1}, \quad \text{and} \quad \gamma_{\text{world},t} = w_i \chi_{\text{world},t-1},
$$

where $a_i$, $c_i$, $d_i$, and $w_i$ are $(7\times1)$ vectors of the parameters that measure the impact on the spillover effect from the world, while $b_i$ and $v_i$ measure the effects from the European region.

The vectors of $\chi_{i,t-1}$ and $\chi_{i,t-1}$ consist of the instrument variables that capture the covariance risks of market $i$ with respect to the world and region portfolios, while the variable of $\chi_{\text{reg},t-1}$ reflects the risk of the European region with respect to the world portfolio. The instruments in $\chi_{i,t-1}$ and $\chi_{\text{reg},t-1}$ include a constant, security transactions per GDP, the ratio of total trade to GDP, exchange rate components (against US), and economic growth components, while $\chi_{\text{reg},t-1}$ contains a constant, the ratio of total trade to GDP, exchange rate components (against Euro), and economic growth components.

Instrumental Variables on Spillovers

Foreign capital flows. The variable of security transactions per GDP, ST, is the data of gross foreign purchases and sales obtained from the US Treasury International Capital (TIC) reporting system and considered as a proxy for financial integration that is increased by liberalization. Bekaert et al. (2002) use the data as the proxy for foreign capital flows. The mobility of international capital flows may lead to financial market integration (see, e.g., Bekaert and Harvey, 2003).

Trade. We use the ratio of total trade to GDP as the proxy for economic integration. The variable may affect equity return correlations through an assembly of cross-country cash flows. Chen and Zhang (1997) found that countries with heavier external trade to a particular region tend to have higher return correlations with that region.
Exchange rate components. Variable Ex1 indicates the movements of exchange rates, and Ex2 is a dummy variable for the depreciation of local currency. Several theoretical links between equity prices and exchange rates are well known, and the effect of exchange rate on the relative importance of international factors over time can be found in Bekaert and Harvey (1997) and Ng (2000).

Economic growth components. For the economic growth components, we create two dummy variables, Gth1 and Gth2, to represent two states: the state when emerging Europe and the world (European region) are simultaneously in recession and the state when the local business cycle is in a recessionary phase. To explore the effect of business cycle deviations on cross-market correlations, we include the dummy to record the economy when it is in the recessionary phase. The dummy is calculated as follows. First, a quadratic trend is fitted for the composite leading indicator of each country as well as for the world (European regional market). Second, the deviations from this trend are generated. Positive deviations indicate boom; negative deviations, recession. Third, for each country, a below-phase dummy is created. This dummy takes a value of one when the deviation of a country’s composite leading indicator from its trend has the same sign as the world (European region), and zero otherwise.

**Estimation Method**

Our model is estimated in three steps. In the first step, a univariate GJR-GARCH model is estimated for the world return. In the second step, an extended univariate GJR-GARCH model is estimated for the aggregate European return. The world residual from the first-step regression is included as an explanatory variable. Finally, conditioning on the effects of the world and regional markets, we examine the model for local markets in eqs. (1a) and (1b). To avoid non-normality in excess returns, we adopt the quasi-maximum likelihood (QML) method to estimate the model, as proposed by Bollerslev and Wooldridge (1992). The multi-step estimation procedure provides consistent, but not necessarily efficient, estimates. Ng (2000) and Baele (2005) use the bivariate GARCH model for US and regional returns by two-step estimation procedure. There are no volatility-spillover effects between the US and Europe. The three-step estimation procedure in our paper distinguishes itself by allowing volatility spillover effects from the world to Europe and avoiding orthogonalization.

**EMPIRICAL RESULTS**

**Data Analysis**

Our data set from Datastream contains the Morgan Stanley Capital International (MSCI) equity indices in terms of US dollars for computing monthly continuously compounded rates of return for the world, region, and emerging European markets. The sample period is from September 1996 to December 2006. We use MSCI world index as the world market and MSCI Europe index as the European regional market. Among all emerging European markets, we select those that are not members of the EMU to test the depreciation effect on world and regional spillover intensities. Thus, the emerging markets include the Czech Republic, Hungary, Poland, Russia, and Turkey. The summary statistics are provided in Table 1.

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4 The variables, Ex1 and Ex2, are measured by the exchange rate against US dollar for the world effect and against euro for the regional effect.
5 The MSCI Europe Price index tracks 16 of the major stock markets in Europe by capturing approximately 85% of the market cap of each country.
In Table 1, the mean returns for all markets are positive, and emerging markets have higher returns than world and European regional markets. Within the entire sample, including the markets that were affected by the Asian crisis, Russia has the highest mean US dollar return of 2.935%, followed by Turkey (2.515%), Hungary (2.022%), the Czech Republic (1.639%), and Poland (1.159%). Volatilities for emerging European markets range from 8.192% (the Czech Republic) to 17.217% (Turkey). It is clear that emerging European markets offer higher average returns than the world (0.602%) and European region (0.813%); however, these high returns are also characterized by higher volatility, which is common for emerging markets and is consistent with Bekaert and Harvey (1995, 1997).

Among the emerging European countries, the first-order autocorrelation of returns ranges from 3.1% (Turkey) to 10.3% (Poland), and the Ljung-Box statistics indicate that linear dependency is not persistent in all markets. For the squared returns, first-order serial correlations vary between −0.103 (the Czech Republic) and 0.382 (Russia), and the Ljung–Box statistics show strong evidence of nonlinear dependency in Russia, the European region, and the world. Nonlinear dependency could be due to the ARCH effect. Finally, Hungary and Russia are rejected at a 5% significance level for the normality test. Most market returns are left skewed and leptokurtic, and all returns are shown to be stationary by the ADF unit root tests.

**World and Regional Models**

A correct specification for the models is important for investigating the influence of world and European regional shocks on emerging European markets. Table 2 presents the results of the specification tests for the world and regional models. All the models for the world and regional markets exhibit no autocovariance in the standardized residuals and squared terms. The Jarque-Bera tests for normality indicate that the standardized residuals for all models are generally normally distributed. All the results of the joint tests are far above their critical values. Negative news from the world may increase the volatilities of the equity returns in the regional market and emerging European markets. For the world model estimation, the likelihood ratio test (at a 10% level) and the Wald test (at a 5% level) reject the null hypothesis of no asymmetry. We find no evidence of asymmetric volatility in the regional model estimation. The results are similar to Bekaert et al. (2005), who find strong asymmetric volatility in the United States, yet fail to reject symmetry in the European, Asian, and Latin American regional portfolios.

### Table 1: Summary Statistics for Equity

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>$\rho$</th>
<th>$LB_1$</th>
<th>$\rho^2$</th>
<th>$LB^2_1$</th>
<th>Skewness</th>
<th>Ex. Kurtosis</th>
<th>Jarque-Bera</th>
<th>ADF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech</td>
<td>1.639</td>
<td>8.192 0.074</td>
<td>7.283</td>
<td>-0.103</td>
<td>1.440</td>
<td>0.019</td>
<td>2.782</td>
<td>0.253</td>
<td>-10.212***</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>2.022</td>
<td>9.366 0.051</td>
<td>4.732</td>
<td>0.131</td>
<td>3.809</td>
<td>-0.559</td>
<td>3.722</td>
<td>9.151**</td>
<td>-10.422***</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>1.159</td>
<td>9.651 0.103</td>
<td>11.414</td>
<td>-0.023</td>
<td>4.592</td>
<td>-0.156</td>
<td>3.085</td>
<td>0.540</td>
<td>-10.109***</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>2.935</td>
<td>15.763 0.022</td>
<td>2.741</td>
<td>0.382</td>
<td>21.602***</td>
<td>-0.463</td>
<td>5.234</td>
<td>30.223***</td>
<td>-10.121***</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>2.515</td>
<td>17.217 0.031</td>
<td>9.940</td>
<td>0.106</td>
<td>3.319</td>
<td>0.470</td>
<td>3.419</td>
<td>5.477*</td>
<td>-10.850***</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>0.602</td>
<td>4.146 0.055</td>
<td>0.933</td>
<td>0.126</td>
<td>10.919**</td>
<td>-0.169</td>
<td>3.586</td>
<td>2.359</td>
<td>-10.411***</td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>0.813</td>
<td>4.595 0.073</td>
<td>1.038</td>
<td>0.249</td>
<td>11.082**</td>
<td>-0.235</td>
<td>3.513</td>
<td>2.504</td>
<td>-10.088***</td>
<td></td>
</tr>
</tbody>
</table>

All monthly log returns from the MSCI database on Datastream are calculated in US dollars and expressed in percentages. Where $\rho$ and $\rho^2$ are the first-order serial correlations of returns and squared returns. $LB_1$ and $LB^2_1$ are the Ljung-Box statistics for returns and squared returns with four lags,
respectively. The normal density is assumed for the Jarque-Bera statistics. The ADF unit root tests for a random walk. ** and *** denote statistical significant at 5% and 1% level, respectively.

### Table 2: Specification and Normality Test

<table>
<thead>
<tr>
<th>Market</th>
<th>Asym/Sym</th>
<th>$LB(4)$</th>
<th>$LB^2(4)$</th>
<th>Jarque-Bera Joint test</th>
<th>LR test</th>
<th>Wald test</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>Symmetry</td>
<td>1.825</td>
<td>2.941</td>
<td>3.921</td>
<td>25.108***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asymmetry</td>
<td>3.112</td>
<td>1.253</td>
<td>4.969*</td>
<td>22.008***</td>
<td>3.579*</td>
</tr>
<tr>
<td>Europe</td>
<td>Symmetry</td>
<td>5.113</td>
<td>1.025</td>
<td>1.435</td>
<td>215.168***</td>
<td>1.257</td>
</tr>
<tr>
<td></td>
<td>Asymmetry</td>
<td>4.323</td>
<td>0.599</td>
<td>1.723</td>
<td>191.272***</td>
<td>1.023</td>
</tr>
</tbody>
</table>

$L B (4)$ and $L B^2(4)$ are the Ljung-Box statistics for returns and squared returns with four lags, respectively. The normal density is assumed for the Jarque-Bera statistics. LR is the likelihood ratio tests for asymmetry. ** and *** denote statistical significant at 5% and 1% level, respectively.

### Constant Spillover Effects

To understand the existence of spillover effects, we first constrain all mean and volatility spillovers to be constant and then consider the time-varying case. In Table 3, we find that the world effect on mean, $\beta_i^{\text{world}}$, is positive and ranges from 1.402 (Hungary) to 0.844 (Russia), but the regional effect on mean, $\beta_i^{\text{reg}}$, is very small for most emerging European markets and even negative for Hungary (-0.026), Poland (-0.064), and Turkey (-0.183). For all emerging European returns, there are significant and positive world effects (at the 1% level), but no significant regional effects. Thus, we can conclude that emerging European markets are more integrated with the world than the region with respect to returns.

In emerging European markets, $\gamma_i^{\text{world}}$ and $\gamma_i^{\text{reg}}$ represent the dependences of local shock on the world and European regional shocks, with ranges from 1.942 (Turkey) to 0.479 (the Czech Republic) and from 1.613 (Russia) to 0.745 (Turkey), respectively. All the parameters for volatility spillover are positive. Both world effect and regional effect on volatility are positive for all emerging European markets. Moreover, there are significant volatility spillovers from the world to the European region and emerging European markets; all the return volatilities in emerging European markets, with the exception of Turkey, are significantly driven by innovations from the European region at the level of 5% or 10% (Russia).

In table 3, the parameter estimates present that $|\beta_i^{\text{world}}| > |\beta_i^{\text{reg}}|$ and $|\gamma_i^{\text{world}}| > |\gamma_i^{\text{reg}}|$ for most countries, which indicate that emerging European markets are more influenced by world than by regional factors with respect to returns and that the regional factor is more important in volatility spillover. The Wald statistics indicate that the world factor has significant explanatory power for the European region and all emerging European markets.

Our results are similar to Miyakoshi (2003) but contrary to Ng (2000). Both studies use the US and Japan equity markets as the proxies for the world and regional factors. Miyakoshi (2003) shows that only the influence of the United States is important for Asian market returns; there is no influence from Japan. However, the volatilities of Asian markets are influenced more by Japan than by the United States. Ng (2000) finds that the world shock of the United States is stronger than the regional one of Japan.

The larger return spillover from world may be caused by the huger international capital flows. For example, the boom in global economic growth brings high economic growth in emerging Europe.
Consequently, the intensity of world information spillover to emerging European markets will become stronger. In contrast, foreign investors make massive capital withdrawal from emerging Europe owing to slack economic growth during recession period. Then, equity returns decline in emerging European markets. On the other hand, regional effects seem to be larger than world effect on volatility. It may be inferred that intra-regional trade and real economic activities, such as direct investment in emerging European markets, enhance regional integration in volatility. Therefore, in the next section, this paper uses foreign capital flows and trade as two controlled variables and tests growth effect and exchange rate effect on mean and volatility spillover from the world and the European region.

### Table 3: Constant volatility spillover effects

<table>
<thead>
<tr>
<th>World</th>
<th>Volatility</th>
<th>Wald test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean spillover</td>
<td>Volatility spillover</td>
<td>World</td>
</tr>
<tr>
<td>$\beta_i^{\text{world}}$</td>
<td>$\beta_i^{\text{reg}}$</td>
<td>$\beta_i^{\text{world}}$</td>
</tr>
<tr>
<td>Europe</td>
<td>0.254</td>
<td>0.993***</td>
</tr>
<tr>
<td>Czech</td>
<td>1.316***</td>
<td>0.073</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.402***</td>
<td>-0.026</td>
</tr>
<tr>
<td>Poland</td>
<td>1.181***</td>
<td>-0.064</td>
</tr>
<tr>
<td>Russia</td>
<td>0.844***</td>
<td>0.094</td>
</tr>
<tr>
<td>Turkey</td>
<td>1.354***</td>
<td>-0.183</td>
</tr>
</tbody>
</table>

Note: ** and *** denote statistical significant at 5% and 1% level, respectively.

#### Time-Varying Spillover Effects

In this section, we examine the time-varying impact of world and regional factors by using the latent variables model. Some studies have found that correlations change over time and that the time-varying correlations are linked to economic activity. Consequently, we test whether the economic growth and exchange rate components are included in the spillover intensities by adding security transactions and trade as controlled variables. The parameter estimations for the economic determinants of mean spillover intensities are reported in Table 4.

For the European region, an increase in security transactions seems to strengthen the mean spillover effect from the world at a 10% level, albeit to a very small extent. The coefficient of the ratio of trade to GDP is negative but not significant. The currency depreciation remarkably mitigates the mean spillover effects from the world. It is probable that the European region becomes more segmented owing to hot money outflows when currency depreciates. In addition, the parameter estimations for both the dummies of economic growth components are positive and significant. Contrary to Ragunathan et al. (1999), our result indicates that the mean spillover effect from the world to the European region is stronger when the world and European regions are simultaneously in recession or when only the European region is in recession. Further, the Wald tests state that exchange rates and economic growth are both significantly related to time-varying world beta at the 5% and 1% levels for the European regional market, respectively.

In the Czech Republic, the world effect on mean is stronger when the total trade with the world decreases and currency depreciation occurs, while the regional effect on mean is greater when the trade within this region increases. The Wald tests show that the currency depreciation is a significant driver of world return integration in the Czech Republic. In Hungary, currency depreciation increases the world

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6 Ragunathan et al. (1999) study the correlations and integration of the Australian and US markets and provide the conclusion that the markets are segmented when the business cycles are in the contraction phase.
effect on mean at the level of 10%; however, the other instruments shown in this table have no significant impact on the return spillover for Hungary. In Poland, currency depreciation magnifies the world effect (at a 5% level) and the European region effect (at a 10% level) on returns. Furthermore, for Russia, the world effect on returns diminishes with the size of trade with the world; the European effect is smaller when currency depreciation occurs. Finally, the Wald tests suggest that the depreciation changes the European effect on Russia and Turkey.

In sum, different from the result in the regional market, the relationship between exchange rate and mean spillover intensities from the world is positive for the majority of emerging European markets, although the coefficients are not all significant. Thus, the importance of world effect for emerging European markets becomes more profound when the currencies depreciate. However, it is mixed for the relationship between exchange rate and European mean spillover intensity. Relative literature from Ng (2000) points out that exchange rate may influence the spillover effect from the United States and Japan to Asian emerging markets, yet the direction of the influence is not unification. An explanation is that exchange rates should affect the competitiveness of firms, and thus their market values. This has an impact on the expected cash flows of firms. Ma and Kao (1990) propose that currency appreciation has a negative effect on the stock market in an export-dominant economy, whereas currency appreciation promotes the stock market in an import-dominant economy. However, we cannot find clear evidence of the impact of economic growth components on the mean spillover intensities from the world and the European region.

Table 5 reports time-varying volatility spillover effects on the European regional market and emerging European markets. In the European regional market, the volatility spillover from the world decreases when the currency depreciates or when the European economy is in recession. However, we find that the world effect becomes stronger when the world and European regions are simultaneously in recession or when the size of trade with the world increases in the European region. The Wald tests indicate that exchange rate and economic growth may significantly influence the world effect.

In the Czech Republic, the result shows that the world effect on volatility is larger when security transactions decline or when the trade with the world increases. However, the European effect is weaker when the Czech economy is in recession (at a 10% level) and is stronger when currency depreciates, or when the European region and the Czech Republic are simultaneously in recession. Then, the Wald tests show that exchange rate can influence the world effect (at a 10% level), and both exchange rate (at a 5% level) and economic growth (at a 1% level) can change the European effect.

Table 5 shows that in Hungary, the world effect is weakened when the total trade with the world increases and when the world and Hungary are simultaneously in recession. Nevertheless, the European effect becomes more important when the trade increases, when Hungary is in recession, and when the European region and Hungary are simultaneously in a recessionary phase. The Wald tests show that exchange rate (at a 10% level) and economic growth (at a 1% level) are the important determinants for the shock spillover intensity from the world, and economic growth (at a 5% level) is important for the European effect.

The world effect on volatility of Poland diminishes when the world and Poland are simultaneously witnessing recession or when only the economy of Poland faces recession. However, the European effect on volatility of Poland decreases during currency depreciation and increases when the economy of Poland is in recession. The Wald tests indicate that economic growth is an important driver of world effect; furthermore, exchange rate and economic growth have a significant impact on the European effect in Poland.
For the Russian market, the world effect extends when the total trade with the world reduces or when currency depreciates. Additionally, less trade with the European region (at a 5% level) or currency depreciation (at a 10% level) degrades the European effect.

In Turkey, currency depreciation declines the European regional volatility spillover. The Wald test indicates that exchange rate effect is important for the European effect at a level of 5%.

Interestingly, Table 5 also shows that the absolutes of the coefficients of the latent variables on the European effect are larger than those on the world effect in most of the emerging European markets. That is, the variables of trade, exchange rate, and business cycle components exhibit a stronger impact on shock spillover intensities from the European region than on those from the world.

In sum, the size of trade appears to have a positive effect on the shock spillover intensities from the European region and a negative effect on the volatility spillover from the world to emerging European markets, except the Czech Republic, although the coefficients are not all significant. The possible reason is that developed European countries are the largest export markets for emerging European markets. As a result, increases in the trade with the European region leads to less diversified trade structure for emerging European markets. Chambet and Gibson (2008) find that countries with less diversified trade structure have more integrated stock markets.

Furthermore, in Table 5, the coefficients of business cycle components on world effect have a negative sign, indicating that when the world and emerging European markets are simultaneously in recession or when only emerging European markets are in recession, there is a lower degree of integration, except in Turkey, although the coefficients are not all significant. The result conforms to Ragunathan et al. (1999), who study the correlation and integration of the Australian and US markets by using single-factor methodology. On the other hand, our paper reveals that growth effect can predict the regional effect in the Czech Republic, Hungary, and Poland, and most signs are positive. In other words, the regional effect is stronger during recession. The Czech Republic, Hungary, and Poland joined the European Union on May 1, 2004. Thus, a possible explanation for the result may be that increased economic integration with the European region and the links connecting regional trade lead to more integration with European region for Czech, Hungary and Poland.

Table 6 displays the summary statistics of the Wald tests for the time-varying spillover effects. All emerging markets as well as the European regional market have significant spillover effects from the world market with respect to mean and volatility. The European region effect in the time-varying model is significant only with respect to volatility but not mean. These results are consistent with the constant spillover model. Moreover, in our study, full tests for the null hypothesis of no mean and volatility spillover effects from the European region are rejected at the significant level of 5% for all emerging European markets. Thus, the world and the European factors are both important for emerging European market integration.

### Table 4: Time-varying Mean Spillover Effects

<table>
<thead>
<tr>
<th></th>
<th>World</th>
<th>European Region</th>
<th>Wald test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S. T.</td>
<td>Trade</td>
<td>Ex 1</td>
</tr>
<tr>
<td>Europe</td>
<td>0.006*</td>
<td>-0.004</td>
<td>-0.014</td>
</tr>
<tr>
<td>Czech</td>
<td>-28.171</td>
<td>-36.408***</td>
<td>0.147***</td>
</tr>
<tr>
<td>Hungary</td>
<td>-43.769</td>
<td>3.412</td>
<td>0.097*</td>
</tr>
<tr>
<td>Poland</td>
<td>-742.575</td>
<td>1.026</td>
<td>0.063</td>
</tr>
<tr>
<td>Russia</td>
<td>0.120</td>
<td>-0.083**</td>
<td>0.121</td>
</tr>
</tbody>
</table>

The effects of currency depreciation can predict the volatility spillover intensities at the 5% level in four of five emerging European countries. Furthermore, the full test suggests that the exchange rate components have significant predictive power at the 10% level for all emerging European countries included in our research. Finally, the Wald tests presented in the last three columns of Table 6 show that shock spillover intensities are significantly related to the state of the business cycle in three emerging European countries at the 1% level; however, the return spillover intensity related to economic growth is found only in the Czech Republic at the 5% level. At the significant level of 1%, a full test reports that business cycle components can influence the spillover intensities for the Czech Republic, Hungary, and Poland.

CONCLUSIONS

This paper measures the mean and volatility spillover effects from the world and the region for five emerging European equity markets. Unlike previous research, we extend the Bekker et al. (2005) model estimated in three stages. This method is suitable for the analysis of emerging market integration.
Our results suggest that there are significant volatility spillover effects for emerging Europe from the world and the European developed region, but return spillover effects only from the world. The positive volatility spillover intensities from the European region seem to be stronger than those from the world. However, the mean spillover effects from the world are greater than those from the European region. Moreover, both mean and volatility spillovers from the world to the European developed region are significant.

This study also provides evidence of exchange rate effect on the degree of spillover for all emerging European markets and growth effect on the shock spillover intensities from the European region for the Czech Republic, Poland, and Hungary. The findings may reflect that economic integration can change financial integration in the three markets. Emerging markets of various geographical regions have different international trading partners and regulations as well as cultures and political environments. Economic activity in a small country could be geographically localized and stocks in large countries might move more independently than those in smaller countries.

Finally, for the European region, currency depreciation remarkably mitigates the mean and volatility spillover effects from the world. The returns spillover from the world to the European region increases when the business cycle is in recession. Additionally, we suggest that world and regional economic instability may also change the degree of the world effect on European regional volatility. Overall, our results are helpful for understanding the sources and behavior of volatilities in emerging European markets. The findings in this paper are also important for portfolio managers and international investors to price securities and to manage risk.

REFERENCES


