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International Stock Market Integration: Central and South Eastern Europe Compared

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Abstract

We examine the international stock market comovements between Western Europe vis-à-vis Central (the Czech Republic, Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) using multivariate GARCH models in 2006–2011. Comparing these two groups, we find that the degree of comovements is much higher for Central Europe. The correlation of South Eastern European stock markets with developed markets is essentially zero. The exemption to this regularity is Croatia with its stock market displaying a greater degree of integration towards Western Europe recently, but still below the levels typical for Central Europe. All stock markets fall strongly at the beginning of the global financial crisis and we do not find that the crisis altered the degree of stock market integration between this group of countries.

JEL-Classification: C22, C32, G15
Keywords: stock market comovements, Central and South Eastern Europe, GARCH

1 Introduction

The economies in Central and Eastern Europe witnessed major structural changes during the last two decades. Many countries, especially in Central Europe, carried out ambitious reforms soon after the fall of communism, successfully integrated in European structures and after the initial period of transition experienced solid growth. On the other hand, some countries, especially in South Eastern Europe, progressed more slowly in creating market-oriented economy and some important reforms have been undertaken only recently (Campos and Horvath, 2012).

In this paper, we want to compare the stock market integration of these two groups Central Europe and South Eastern Europe with the developed markets and examine, whether the degree of integration differs. While we know relatively a lot about the stock market behavior in Central Europe (Hanousek and Kocenda, 2011), a systematic examination of stock market comovements in South Eastern European countries is, to our knowledge, missing. We want to bridge this gap and examine, whether the degree of stock market comovements with developed markets differ from those in Central Europe. For this reason, we collect the daily data on stock market indices from the Central European countries (Czech Republic, Hungary, Poland) and several South Eastern European countries (Croatia, Macedonia and Serbia) in 2006–2011. As regards the South Eastern European countries, we specifically focus on countries that used to be a part of Yugoslavia and are not integrated in the European Union.[1]

Although the financial systems in Central European and South Eastern European countries are largely bank-based, the analysis of stock market developments can still provide useful insights. First, it may help policy makers understand the nature of cross-country shock transmission in a timely fashion since unlike many other economic series, stock market data are available at a high frequency. Similarly, it may be useful to investment managers for international portfolio diversification. Second, although the stock markets in these countries are relatively small in size, they still possess a predictive power for future economic activity and prices. Using the Czech data, Havranek et al. (2011) compare the forecasting accuracy of various financial variables such as credit growth, loan loss provisions, banking sector liquidity, the share of non-performing loans and stock market index and find that stock market index tends to provide more accurate forecasts for macroconomic environment that the remaining financial variables. Third, Baele (2004) puts forward that looking at stock market comovements is one way to assess the financial integration. Clearly, financial integration has a direct consequences for financial stability (see De Nicolo and Tieman, 2006 or Fecht et al., 2007).

Our results suggest that Central European stock markets are highly integrated with the developed markets. The conditional correlations between Central European and Western

[1] As concerns other former Yugoslavian countries with stock market, Bosnia and Herzegovina iss excluded, since the European Bank for Reconstruction and Development show that the degree of financial reforms is still rather low. Slovenia is excluded since it is fully integrated into European structures (EU member since 2004 and the euro area member since 2007).

European stock markets reach the value around 0.6, which is close to the correlation reported by literature for the US and Canadian stock markets (see, for example, Longin and Solnik, 1995, or Forbes and Rigobon, 2002). On the other hand, the degree of comovements between Serbian as well as Macedonian stock markets with developed markets is practically zero. The Croatian stock market evolves from nearly zero comovements at the beginning of our sample, to the values as high as the ones for Central Europe before the outset of global financial crisis and subsequently falls to lower, but still positive values during the crisis. The results for Croatia should not come as a surprise, as the stock market capitalization is greater in Croatia than in remaining South Eastern European stock markets, financial reforms progressed faster and EU entry negotiations are in progress.

The paper is organized as follows. Section 2 discusses the related literature. Section 3 describes the data. Section 4 briefly introduces the multivariate GARCH model. Section 5 presents the results. The concluding remarks are offered in section 6. Appendix with additional results follow.

2 Related Literature

This section briefly reviews the literature on stock market comovements that focuses on Central and South Eastern European countries. The literature typically employs either vector autoregression or vector error correction modelling to examine the short-term and long-term transmission, respectively. It also uses various GARCH models to assess the degree of stock market volatility transmissions. Most research relies on the stock market data on the Czech Republic, Hungary and Poland, e.g. on Central Europe. As we will see, stock markets in South Eastern Europe have been analyzed rather rarely.[2]

Cappiello et al. (2006) examines the degree of integration between the stock markets in several new EU members and the euro area. Investigating the comovements of the equity markets returns suggests an increasing degree of integration between the new EU members and the euro area in the process towards EU accession especially in the Czech Republic, Hungary and Poland.

Based on various cointergration tests, Gilmore et al. (2008) find increasing degree of integration of the Czech, Hungarian, and Polish equity markets with respect to the German and UK markets for the period from 1995 to 2005. Similarly to Cappiello et al. (2006), the stronger linkages of these stock markets are found to reflect the integration Central European countries into the EU.

There are several contributions examining the stock market interdependence between Central and Western European countries based on intraday data. In general, these studies find that the interdependence is – in contrast to studies based on cointegration – rather weak, when relying on ultra high frequency data.

Using intraday data from June 2003 to February 2004, Cerny and Koblas (2008) examine the degree of stock market integration and the speed of information transmission between Western and Central Europe. The results suggest fast transmission of shocks from Western to Central Europe, with the stock market in the Czech Republic displaying the fastest reaction.

Egert and Kocenda (2007) analyze the interconnections between the Western European stock markets and the stock markets in the Czech Republic, Hungary and Poland. Using Granger causality tests based on 5-minute tick intraday data from the mid 2003 to the early 2005, they do not find any robust cointegration relationship between Central European and Western European stock markets. Kocenda and Egert (2011) also employ ultra high frequency data for three developed (France, Germany, and the United Kingdom) and three emerging (the Czech Republic, Hungary and Poland) European stock markets. They find that the correlation between these developed and emerging markets is rather weak during the trading day. This suggests that the shock transmission among these markets, if there is

[2] Obviously, there is a large literature examining stock market comovements among developed countries. See, for example, Bekaert and Harvey (1995), Longin and Solnik (1995), Forbes and Rigobon (2002), Johnson and Soenen (2003), Benelli and Ganguly (2007), among many others.

any, materializes more at daily or even weekly frequency rather than at tick-by-tick data frequency. The question of the speed of shock transmission is tackled by Babestkii et al. (2007).

Babetskii et al. (2007) take a different perspective to assess stock market integration. They calculate the rolling ß–convergence (to assess the convergence of stock market returns) and σ–convergence (to assess the convergence of stock market volatility) for evaluating the interdependence of Central European and Western European stock markets. Doing so, their findings support the existence of ß–convergence and, to a certain extent, σ–convergence, too. In terms of the speed of shock transmission, they find that shocks are fully absorbed typically in less than half of a week. This also explains, why studies employing the intraday data find little stock market interdependence, while studies based on cointegration techniques with daily or weekly data – i.e. focusing more on establishing the long-term relationship – typically reach the opposite conclusions.

Kasch-Haroutounian and Price (2001) examine the volatility transmission among stock markets in Central Europe (the Czech Republic, Hungary and Slovakia) using bivariate BEKK model. The results indicate that the returns in all these stock markets are positively correlated. Interestingly, the results suggest that the volatility in the Polish stock market is affected by the volatility originating in the Hungarian stock market, but not *vice versa*.

Samitas et al (2011) investigates the stock market integration in a number of Balkan countries and compares it to the integration among several developed markets (US, UK, Germany) in 2000–2006. Using several cointegration tests, the results support the existence of long-term relationships among Balkan stock markets and developed markets. On the other hand, Vizek and Dadic (2006) examines the integration between German equity markets, selected CEE equity markets and the Croatian equity market. Interestingly, no evidence of long-term relationship between the Croatian and German stock markets is found. Similar conclusion is drawn for the Central European stock marktes with respect to the German stock markets.

All in all, previous research gives somewhat mixed results. Some papers fail to find even the long-term relationship between Central European and Western European stock markets. Nevertheless, it seems that majority of papers suggest that there are some interconnections among these stock markets in the short-term, but the speed of volatility transmission is not very fast.

3 Data

The daily closing levels of the indices PX (Prague Stock Exchange), WIG (Warsaw Stock Exchange), BUX (Budapest Stock Exchange), MBI10 (Macedonian Stock Exchange), CROBEX (Zagreb Stock Exchange) and BELEX15 (Belgrade Stock Exchange) are used. Therefore, three Central European and three South Eastern European stock markets are chosen. STOXX Europe 600 index is chosen as some sort of benchmark for European stock markets movements in Europe. The STOXX Europe 600 represents large, medium and small capitalization companies across 18 countries of the European region: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.[3] Our daily data starts in January 2006 and ends in mid-May 2011 (see Figure 1 for the plot of all time series). The number of observations is between 1325–1370 depending on stock market; it differs somewhat due to different national holidays, see Table in the Appendix for descriptive statistics. The liquidity, turnover as well as market capitalization in many emerging stock markets – especially in South Eastern Europe is not high. To reduce these considerations, we focus on data from 2006 onwards and do not use previous data. The source of data is Reuters Wealth Manager.

Some basic information about the Central European and South Eastern European stock markets is available in Table 1. The stock markets were set up after the fall of communism in these countries, although it is interesting to mention that stock markets in most of these countries existed already decades before. For example, Belgrade Stock Exchange was founded already in 1894 and functioned until the beginning of World War II. Market capitalization is higher in Central Europe, although the market capitalization of Croatian stock market is not too far below the Hungarian stock market.

For our econometric analysis we study the daily returns, which are represented by continuously compounded rate specified for country *i* at time *t* as follows:

$$r_{i,t} = (ln(p_{i,t}) - ln(p_{i,t-1})) \times 100 \tag{1}$$

It is noteworthy that unit root (augmented Dickey-Fuller) and stationarity (KPSS) tests were used to assess the degree of integration of all series (the results from these tests are available upon request). We find that the original series in levels are not stationary. To the contrary, the daily returns, $r_{i,t}$, are found stationary.

[3] Since Iceland and Norway companies enter into the calculation of this index, we label this group as Western Europe (and not, for example, the old EU members).

Figure 1: Stock Market Developments in 2006–2011 – Levels and Returns

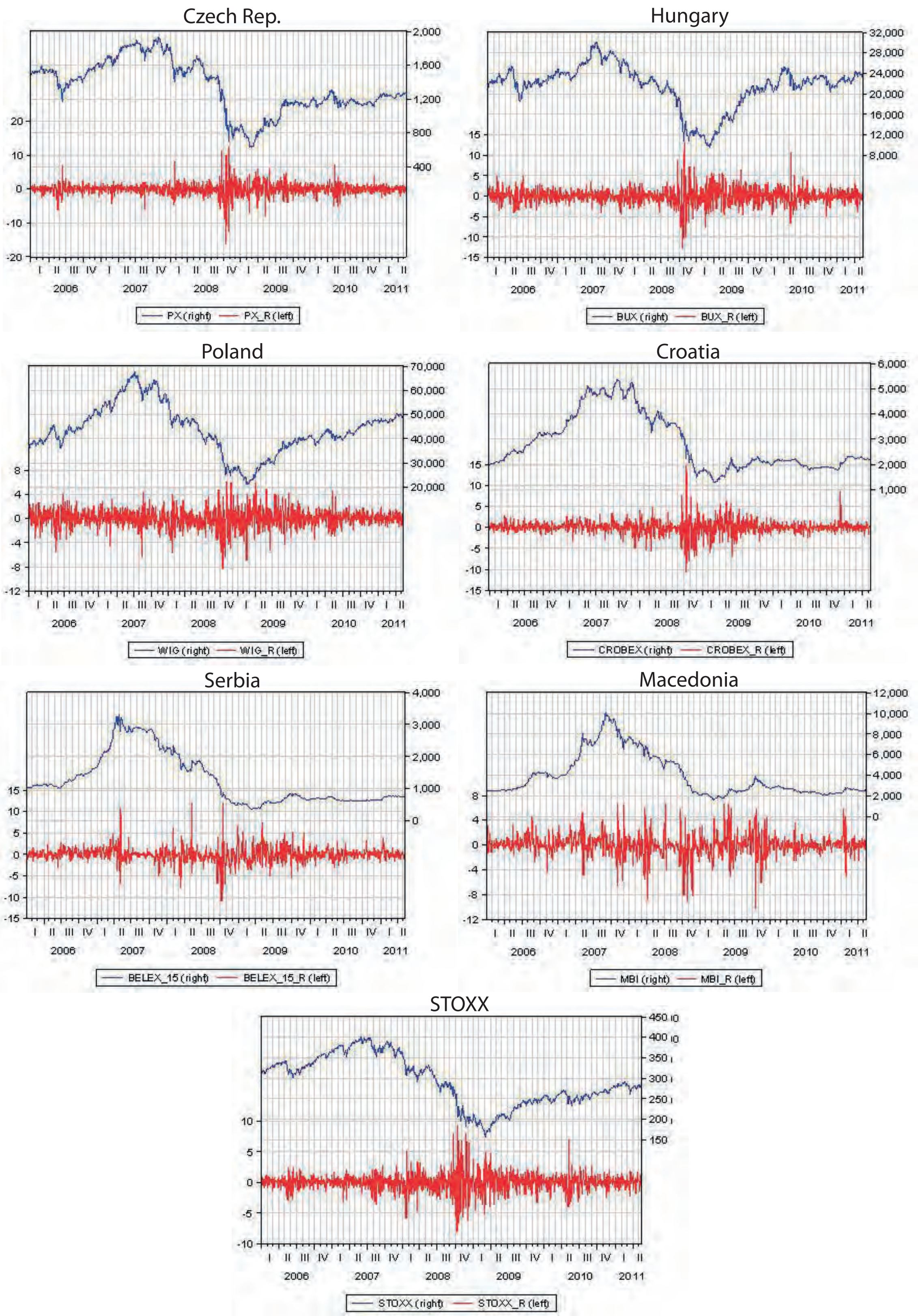


Table 1: Stock Markets in Central and South Eastern Europe – Key Indicators

	Czech Rep.	Hungary	Poland
Year established	1993	1990	1991
Market Capitalization	31922	20624	142272
Number of Companies	25	46	486
Index	PX	BUX	WIG
	Serbia	Macedonia	Croatia
Year established	1992	1995	1991
Market Capitalization	7268	1985	18971
Number of Companies	1779	86	271
Index	BELEX	MBI	CROBEX

Source: Federation of European Securities Exchanges Statistics December 2010, market capitalization in EUR mil.

The plot of all stock markets – both levels as well as returns – is available in Figure 1. All stock markets were hit substantially by the global financial crisis and the values of stock market indices often fall below the level at the beginning of our sample. There is a clear volatility clustering, with the stock markets being the most volatile in the second half of 2008 after the fall of Lehman Brothers.

4 Multivariate GARCH model

We use multivariate GARCH model to assess the comovements among stock markets. For the ease of exposition, we present the model for $N = 2$, i.e. two stock markets. A survey of multivariate GARCH models is available in Bauwens et al. (2006).

Consider 2 x 1 dimensional vector of daily returns $\boldsymbol{r_t}$. We assume that the mean equation is specified as:

$$\boldsymbol{r_t} = \boldsymbol{\mu} + \boldsymbol{u_t} \tag{2}$$

where $\boldsymbol{\mu}$ is conditional mean vector, i.e. $\mathbb{E}(\boldsymbol{r_t}|\Omega_{t-1}) = \boldsymbol{\mu}$ and

$$\boldsymbol{u_t} = {H_t}^{1/2}\boldsymbol{v_t} \tag{3}$$

where ${H_t}^{1/2}$ is a 2 x 2 conditional variance matrix, i.e. $var(\boldsymbol{r_t}|\Omega_{t-1}) = H_t$, and $\boldsymbol{v_t}$ is a 2 x 1 random vector with the following properties:

$$\mathbb{E}(\boldsymbol{v_t}) = 0 \tag{4}$$

$$var(\boldsymbol{v_t}) = I_N \tag{5}$$

where I_N is a 2 x 2 identity matrix.

The direct generalizations of the variance formula in univariate GARCH model for the multivariate variance-covariance matrix H_t include primarily VECH and BEKK models. The VECH model was introduced by Bollerslev, Engle, and Wooldridge (1988). The specification of the VECH model is as follows:

$$VECH(H_t) = W + A.VECH(\boldsymbol{u_{t-1}}\boldsymbol{u'_{t-1}}) + B.VECH(H_{t-1}), \quad \boldsymbol{u_t}|\Omega_{t-1} \sim N(0, H_t) \tag{6}$$

where $\boldsymbol{u_t}$ is a 2 x 1 disturbance vector, W is a 3 x 1 parameter vector, A and B are 3 x 3 parameter matrices and VECH(ů) stands for the operator that stacks the upper triangular portion of a symmetrical matrix.

The VECH operator transforms a 2 x 2 matrix into a 3 x 1 vector in the following way:

$$VECH(H_t) = VECH \begin{pmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{pmatrix} = \begin{pmatrix} h_{11,t} \\ h_{22,t} \\ h_{12,t} \end{pmatrix} \tag{7}$$

and analogously for other elements. We can now rewrite it as follows:

$$\begin{pmatrix} h_{11,t} \\ h_{22,t} \\ h_{12,t} \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} u_{1,t}^2 \\ u_{2,t}^2 \\ u_{1,t}u_{2,t} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \begin{pmatrix} h_{11,t-1} \\ h_{22,t-1} \\ h_{12,t-1} \end{pmatrix} \quad (8)$$

Thus, we have the conditional variance equations for both returns series ($h_{11,t}$ and $h_{22,t}$) and conditional covariance equation between the series ($h_{12,t}$). The drawback of this model is that we have to estimate 21 parameters (3 in matrix W and 9 in each of matrices A and B), which is computationally demanding and risky in the sense that the local instead of global maximum of likelihood function is more likely to be encountered. To account for this problem, several extensions of the VECH models were proposed, such as constant correlation or diagonal multivariate GARCH.

In addition, the VECH model cannot ensure that the covariance matrix H_t is positive definite, which is necessary because variance cannot be less than zero. The BEKK model, as introduced by Engle and Kroner (1995), resolves this drawback. In this model the matrix Ht is defined as:

$$H_t = W'W + A'\boldsymbol{u_{t-1}u'_{t-1}}A + B'H_{t-1}B \quad (9)$$

where A and B are 2 x 2 parameter matrices and W is a 2 x 2 upper triangular parameter matrix. It is easy to show that after multiplication we can express the conditional variances and covariance of H_t as:

$$\begin{aligned} h_{11,t} &= w_{11}^2 + (a_{11}u_{1,t-1})^2 + b_{11}^2 h_{11,t-1} + 2b_{11}b_{21}h_{12,t-1} + b_{21}^2 h_{22,t-1}, \\ h_{12,t} &= w_{11}w_{12} + a_{11}a_{12}u_{1,t-1}^2 + u_{1,t-1}u_{2,t-1}(a_{12}a_{21} + a_{11}a_{22}) + a_{21}a_{22}u_{2,t-1}^2 + \\ &\quad b_{11}b_{12}h_{11,t-1} + (b_{11}b_{22} + b_{12}b_{21})h_{12,t-1} + b_{21}b_{22}h_{22,t-1}, \\ h_{22,t} &= (w_{12}^2 + w_{22}^2) + (a_{12}u_{1,t-1} + a_{22}u_{2,t-1})^2 + b_{12}^2 h_{11,t-1} + 2b_{12}b_{22}h_{12,t-1} + \\ &\quad b_{22}^2 h_{22,t-1} \end{aligned} \quad (10)$$

The right hand sides of the three equations above contain mainly quadratic terms and the matrix H_t is indeed positive definite even "under very weak conditions," Engle and Kroner (1995). Moreover, the number of parameters to be estimated reduces to eleven, as compared to twenty one in the VECH model.

Note also, that the conditional variances ($h_{11,t}$ and $h_{22,t}$) and the conditional covariance ($h_{12,t}$) depend on lagged values of conditional variances ($h_{11,t-1}$ and $h_{22,t-1}$) and the conditional covariance between the two series ($h_{12,t-1}$) as well as on lagged values of squared disturbances of both series and the cross–products of the disturbances. This feature distinguishes the BEKK–GARCH model from the univariate GARCH model.

Maximum likelihood method is used to estimate the parameters. Assuming the conditional normality, the log–likelihood function has the following form:

$$L(\theta) = -\frac{TN}{2} log(2\pi) - \frac{1}{2}\sum_{t=1}^{T} log(|H_t| + \boldsymbol{u_t}' {H_t}^{-1}\boldsymbol{u_t}) \tag{11}$$

where θ represents the set of all parameters to be estimated, N is the number of dependent variables (in our case $N = 2$) and T is the number of observations.

Using multivariate GARCH we can model time–varying variances and covariances between stock market returns. We estimate the magnitude of comovements by computing dynamic conditional correlations, which are defined in time t as:

$$\rho_{12,t} = \frac{h_{12,t}}{\sqrt{h_{11,t}h_{22,t}}} \tag{12}$$

5 Results

This section presents our results on measuring the comovements among stock markets. More specifically, we use the BEKK-GARCH model to receive the time-varying conditional correlations among the stock markets, e.g. $\rho_{12,t}$.

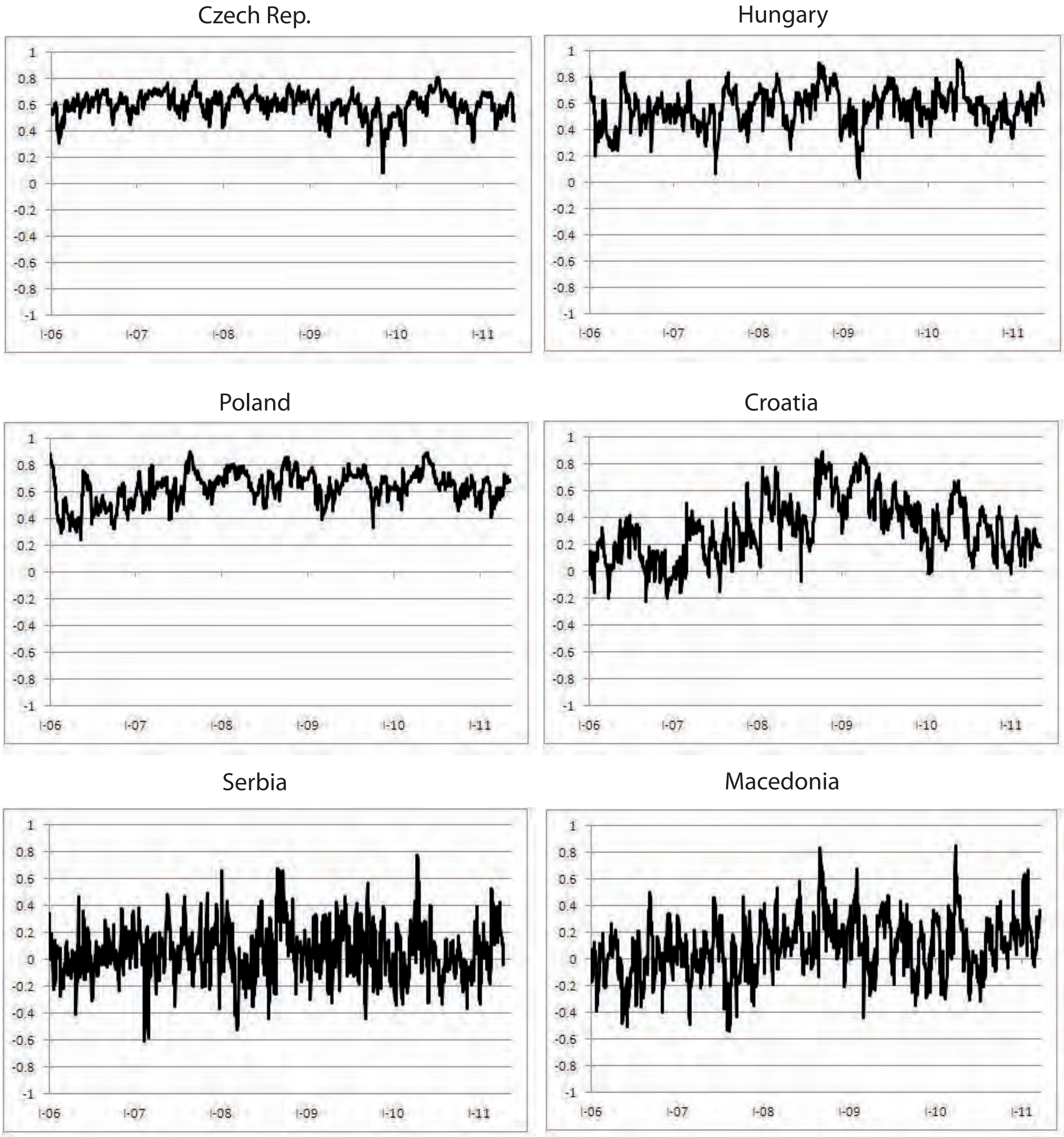
Figure 2 reports the conditional correlations for all Central and South Eastern European stock markets vis-a-vis STOXX 600. The results indicate that Central European stock markets comove strongly with Western European stock markets. The value of conditional correlation fluctuates somewhat, but typically it is around 0.6. This complies with the previous findings of Hanousek and Kocenda (2011), who document strong linkages between Central European and old EU members stock markets.

Interestingly, the conditional correlation decreases somewhat in the Czech Republic and Hungary in about mid-2009. However, in general, global financial crisis does not change the degree of stock market integration between Central and Western Europe. This is also apparent when looking at the stock market series in Figure 1 (in the Data section). All stock markets tend to grow before the outset of global financial crisis, then fall sharply in 2008 and recover, to a certain extent, afterwards.

On the other hand, the volatility between Serbian and Macedonian stock markets and Western European stock markets is not correlated. In other words, these stock markets are unlikely to be integrated. Interestingly, the Croatian stock market evolves from nearly zero comovements at the beginning of our sample, to the values as high as the ones for Central Europe before the outset of global financial crisis and subsequently falls to lower, but still positive values during the crisis. The results for Croatia are likely to reflect three main factors: 1) greater stock market capitalization in Croatia than in remaining South Eastern European stock markets, 2) financial reforms progressing faster in Croatia than in other countries in the region with financial services legislation largely aligned with the EU's *acquis communautaire* by 2009 and 3) the EU entry negotiations in progress. The results for Croatia are broadly in line with Cappiello et al. (2006) and Gilmore et al. (2008), who report the increasing integration of the Central European stock markets before the EU entry, but not afterwards (see also Babetskii et al., 2007).

All in all, the results suggest that the stock market integration between Central Europe and Western Europe is high with the values typical for any most major stock markets in developed countries. South Eastern European stock markets exhibit much lower degree of integration, but also show more heterogeneity. While the volatility of Croatian stock market is positively correlated with the volatility of Western European stock markets, the remaining stock markets – Serbia and Macedonia – tend to display no common pattern.

Figure 2: Assessing the Degree of Stock Market Integration



Notes: The figures present the conditional correlations from the estimation of multivariate GARCH model between the returns of STOXX index (to represent Western Europe) and the respective Central or South Eastern European stock market returns.

6 Conclusion

In this paper, we examine the stock market comovements between Western Europe vis-à-vis Central (the Czech Republic, Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) using the daily data in 2006–2011. For this reason, we estimate bivariate BEKK-GARCH models to recieve the conditional correlation in order to shed light on stock market integration in this set of countries.

Our motivation for this exercise is to assess whether stock markets in Central Europe, e.g. in countries sufficiently integrated into European structures, are indeed more closely linked with stock markets in the Western Europe. Next, as the conditional correlations are available on a daily basis, we may also assess whether the stock market integration changes over time. More specifically, we assess the hypothesis whether some countries that intensified their integration process towards the EU are more likely to exhibit increased stock market integration. In addition, our motivation is also to evaluate whether global financial crisis changed the nature of shock transmission between these countries. Doing so, we not only update previous research by including the current global financial crisis period, but we also evaluate the stock market integration of Western Europe vis-à-vis several South Eastern European countries, i.e. a topic about which we have very limited empirical evidence.

The results show that the degree of stock market integration of Central Europe vis-à-vis Western Europe is much higher that integration of South Eastern Europe vis-à-vis Western Europe. As concerns the Central Europe, the corresponding conditional correlation is around 0.6. This is a sizeble correlation especially in the light of previous studies examining the correlation among developed countries with a high degree of economic integration. For example, Longin and Solnik (1995) report the value of 0.7 for the conditional correlation of US and Canadian stock markets.

On the other hand, the conditional correlation between South Eastern European vis-à-vis Western European stock market is much lower. In case of Serbia and Macedonia, the correlation is, on average, zero, for the full sample. Croatia displays zero correlation at the beginning of our sample, the correlation increases to the values as high as the ones for Central Europe before the outset of global financial crisis and subsequently falls to lower, but still positive values. The evolution of conditional correlation of Croatia is in some sense unique, as the corresponding correlations do not exhibit any apparent trend and remain largely the same for all countries. The increasing correlation for Croatia is likely to be associated with the growing economic integration towards the EU coupled with the intensified negotiation process especially in 2007–2010, when Croatia aligned most of the negotiation chapters including those related to financial sector in line with EU's *acquis communautaire*.

In terms of future research, we believe it would be worthwhile to examine other South Eastern European countries as well as to broaden the scope in the direction of covering a wider array of various financial segments in order to evaluate financial integration of these countries with the EU in a fuller manner.

References

[1] Babetskii, I., Komarek, L. and Z. Komarkova, 2007. Financial Integration of Stock Markets among New EU Member States and the Euro Area. *Czech Journal of Economics and Finance*, 57(7–8), 341–362.

[2] Baele, L., 2004. Measuring European Financial Integration. *Oxford Review of Economic Policy*, 20(4), 509–530.

[3] Bauwens, L., Laurent, S. & Rombouts, J.V.K., 2006. Multivariate GARCH models: A Survey. *Journal of Applied Econometrics*, 21(1), 79–109.

[4] Bekaert, G. and C.R. Harvey, 1995. Time-Varying World Market Integration. *Journal of Finance*, 50(2), 403–444.

[5] Bollerslev, T., Engle, R. F. and J. M. Wooldridge, 1988. A Capital Asset Pricing Model with Time-Varying Covariances. *Journal of Political Economy*, 96(1), 116–131.

[6] Benelli, R. and S. Ganguly, 2007. Financial Linkages Between the U.S. and Latin America: Evidence from Daily Data. IMF Working Papers 07/262, International Monetary Fund.

[7] Campos, N. and R. Horvath, 2012. Reform Redux: Measurement, Determinants and Reversals, *European Journal of Political Economy*, 28(2), 227–237.

[8] Cappiello, L. Gérard, B., Kadareja, A. and S. Manganelli., 2006. Financial Integration of New EU Member States. European Central Bank working paper no. 683.

[9] Cerny, A., and M. Koblas 2008. Stock Market Integration and the Speed of Information Transmission. *Czech Journal of Economics and Finance*, 58(1–2), 2–20.

[10] De Nicolo, G. and A.F. Tieman, 2006. Economic Integration and Financial Stability: A European Perspective, IMF Working Papers 06/296.

[11] Egert, B. and Kocenda, E., 2007. Interdependence between Eastern and Western European stock markets: Evidence from intraday data. *Economic Systems*, 31(2), 184–203.

[12] Engle, R.F. and Kroner, K.F., 1995. Multivariate Simultaneous Generalized ARCH. *Econometric Theory*, 11(1), pp.122–150.

[13] Fecht, F., Gruner, H.P. and P. Hartmann, 2008. Financial Integration, Specialization, and Systemic Risk, Deutsche Bundesbank Diskussionspapier Serie 1, 23/08.

[14] Forbes, K. J. and R. Rigobon, 2002. No Contagion, Only Interdependence: Measuring Stock Market Comovements. *Journal of Finance*, 57(5): 2223–61.

[15] Gilmore, C., B. Lucey and G. McManus 2008. The Dynamics of Central European Equity Market Integration. *Quarterly Review of Economics and Finance*, 48 (3), 605–622.

[16] Hanousek, J. and E. Kočenda, 2011. Foreign News and Spillovers in Emerging European Stock Markets. *Review of International Economics*, 19(1), 170–188.

[17] Havranek, T., Horvath, T. and J. Mateju, 2011. Monetary Transmission and the Financial Sector in the Czech Republic, *Economic Change and Restructuring*, forthcoming.

[18] Kasch-Haroutounian, M. & Price, S., 2001. Volatility in the Transition Markets of Central Europe. *Applied Financial Economics*, 11(1), 93–105.

[19] Kocenda, E. and B. Egert, 2011. Time-Varying Synchronization of European Stock Markets. *Empirical Economics*, 40(2), 393–407.

[20] Longin, F. and B. Solnik, 1995. Is the correlation in international equity returns constant: 1960–1990?. *Journal of International Money and Finance*, 14(1), 3–26.

[21] Johnson, R. and L. Soenen, 2003. Economic integration and stock market comovements in the Americas. *Journal of Multinational Financial Management*, 13(1), 85–100.

[22] Samitas, A. and D. Kenourgios, 2011. Equity Market Integration in Emerging Balkan Markets. *Research in International Business and Finance*, 25, 296–307.

[23] Vizek, M. and T. Dadic, 2006, Integration of Croatian, CEE and EU Equity Markets: Cointegration Approach, *Ekonomski pregled*, 57 (9–10), 631–646.

Appendix

Table 2: Descriptive Statistics – Stock Market Returns

	STOXX	PX	BUX	WIG
Mean	–0.007	–0.012	0.007	0.022
Median	0.074	0.046	0.036	0.052
Maximum	9.41	12.36	13.177	6.083
Minimum	–7.92	–16.18	–12.64	–8.288
Std. Dev.	1.428	1.836	1.931	1.499
Skewness	–0.052	–0.497	–0.017	–0.356
Kurtosis	9.586	15.366	9.076	5.647
Jarque-Bera	2476.9	8644.8	2069.2	421.6
P-value	0	0	0	0
Observations	1370	1348	1345	1346
	CROBEX	BELEX-15	MBI	
Mean	0.008	–0.025	0.009	
Median	0.066	–0.028	0	
Maximum	14.77	12.15	6.661	
Minimum	–10.76	–10.86	–10.28	
Std. Dev.	1.605	1.677	1.652	
Skewness	–0.008	0.168	–0.404	
Kurtosis	14.17	12.54	8.614	
Jarque-Bera	6953.3	5118.1	1776.3	
P-value	0	0	0	
Observations	1337	1346	1325	

Notes: P-value for Jarque-Bera test for normality reported.