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What determines stock market behavior in Russia and other emerging countries?

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Contents

Iikka Korhonen and Anatoly Peresetsky

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Abstract

We empirically test the dependence of the Russian stock market on the world stock market and world oil prices in the period 1997:10–2012:02. We also consider three Eastern European stock markets (Poland, the Czech Republic, and Hungary), as well as two markets outside Europe (Turkey and South Africa). We apply a rolling regression to identify periods when oil prices or stock indices in the US and Japan were important. Surprisingly, oil prices are not significant for the Russian stock market after 2006.

A TGARCH-BEKK model is employed to assess the degree of correlation between markets, taking into account the global market stochastic trend. We find that correlation between markets increased between 2000 and 2012. Growth was especially high in Eastern European markets during 2004–2006, which is likely connected with the EU accession of these countries in 2004.

Key words: Russian stock market, oil, financial market integration, stock market returns, news, emerging markets, transition economies.
JEL: G10, G14, G15, C5.

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1 Introduction

Business writers routinely link changes in prices and performance of the US stock market to moves on equity markets in Russia and other emerging market countries. While intuitively appealing, this popular assertion has apparently evaded most empirical scrutiny. This paper aims at assessing the degree of dependence of the equity market returns in select emerging markets to returns in the US market.[1] We also explore the impacts of the Japanese stock market (the world's second largest stock market) and oil prices on emerging market equity returns.

Our empirical estimations start with a few questions. Why might US stock market returns have an explanatory power for emerging markets stock returns? Do investors in emerging markets make their decisions solely on the basis of observing previous-day US stock market returns or movement of oil prices in the US, or do they monitor global market movements over the past 24 hours and the US stock market is important only because it is a big part of the global market? If the latter is the case, are the returns in markets (i.e. Japan) that absorb news after the US market closing and have closing times closer to the emerging market better predictors of emerging market returns?

Intensification of economic and trade relations between countries could increase correlation between stock markets, but increasing correlation of equity markets could also reflect greater integration of market participants. As more investors seek portfolio diversification opportunities and operate simultaneously in different markets, all news becomes "international" or "global" and affects all markets to some degree.

There are many papers on the correlations of market returns, but few focus on Russian stock market returns in particular or integration of the Russian stock market into the global financial market. There are also only a handful of papers studying the influence of political shocks on Russian stock market returns.

Rockinger and Urga (2000) investigate the weak-form efficiency for markets in transition economies (including Russia), and, indeed, find evidence of market efficiency. Peresetsky and Ivanter (2000) look at integration of the Russian financial markets with international financial market. Analyzing daily market data for the period 1996:05–1997:10, they conclude that integration of the Russian market and international financial markets

[1] We assume causality runs from the US market, by far the largest equity market in the world, to emerging markets.

increased during that period. They further interpret the weakening of integration as the August 1998 crisis draws near as evidence of global movement of the international financial market. Noting the correlation of daily market returns among financial markets in Russia, the US, Japan, and Europe, they add that the lag between different market closing times should be taken into account.

Jalolov and Miyakoshi (2005) employ an EGARCH model using monthly data for the period 1995:05–2003:03. They find the German market is a better predictor of Russian stock market monthly returns than the US market due to the Germany's closer relations with Russia in trade and investment. They find no significant influence of oil and gas prices on Russian stock returns, and point out that the one-step prediction with the EGARCH model is worse than a prediction of the random walk model in terms of root mean squared error.

Hayo and Kutan (2005) study Russian stock market daily returns using an asymmetric GARCH model with Student distribution of errors. As lagged values of Russian stock index return, S&P return, and oil index return are all significant predictors of the Russian stock index return,[2] the hypothesis of an efficient market is rejected. They also analyze the direct influence of news on returns and volatility of the Russian stock index. Since the Russian economy depends heavily on oil and gas, they treat energy news as economic news and news on the Chechen war as political news. They find that all news fails to be significant both in explaining returns and for volatility of returns. Only S&P shocks are found to be significant in the TGARCH variance equation. Negative S&P shocks increase volatility of the Russian stock index and positive S&P shocks decrease it. When the square of the lagged S&P return is included into the variance equation, they see a significant positive effect that indicates a "direct" volatility link between the two markets.

Anatolyev (2008) analyzes weekly stock market returns for the two periods: 1995:01–2005:01 and 1999:10–2005:01 (i.e. the post-crisis period only). In addition to decreasing influence of oil prices during the last years of the second period and increasing influence of US stock market indices, he finds significant variation in explanatory power of different models over sub-periods. Integration of the Russian stock market with European market is shown to be higher than with the US or Asian markets.

[2] They find that only 1-day lagged returns are significant. This is in line with the analysis of Eun and Shim (1998) on relations between stock index returns of industrial countries.

Fedorova (2011) focuses on the contagion effects in the Eastern European stock markets and possible changes in their interconnections after EU accession in 2004. She investigates the relationship among the stock market sectors of Poland, Hungary and the Czech Republic during 1998−2009 using weekly returns and a GARCH-BEKK model. She finds evidence of direct linkages between various stock markets with respect to returns and volatilities with increased equity-shock transmission between markets after EU accession in 2004.

Given the nonsynchronous nature of trading, Baumöhl and Výrost (2010) demonstrate the importance of correctly matching daily observations on stock market indices. They identify bidirectional Granger causality between European, Asian and US indices in their modified approach, and conclude that integration between international stock markets has strengthened.

Ji and Fan (2012) use daily returns to study the relationship between oil and commodity markets in the US during 2006–2010. They find that crude oil as a strategic resource plays an important role in commodity markets. Regardless of whether the commodity market is in a boom (7/2006–7/2008) or a downturn (8/2008–6/2010), the volatility of crude oil prices always affects other commodity prices, and volatility spillover from the crude oil market to other commodity markets is significant. Moreover, they observe the relationship between crude oil and other commodity markets has been enhanced since the recent global financial crisis.

Grigoryev, Jaffry, and Marchenko (2012a,b) note the importance of taking daily data non-synchronism into account when implementing a Granger causality test.

Our paper contributes to the literature in three ways. First, we analyze Russian stock index daily returns for the period of 1997:10–2012:02, which includes the relatively stable period of 2000–2007. Second, we allow model coefficients to evolve over that period estimating models in rolling windows. From this, we can draw conclusions on trends of dependence of Russian stock market of external shocks. Third, we consider stock market return correlations after global market information is taken into account. Here, we find that correlation increases during our data sample. We are observing globalization of markets and the growing importance of global news relative to local news.

2 Data and models

We use daily market indices and oil prices for the period of 1999:06–2012:02 from Bloomberg and Datastream. We take RUB-denominated MICEX index to represent the Russian stock index.[3] At the time, the MICEX stock exchange was Russia's leading stock exchange.[4] It accounted for over 80 % of the the Russian on-exchange share market and was the largest stock exchange in the CIS, or Eastern and Central Europe. Following (Fedorova, 2011), we take the main exchanges in Poland (Warsaw, POL), Hungary (Budapest, BUX), and the Czech Republic (Prague, PX) as representatives of Eastern European countries, along with the indices of Turkey (Istanbul, XU100) and the Republic of South Africa, (Johannesburg, TOP40) as representatives of non-European emerging markets.

For the global market we use US index S&P500, Japanese index NIKKEI 225, and oil price WTI (WTI Spot Cushing, CRUDOIL). The superior explanatory power of these indicators over other indices is discussed in Peresetsky (2011).

Since the trading session in New York opens later than trading in Moscow, only the previous day's S&P can be used in regression explaining stock market returns in Moscow. Even the main trading sessions in Europe open two or three hours later than in Moscow, so again only lagged European index returns can be used in regression. Since the US market's closing is closer to the next day's opening in Moscow, it is not surprising that the US index outperforms the European index in the explanation of the Russian stock index. The trading session in Japan is already closed before the Moscow trading session opens. For this reason, the same day NIKKEI return, which includes additional information on the global financial market arriving after closing of the previous day's US trading, can be used in the regression. Since closing time of markets in Eastern Europe, Turkey, and SAR are close in time to each other, we use same set of explanatory variables for each index.

Our main equation for estimation is

$$R\_EM_t = \beta_0 + \beta_1 R\_MICEX_{t-1} + \beta_2 R\_SNP_{t-1} + \beta_3 R\_WTI_{t-1} + \beta_4 R\_NIKKEI_t + \varepsilon_t, \quad (1)$$

[3] We also performed our main estimations with a USD-based index and the results were virtually identical. Details are available from the authors upon request.
[4] The MICEX merged with the Russian Trading System (RTS) in 2012 to form the Moscow Stock Exchange.

where the prefix $R\_$ denotes log-return, $R\_INDEX_t = \ln(INDEX_t / INDEX_{t-1})$, $MICEX$, SNP, $NIKKEI$, and WTI denote MICEX, S&P500, NIKKEI 225 stock indices and WTI oil price, respectively. For EM (emerging markets), we use the MICEX, POL, PX, BUX, XU100, TOP40 indices.

Weekends and national holidays in the US, Japan and Russia are deleted from the data, giving a total of 3,353 observations for the period 1997:10–2012:02. As noted in Peresetsky (2011), values of the coefficients and their significance at the 5 % significance level are almost independent of the specification of the error term ε_t (homoscedastic, OLS, or various TGARCH specifications). Thus, we use standard OLS specification for the rolling regressions in section 3. Descriptive statistics of our data are presented in Table 1.

Correlations between daily returns are presented in the Table 2. For S&P and WTI lagged returns were used for correlations. Correlations between emerging market returns (right bottom corner) are larger than others as they have approximately the same closing times (see Table 3) and get roughly the same sets of news.

Table 1 Descriptive statistics of daily returns, 1997:10–2012:02

	R_SNP	*R_WTI*	*R_NIKKEI*	*R_MICEX*	*R_POL*	*R_PX*	*R_BUX*	*R_TA25*	*R_TOP40*
Mean	0.01%	0.05%	–0.01%	0.08%	0.03%	0.04%	0.02%	0.04%	0.03%
Median	0.07%	0.14%	–0.01%	0.19%	0.08%	0.07%	0.12%	0.00%	0.05%
Maximum	9.77%	21.28%	12.57%	26.96%	16.90%	12.45%	20.60%	9.82%	19.06%
Minimum	–9.47%	–17.22%	–11.19%	–23.34%	–17.94%	–16.15%	–22.66%	–11.96%	–15.62%
Std. Dev.	1.38%	2.69%	1.73%	3.07%	2.08%	1.89%	2.41%	1.67%	2.09%
Skewness	–0.324	–0.085	0.019	0.014	–0.315	–0.417	–0.429	–0.598	–0.400

Note: "daily" here means return from two consecutive observations. They could be separated by weekend or national holiday.

Table 2 Correlation of daily returns, 1997:10–2012:02

	R_SNP(-1)	*R_WTI1(-1)*	*R_NIKKEI*	*R_MMVB*	*R_POL*	*R_PX*	*R_BUX*	*R_XU100*
R_SNP(-1)	1							
R_WTI1(-1)	0.13	1						
R_NIKKEI	0.38	0.05	1					
R_MMVB	0.18	0.07	0.21	1				
R_POL	0.27	-0.01	0.29	0.48	1			
R_PX	0.23	0.02	0.30	0.45	0.65	1		
R_BUX	0.22	-0.01	0.24	0.44	0.68	0.62	1	
R_XU100	0.18	0.00	0.16	0.34	0.42	0.41	0.40	1
R_TOP40	0.27	0.02	0.32	0.47	0.62	0.59	0.61	0.41

Table 3 Closing times (GMT)

	US *SNP*	US *WTI*	Japan *NIKKEI*	Russia *MICEX*	Poland *POL*	Czech R. *PX*	Hungary *BUX*	Turkey *XU100*	SAR *TOP40*	Germany *DAX*
Closing time	21:00	21:00	06:00	15:00	16:30	15:30	15:30	15:30	15:00	16:30

3 Estimates of models in rolling windows

To study evolution of the coefficients of equation (1) over time, we perform our estimations as follows. For each t $(t > 241)$, equation (1) is estimated over the interval $(t-240,\, t)$, approximately a year of observations, and estimated coefficients $\beta_i(t)$, $i = 1,...,5$, $t = 241,...,2382$ and their standard errors are recorded. As discussed, we prefer results for "normalized" coefficients. For example, $\beta_2(t)$, the coefficient of S&P returns, is multiplied by sample standard deviation of S&P returns over the interval $(t-240,\, t)$. Values of these normalized coefficients present the impact of increasing the regressor by one sample standard deviation. Hence, we can directly compare impact of different regressors on the dependent variable. The product is denoted $nR\_SnP(-1)$. The $\beta_i(t)$ "normalized" plots are presented in Figures 1–6. Only values of coefficients that are statistically significant at the 5 % level are plotted.

Figure 1 provides five insights. First, oil prices (WTI) are largely significant only until 2006. Second, the previous-day return of the Russian index (MICEX) became significant only after spring 2006. Third, the US index (S&P) remains significant in practically all periods before the August 2008 crisis, and regains significance after the recession during spring 2010. Fourth, the Japanese index (NIKKEI) is significant through the entire observation period. Fifth, the "degree of influence," measured as "normalized" coefficients,

was approximately equal during quiet periods for the US, Japanese and oil indices. All were larger than the influence of the lagged Russian index (MICEX). It should be noted that the coefficient of the lagged MICEX is always negative, implying some mean-reversion in returns. The Japanese NIKKEI is the only significant index during the 2008–2009 crisis, presumably because it reacts to more recent news than the WTI and S&P.

For the Czech PX index (Fig. 2), oil is important in 2004 and occasionally after the 2008−2009 crisis. Unlike for Russia, the S&P is important for most of the observation period, except 2003–2006. The NIKKEI is important throughout the observation period.

For the Polish POL index (Fig. 3), the NIKKEI is important throughout the observation period. The S&P is not significant in 2003–2006 (as for the Czech Republic) and in the 2008–2009 crisis (as for Russia). Oil is important in 2004–2006, and during the crisis years 2008–2009.

The Hungarian BUX (Fig. 4) is the index of the smallest market in our study. Even so, the behavior of the model coefficients in most periods is quite similar to that of the previous three countries.

The plot for Turkey's XU100 (Fig. 5) is distinct from the plots in Figures 1–4. In the crisis years of 2000–2001 and 2008–2009, the S&P is significant, not the NIKKEI. Indeed, the S&P is the most important factor in the periods 2000:11–2001:12, 2007:10–2008:10, 2009:12–2011:04. The XU100 appears to be the most S&P-oriented of any in our study.

For South Africa's TOP40 (Fig. 6), the S&P and NIKKEI are important over the entire period, but in the crisis years 2008−2009, the importance of the NIKKEI is greater than that of the S&P, because it contains more recent information. Oil is significant in 2004:10–2007:01 and in 2009:09–2010:03, 2011:08–11, which is not surprising given South Africa's dependence on raw material exports.

Figure 1 Russia (MICEX). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R^2 (right y-axis) over time.

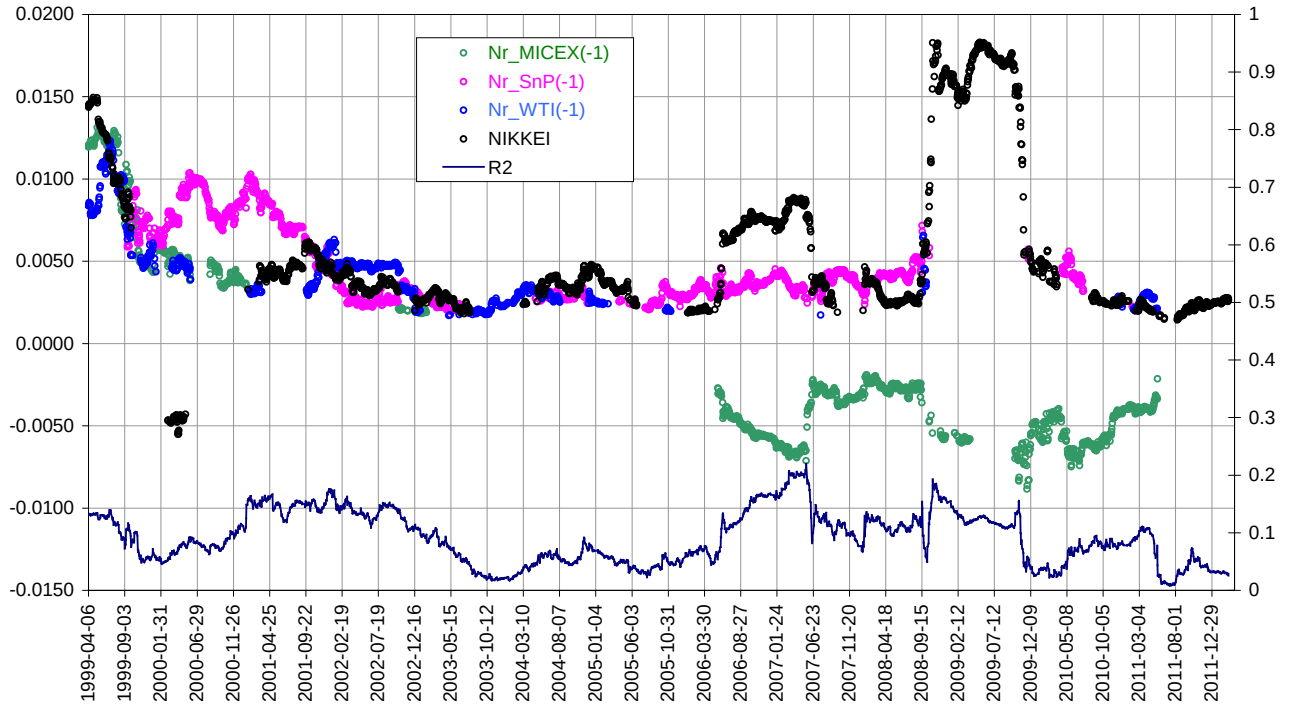


Figure 2 Czech Republic (PX). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R^2 (right y-axis) over time.

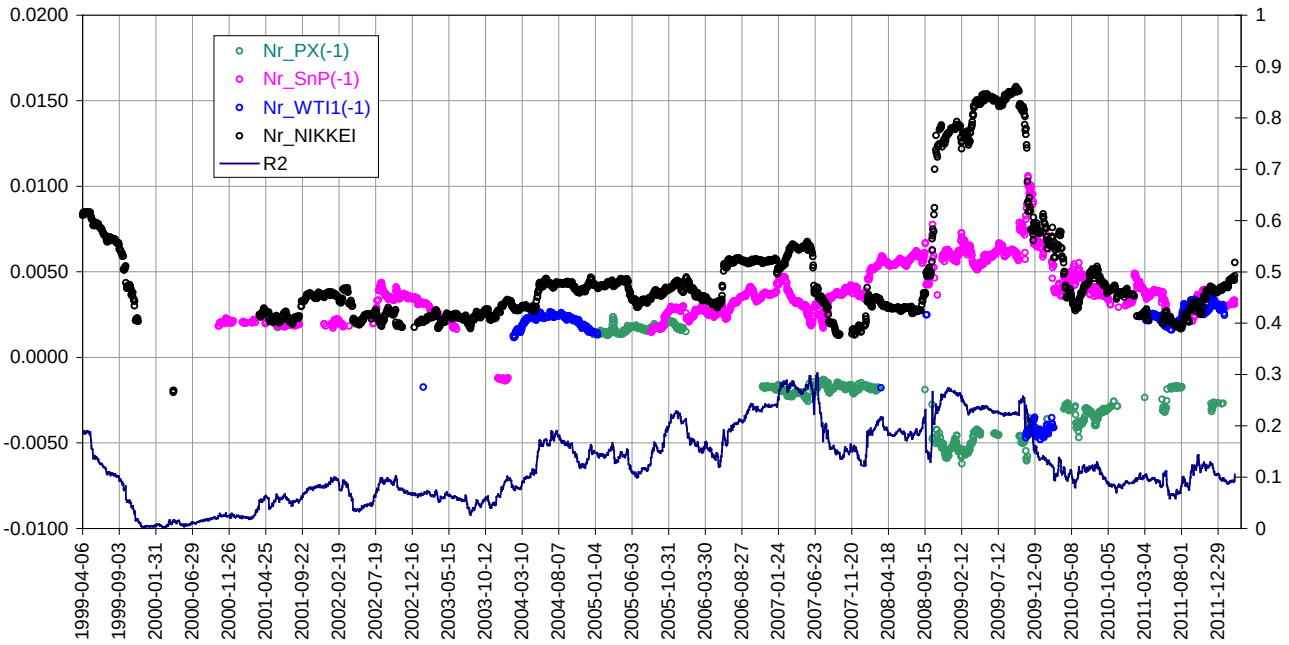


Figure 3 Poland (POL). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R^2 (right y-axis) over time.

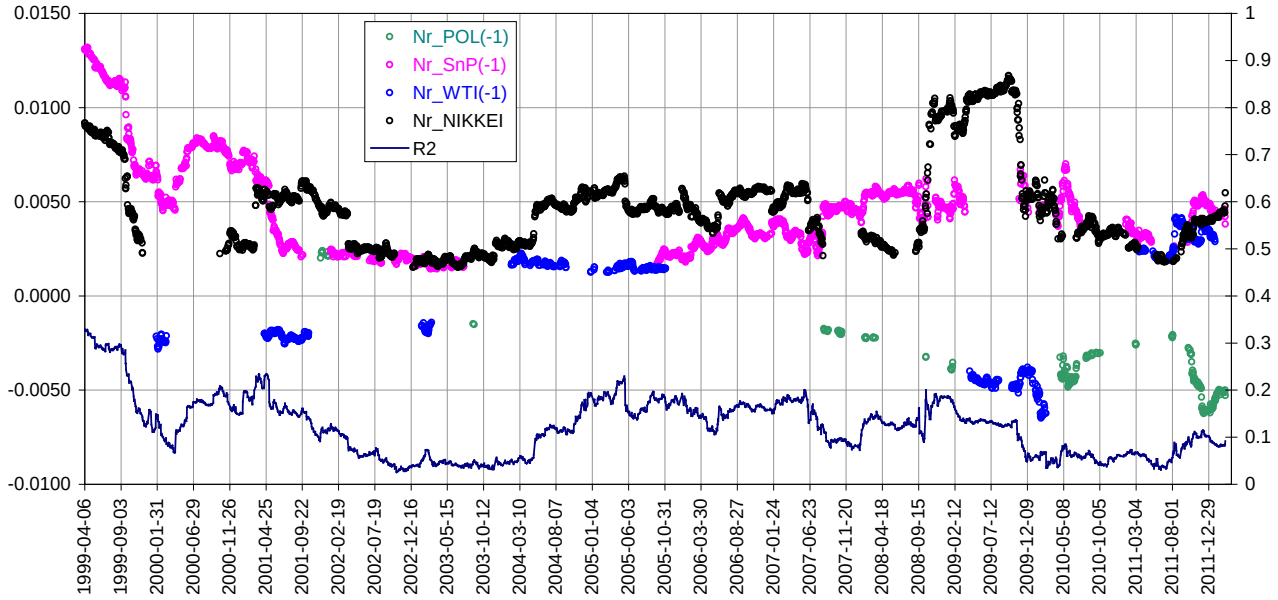


Figure 4 Hungary (BUX). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R2 (right y-axis) over time.

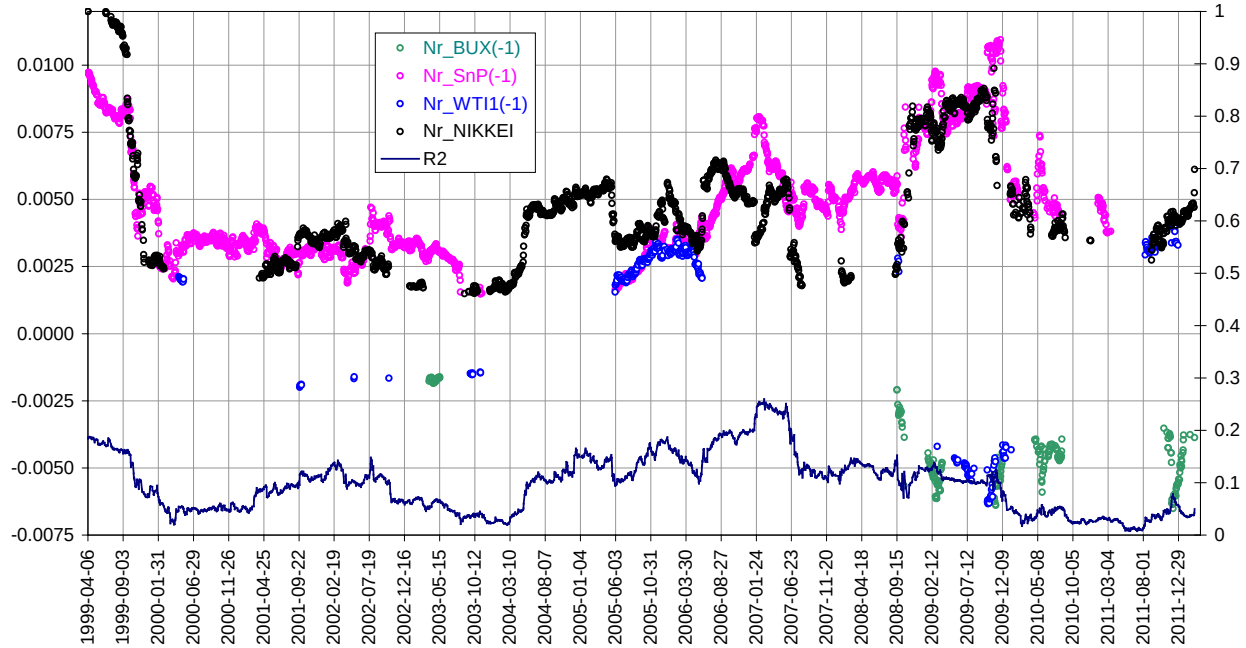


Figure 5 Turkey (XU100). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R^2 (right y-axis) over time.

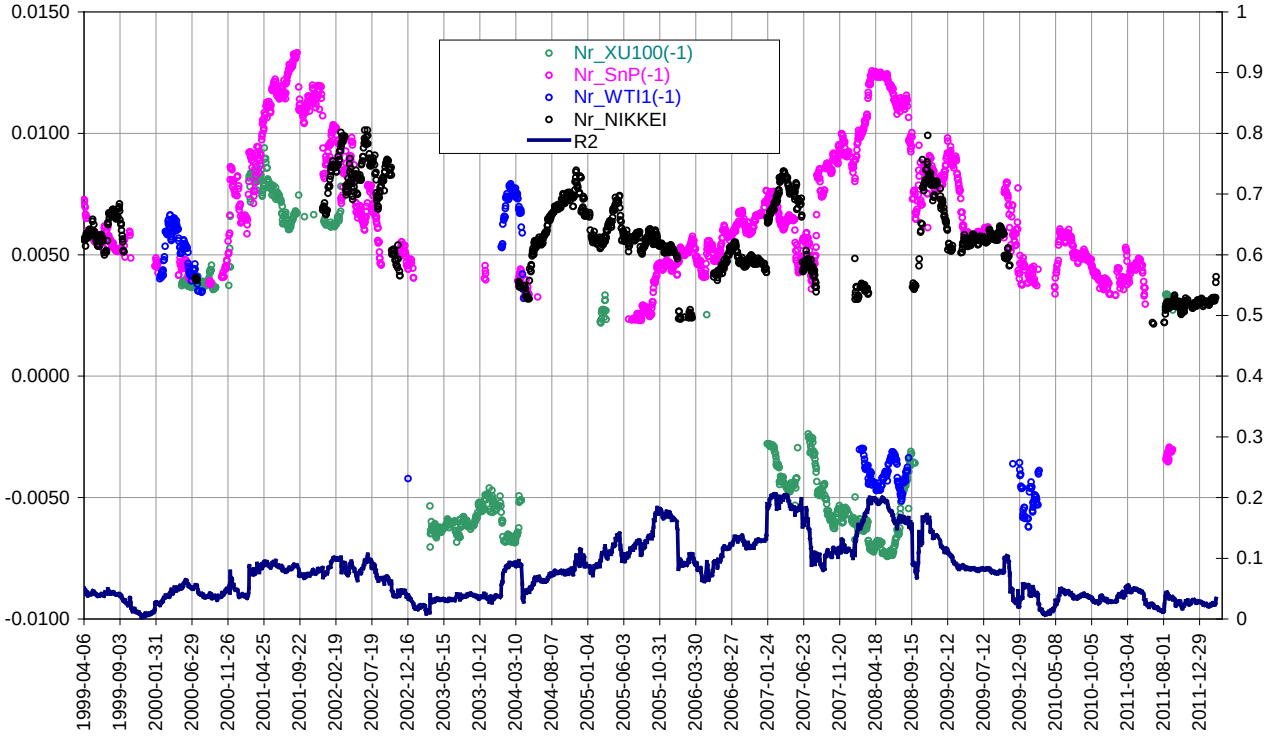
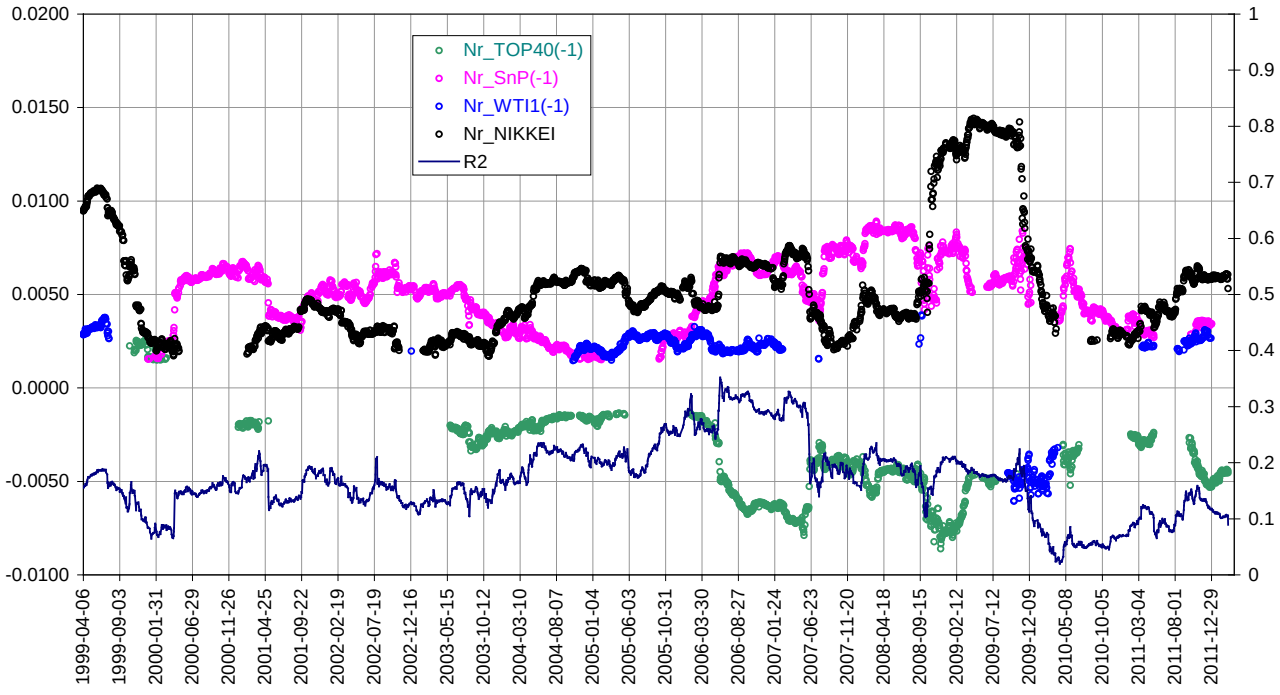


Figure 6 South Africa (TOP40). Evolution of coefficients of equation (1) (left y-axis) and goodness-of-fit measure R^2 (right y-axis) over time.



4 Correlations

To measure a degree of correlation between two stock indices with approximately the same closing time, we use the TGARCH(1,1)-BEKK model (Engle and Kroner, 1995).

When considering two countries (say, Russia and Poland), we let r_{it}, where $i = 1, 2$ represents the corresponding daily returns for the stock market indices in these countries on day t. Hence, $r_t = \begin{bmatrix} r_{1t} \\ r_{2t} \end{bmatrix}$ is 2×1 vector of daily returns. We know that some of the correlation between r_{1t} and r_{2t} is explained by the movement of the global financial market, which means the rest (i.e. the part in which we are most interested) is that part of the correlation that can be attributed to a direct relation between the two markets.

We consider the model

$$r_t = \beta r_{t-1} + \gamma x_{t-1} + \varepsilon_t, \tag{2}$$

where r_t, ε_t are 2×1 vectors, β and γ are 2×2 and $2 \times k$ matrices of coefficients, and $k \times 1$ vector x_{t-1} contains information from the global market available before the closing time of the two markets. We include in the global information vector daily returns of S&P500 index and WTI oil price from the previous day $t-1$. We also include the NIKKEI225 index return from the same day t, since at the opening time of the Russian and Polish markets return of the Japan index on day t is already known. An intercept is also included at x_{t-1}. Thus, in our model (2) $k = 4$:

$$x_{t-1} = \{nikkei_t,\ snp_{t-1},\ wti_{t-1},\ const\}'. \tag{3}$$

Error term ε_t is supposed to have conditional normal distribution with 2×2 covariance matrix H_t:

$$\varepsilon_t \mid x_{t-1} \sim N(0,\ H_t). \tag{4}$$

For the matrix H_t we assume a Diagonal-BEKK structure:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + G'H_{t-1}G + B'(\varepsilon_{t-1}^{-}\varepsilon_{t-1}^{-}{}')B, \tag{5}$$

where $\varepsilon_{it}^{-} = \begin{cases} \varepsilon_{it}, & \varepsilon_{it} < 0, \\ 0, & \varepsilon_{it} \geq 0. \end{cases}$ The matrices of the coefficients *A*, *G*, and *B* are assumed to be diagonal.

From equations (2)–(5), we estimate the evolution of the covariance matrix H_t and define the correlation between the two market returns "taking into account the global market movement" as $\rho_{12,t} = H_{12,t} / (H_{11,t} H_{22,t})^{1/2}$ [5].

First, we estimate equations (2)–(5) for pairs of four stock indices of Russia, Poland, the Czech Republic and Hungary. Since the estimated correlations $\hat{\rho}_{ij,t}$ are volatile, we present their 51-day moving averages in the Figure 7 (51 observations corresponds to approximately 2.5 months).

Figure 7 presents evolution of the conditional correlations $\hat{\rho}_{Rus\,X,t}$ of Russian stock market returns with returns of the three emerging Eastern European stock markets. In addition to the relatively low correlation after the 1998 crisis, we observe another common pattern for the three correlations − increasing relations between the Russian and Eastern European stock markets during 2004–2006, when the average value of the $\hat{\rho}$ increased from 0.3 to 0.5. This could be attributed to the EU accessions of the Czech Republic, Hungary, and Poland (cf. Fedorova, 2011). On the other hand, the 2008 crisis had no long-term effect on the pair-wise market correlations.

Figure 8 presents the evolution of conditional correlations between the three emerging Eastern European stock markets returns. We observe a drop in correlations in 1998−1999. The largest de-synchronization was between Poland and the Czech Republic. In 2004–2006, the correlations increased from 0.40–0.45 to 0.60–0.65. The crisis of 2008 slowed this process, but in 2009–2012, the correlations fluctuated around 0.70–0.75. Correlation between the three markets is somewhat higher than their correlation with the Russian market. This might be explained by closer economic relations between the neighboring Eastern European countries or their greater involvement in the international financial market (especially after their accession to the EU).

[5] This BEKK model guarantees the estimated matrix H_t will be positive definite. We also tried the Diagonal VECH specification (Bollerslev, Engle, and Wooldridge, 1988). It yielded very similar results, which is why we prefer to use BEKK specification for the covariance matrix.

Next, we compare correlations between emerging markets with the correlation for the German stock market, the largest in continental Europe, with the markets of our three Eastern European countries. The results are presented in Figure 9. A more or less permanent increase in correlations is observed, from 0.40 (Poland) and 0.20 (Czech Republic, Hungary) in 2003 to approximately 0.7 in 2009–2012. The correlation with Poland after 2003 looks higher than other countries' correlation coefficients. This might be because the Polish stock market is larger and more integrated with the world market (i.e. less driven by local news). Moreover, the closing times for markets in Germany and Poland are that same, and half an hour later than closing time in Hungary or the Czech Republic.

Figure 10 in contrast shows the conditional correlation between the indexes of Europe's two largest stock markets, i.e. the German DAX and the British FTSE, is presented as a benchmark. This correlation is significantly higher than correlations from emerging markets. The correlation steadily increases from 0.60–0.65 in 1999 to 0.80–0.85 in 2009–2012. One explanation could be that the closing times of Germany and UK markets are identical. It could also be that both markets are more synchronized with the global market, so the impact of local news is relatively small in comparison to the impact of global news. It could also be that most local news at these markets is in fact global news.

In Figures 7–10, we observe increasing correlation between daily returns of the mature European stock markets (Germany, UK) and emerging markets in Eastern Europe (Hungary, Czech Republic, Poland, and Russia). This increase in correlation is especially sharp for 2004–2006. Is this related to the accession of new EU members in 2004 and the resulting impact on the structure of European stock markets and investor portfolio allocation?

To answer this, consider two stock markets outside Europe: Turkey and the Republic of South Africa (SAR). In Figure 11, we present correlations between stock market returns in Russia, SAR, and Turkey. Surprisingly, the long-term pattern of the correlations is very similar to that of Figure 7, i.e. rapid growth in 2004–2006 and correlation coefficients averaging between 0.25 and 0.55.

In Figure 12, we present correlations between stock market returns in Germany, SAR, and Turkey. Trading volume on the SAR exchange is approximately three times larger than that on the Istanbul exchange, which may be why the correlation between Germany and SAR returns are higher than the correlation between German and Turkish returns. That difference was especially large in 1999−2001 due to the 2000−2001 banking

and financial crisis in Turkey. Germany-Turkey correlation increases in 2004−2008 from 0.20–0.25 to 0.60. Note that the correlation coefficient starts to increase in 2004, i.e. the same time as for the Eastern European economies, but here growth continues up to the 2008 financial crisis. The Germany-SAR correlation dynamic resembles that of Germany-UK (Fig. 10), i.e. permanent growth in 2002–2008 in the range of about 0.40 to 0.70. However, these correlations are lower than Germany-UK correlations, which is in line with the hypothesis that the larger the markets, the higher the correlation.

The correlations of Poland stock index returns with SAR and Turkey stock market returns are presented in Figure 13. The pattern of the correlation dynamic is similar to that of Figure 12, but the correlation with SAR is higher than correlation with Turkey at approximately 0.05–0.10. In the period 2003–2008, an increase in the correlation coefficient is observed for Poland-SAR and for Poland-Turkey correlation coefficients. This higher correlation survives the financial crisis of 2008 and 2009.

Figure 7 Conditional correlations $\hat{\rho}_{Rus\,X,t}$ between Russian index returns and Poland, Czech Republic, and Hungary.

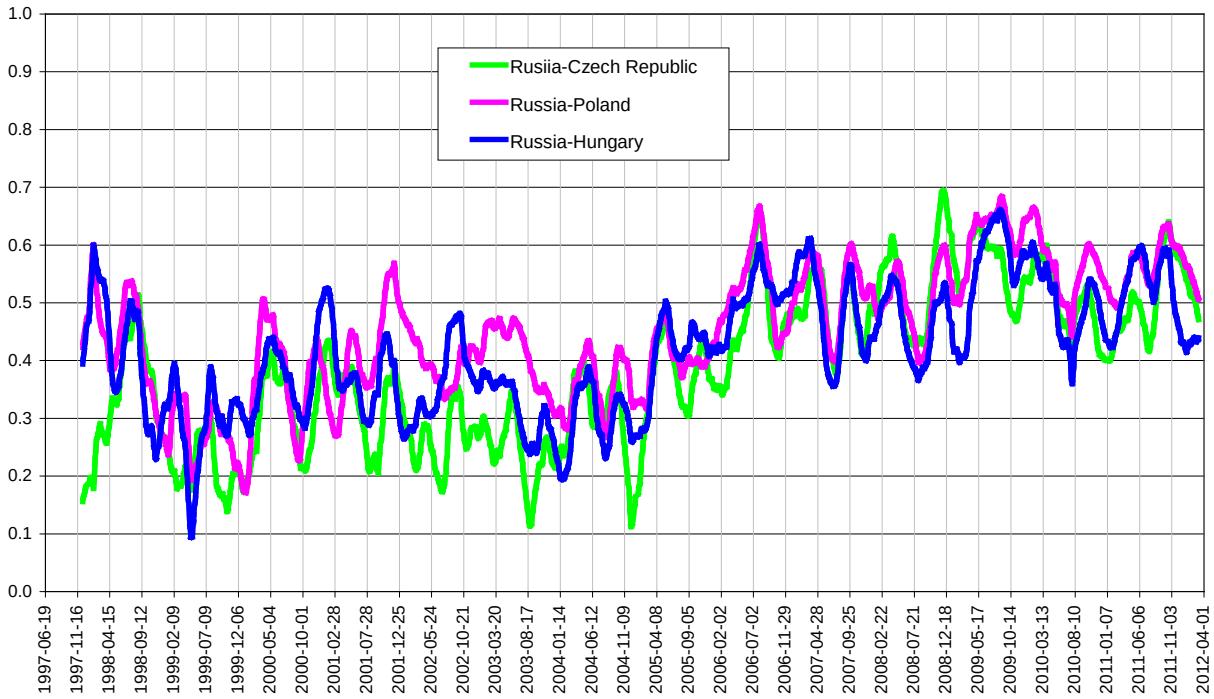


Figure 8 Conditional correlations $\hat{\rho}_{Rus\,X,t}$ between Poland, Czech Republic, and Hungary stock indices returns.

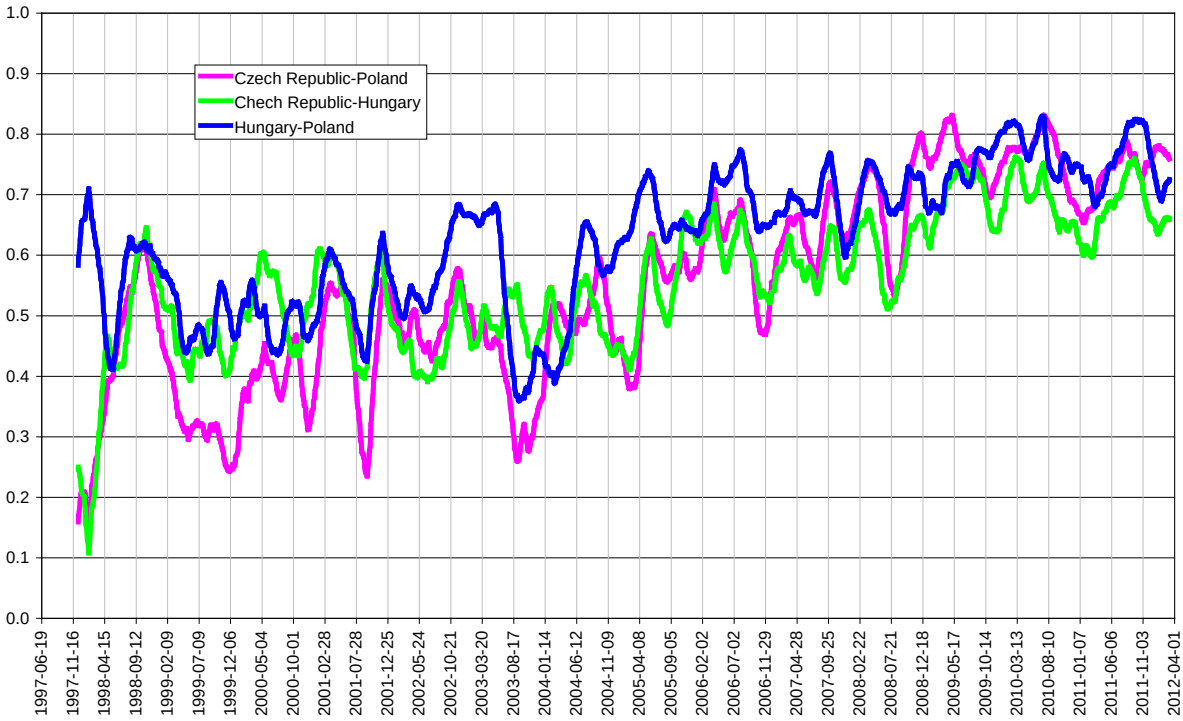


Figure 9 Conditional correlations $\hat{\rho}_{Rus\,X,t}$ between German and Poland, Czech Republic, and Hungary index returns.

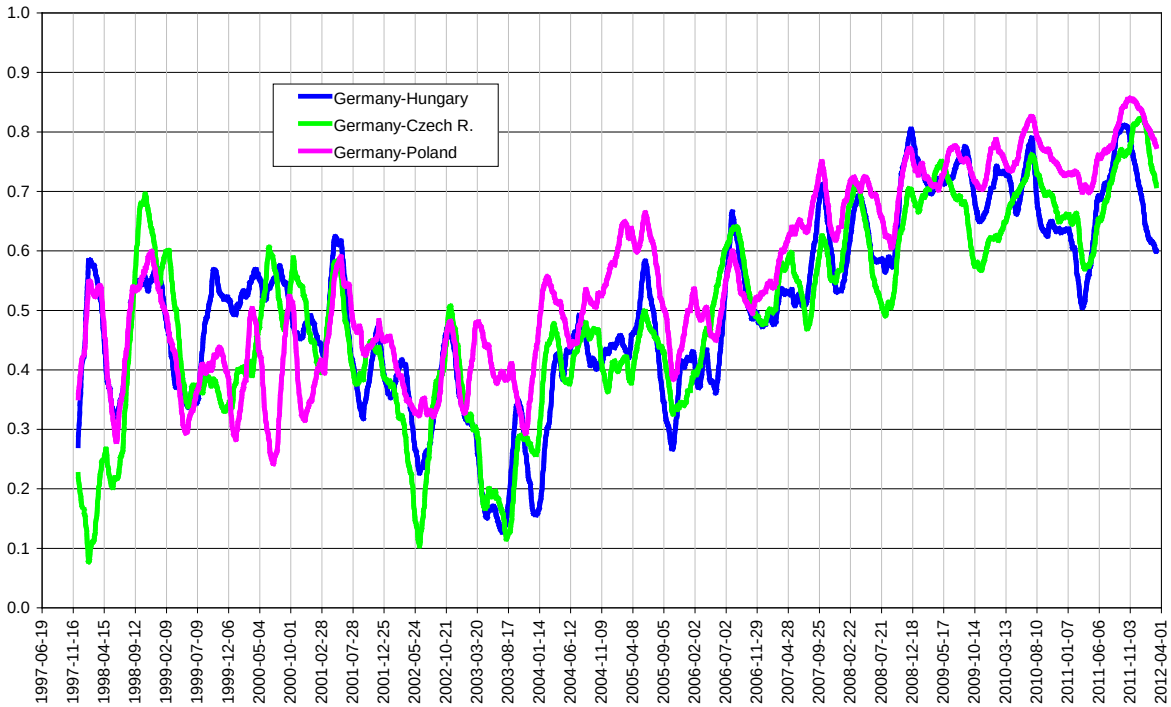


Figure 10 Conditional correlations between German and UK index returns.

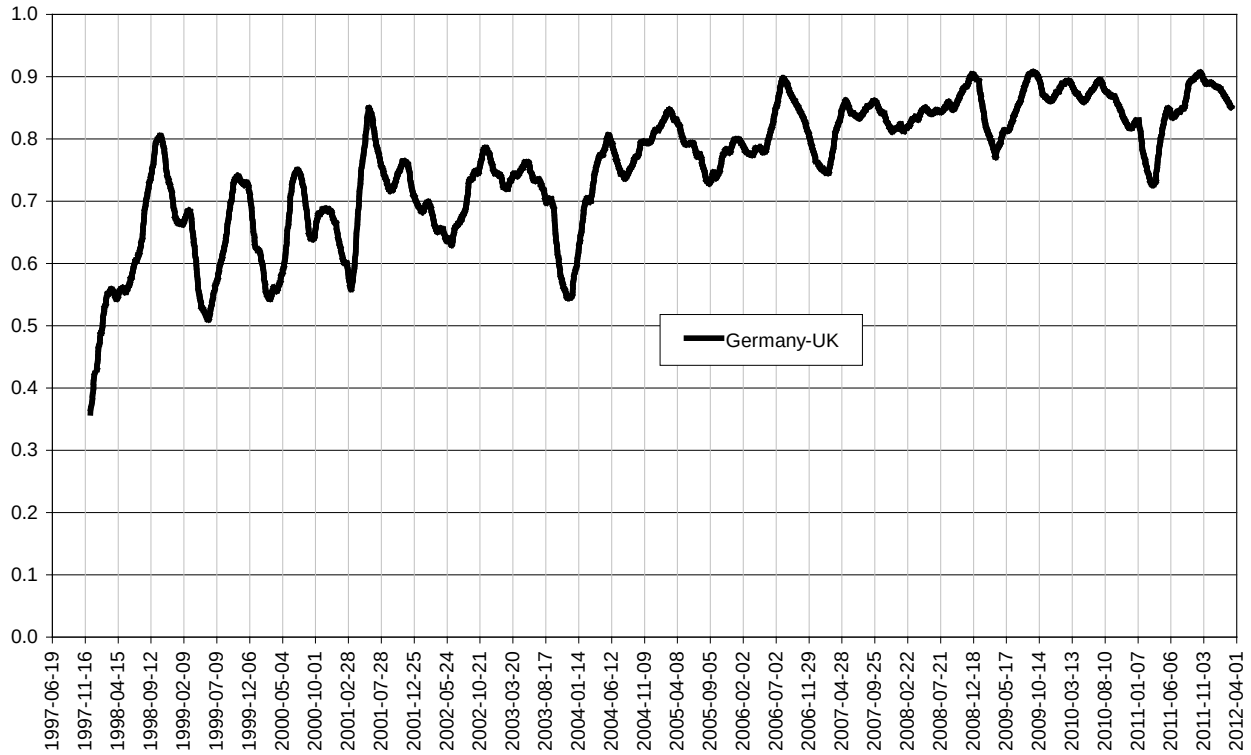


Figure 11 Conditional correlations between Russia, SAR, and Turkey stock market returns.

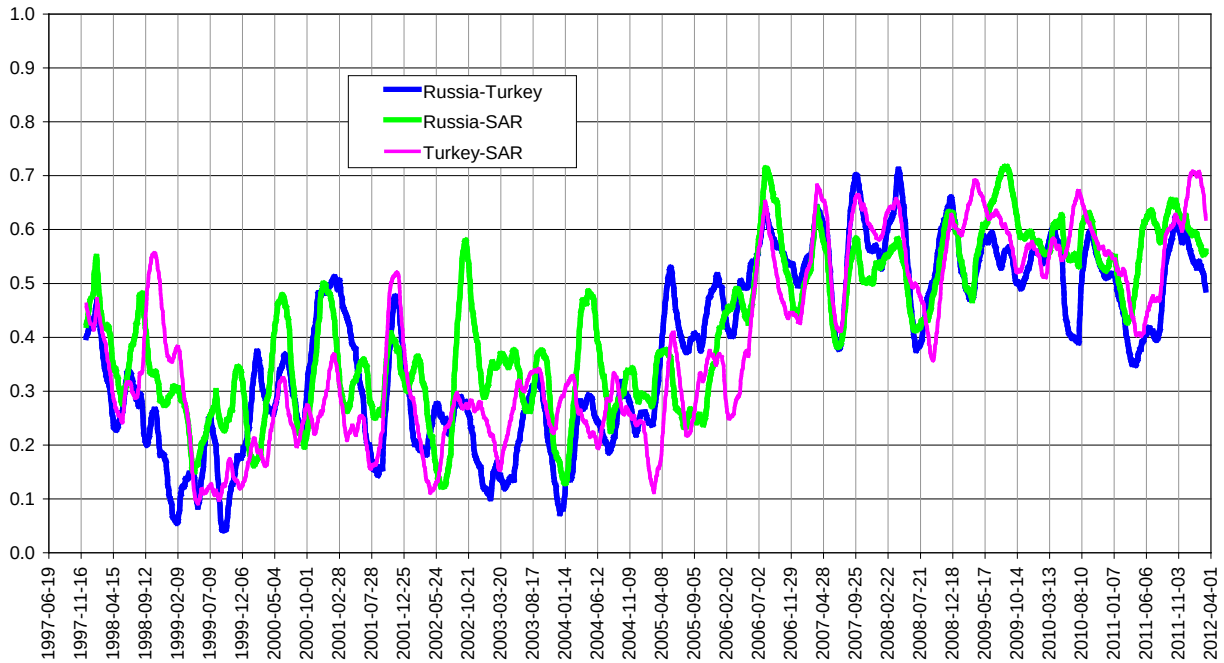


Figure 12 Conditional correlations between Germany, SAR, and Turkey stock market returns.

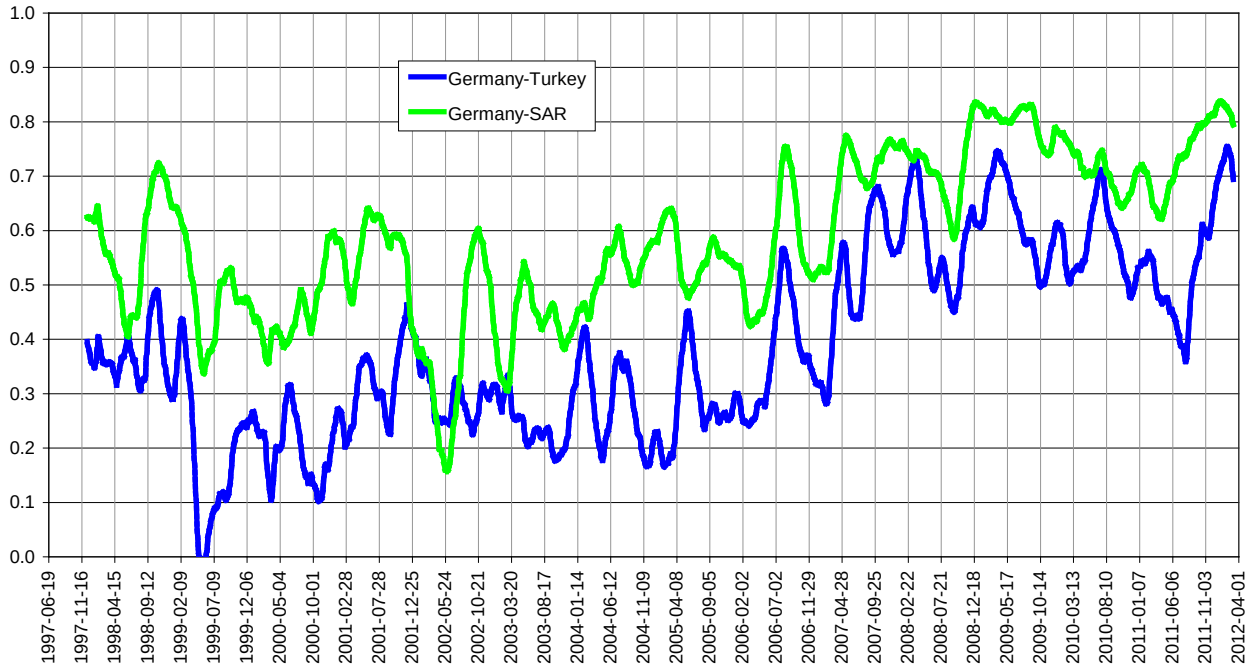
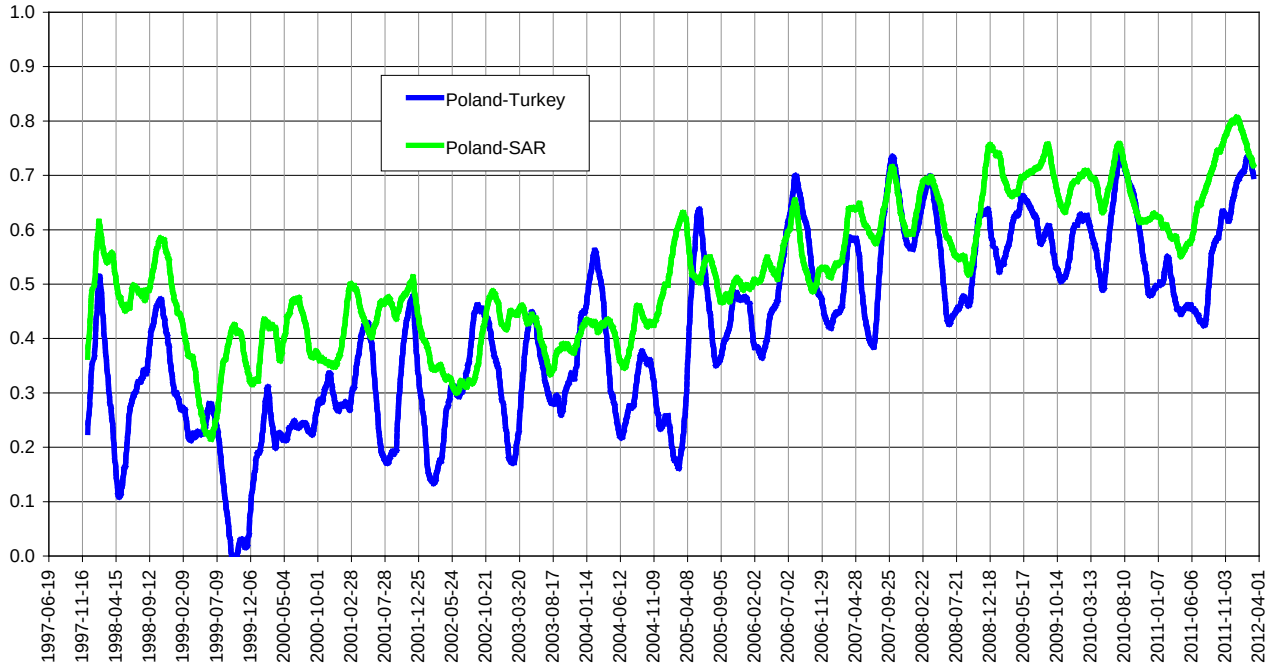


Figure 13 Conditional correlations between Poland, SAR, and Turkey stock market returns.



5 Interpreting the results

Our overall conclusion from sections 3 and 4 is that local stock market index return I_t can be split into two parts as a result of globalization of financial markets and integration with the world economy. The first is the global stochastic trend IG_t. The second is the local trend, specific to each market IL_t. Thus $I_t = IG_t + IL_t$. Global trend IG_t absorbs all news from world economy and world financial markets that is available at time t and important for all markets. Local stochastic trend IL_t absorbs local news that is important only to investors in a particular local market. Globalization is driven by more traders/financial firms operating in many markets and continuous 24-hour trading in certain financial instruments.

With increasing globalization, the share of global trend IG_t in I_t increases. This also holds for daily returns such that

$$R\_I_t = R\_IG_t + R\_IL_t . \quad (6)$$

(Here we use notation I_t for the log of the index, thus $R\_I_t = I_t - I_{t-1}$). If we have two markets, A and B, with the same closing time, and assuming that local returns are independent from each other and independent from the global trend return, then

$$r^2_{AB,t} = Corr^2(R\_I_{A,t},\ R\_I_{B,t}) = \frac{Cov^2(R\_I_{A,t},\ R\_I_{B,t})}{\left(Var(R\_I_{A,t})\right)\left(Var(R\_I_{B,t})\right)} =$$

$$= \frac{Var^2(R\_IG_t)}{\left(Var(R\_IG_t) + Var(R\_IL_{A,t})\right)\left(Var(R\_IG_t) + Var(R\_IL_{A,t})\right)} =$$

$$= \frac{1}{\left(1 + \frac{Var(R\_IL_{A,t})}{Var(R\_IG_t)}\right)\left(1 + \frac{Var(R\_IL_{B,t})}{Var(R\_IG_t)}\right)} . \quad (7)$$

With globalization, certain news becomes important for the global market and global market news becomes more important for local markets due to the increasing number of international traders. Hence, the ratio of local news to global news, $\frac{Var(R\_IL_t)}{Var(R\_IG_t)}$ increases,

and, by (7) correlation $\rho_{AB,t}$ increases as well. Here, increasing integration between markets A and B does not necessarily mean increasing trade and other economic relations between these two countries. It merely reflects a process of the globalization of financial markets.

Now assume two markets with a difference in closing times Δt (measured in days = 24 h and using GMT)

$$R\_I_{A,t} = R\_IG_t + R\_IL_{A,t}, \quad R\_I_{B,t} = R\_IG_{t+\Delta t} + R\_IL_{A,t+\Delta t}.$$

For the sake of simplicity, we further assume that increments in the global trend are independent, so that

$$Cov(R\_I_{A,t},\ R\_I_{B,t}) = Cov(R\_IG_t,\ R\_IG_{t+\Delta t}) = Cov(R\_IG_t,\ R\_IG_{t+\Delta t}) =$$
$$= Cov\big((IG_t - IG_{t+\Delta t-1}) + (IG_{t+\Delta t-1} - IG_{t-1}),\ \ (IG_{t+\Delta t} - IG_t) + (IG_t - IG_{t+\Delta t-1})\big) = Var(IG_t - IG_{t+\Delta t-1}).$$

Finally, if we additionally assume that density of the news is constant, then variance of the global index increment by time τ is proportional to that time, yielding

$$Cov(R\_I_{A,t},\ R\_I_{B,t}) = Var(IG_t - IG_{t+\Delta t-1}) = c(1-\Delta t), \text{ and}$$
$$r_{AB,t} = Corr(R\_I_{A,t},\ R\_I_{B,t}) = \frac{(1-\Delta t)}{\sqrt{\left(1+\frac{Var(R\_IL_{A,t})}{Var(R\_IG_t)}\right)\left(1+\frac{Var(R\_IL_{B,t})}{Var(R\_IG_t)}\right)}}. \qquad (8)$$

The smaller the difference between the closing times of the two markets, the larger the correlation.

This simple model (6) and its consequences (7) and (8) may explain some empirical findings in sections 3 and 4. The results of sections 3 and 4 do not contradict the equations (6)–(8).

In Section 3, the NIKKEI is most important for all 6 indices. Here, the difference in closing time Δt is smaller than for the S&P and WTI indices. In a crisis, an increase in volatility of a small (less diversified and less liquid) market is higher than the increase in

the volatility of large market. Hence, ratio $\frac{Var(R\_IL_{A,t})}{Var(R\_IG_t)}$ increases, and correlation decreases, which could explain why only the nearest index, the NIKKEI, is important during the crisis for many markets.

In section 4, conditional correlation ρ includes only news between the closing time in Japan and closing time of the local market (all six have approximately the same closing time, see Table 3). The larger the markets, the larger the conditional correlation ρ. This is because "local" news for large markets is actually global news. Armed with this insight, we find the highest conditional correlation between Germany and the UK. Also, the SAR-Germany correlation is higher than Turkey-Germany, and the SAR-Poland correlation is higher than Turkey-Poland (as SAR market is larger than the Turkish market). Sharp increase in correlations of the Eastern Europe countries in 2004–2006 could be explained by accession of these countries to EU, which may lead to internationalization of their local markets, whereby the ratio $\frac{Var(R\_IL_{A,t})}{Var(R\_IG_t)}$ decreases and correlations increase.

6 Conclusions

This paper assessed the correlation of Russian and other Eastern European stock market returns with returns of largest global equity markets, taking into account the different trading times of the different markets. We find that the Japanese market, embodying the most recent global news, has a statistically significant and economically large influence on the same-day returns of all the emerging market stock market returns studied here. In contrast, e.g. oil prices have much more sporadic effect, even on the Russian stock market. Given the importance of energy products for the Russian economy, this result shows the extent to which the Russian stock market is already integrated with global markets. We also observe a significant increase during the 2000s in the conditional correlation of equity returns of emerging markets with each other and with markets in more mature economies. EU accession seems to have increased the correlation dramatically for Eastern European countries. Correlation between the German and UK markets has also increased. Conditional correla-

tions decreased during the most recent economic and financial crisis, but then recovered rapidly.

Our research shows that stock markets in emerging markets have become more integrated with the global equity markets over the past 15 years. Emerging stock markets have become more correlated with the largest stock markets, regardless of the bilateral trade links between them. Periods of financial stress seem to induce temporary decreases in the degree of correlation, but recovery to the long-term trend is fast. Given that high levels of correlation have already been achieved, further substantial increases in integration are unlikely.

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