IIIS Discussion Paper

No.54 / January 2005

Linkages and relationships between Emerging European and Developed Stock Markets before and after the Russian Crisis of 1997-1998

Svitlana Voronkova
Institute for International Integration Studies
University of Dublin - Trinity College

Brian M Lucey
School of Business Studies and Institute for International Integration Studies, University of Dublin

IIIS Discussion Paper No. 54

Linkages and relationships between Emerging European and Developed Stock Markets before and after the Russian Crisis of 1997-1998

Svitlana Voronkova
Brian M Lucey

Linkages and relationships between Emerging European and Developed Stock Markets before and after the Russian Crisis of 1997-1998

Brian M Lucey *
School of Business Studies & Institute for International Integration Studies
University of Dublin - Trinity College
Dublin 2
Ireland

Svitlana Voronkova
Institute for International Integration Studies
University of Dublin - Trinity College
Dublin 2
Ireland

Abstract

This paper examines the linkages between the Russian stock market and those of its largest neighbors in Central and Eastern Europe, and the world stock markets over the 10 year period 1995-2004. What we find is that there was a major change in the nature of these relationships after the so called Russian Crisis of 1997-1998. The nature of this change is such that we can no longer rely on the the traditional methods used to examine linkages between equity markets. Using a more appropriate set of tools we find that the major influences on the Russian stock market have become the equity markets of the European Union and the USA. There is very little evidence of influence from (or to) regional markets such as Poland or Hungary.

Keywords: Stock Market Integration, CEE Stock markets, Russian Stock Market, Cointegration
JEL Classification: G10, G15

*Corresponding author.

1. Introduction

After the collapse of communist and socialist regimes at the beginning of 1990s, a number of Central and Eastern European (CEE) economies started their journey into capitalism by establishing private property and capital markets. As a result, a number of stock markets have been established in the region. Since then they displayed considerable growth in size and degree of sophistication. CEE stock markets attracted interest of academics due to a number of reasons.

Firstly, these markets provided a possibility to re-examine existing asset pricing models and pricing anomalies in the conditions of the evolving markets. Market efficiency of the CEE markets is tested in Ratkovicova (1999) and Gilmore and McManus (2001); a version of CAPM is tested in Charemza and Majerowska (2000); Mateus (2004) explores the predictability of the European emerging market returns within an unconditional asset-pricing framework while the January pricing anomaly is studied in Henke (2003).

Secondly, in the light of growing interdependencies between world equity markets due to enhanced capital movements, numerous studies investigated the extent to which emerging European stock markets are integrated with global markets, and the extent to which they are subjects to global shocks (Gelos and Sahay, 2000; Gilmor and McManus, 2002; Scheicher, 2001). Among the CEE markets, those of the Vysegrad countries (Poland, Hungary and the Czech Republic) have attracted most of the attention of the academics due to their economies faster growth relative to their regional counterparts (Slovakia, Slovenia, Bulgaria, Croatia and Baltic countries), in addition to political stability and their (successfully realised) prospects of joining the European Union.

The repercussions of the Russian currency and debt crises for the world stock markets have been extensively discussed in the literature (see, among others, Baig and Goldfain, 2000; Gelos and Sahay, 2000; Hernández and Valdés, 2001; Dungley et al., 2003). However, as far as we are aware, no studies have been done on linkages shared by this market after 1998. This lack of research is surprising. Firstly, Russia is the largest among the CEE stock markets in terms of market capitalization. Secondly, the Russian economy remains important for the Eastern European region.

Although trade links have declined significantly since the collapse of the Soviet Union, Russia still remains an important trading partner for the Vysegrad countries, as well as a source of significant direct investment in the region (Jochum, Kirschgässner and Platek, 1998; UNCTAD, 2004a; 2004b; 2004c). Thirdly, a number of studies have shown that the nature market linkages is time-varying (Bekaert and Harvey, 1995; 1997). Gelos and Sahay (2000) suggest that "*…the reaction of the more advanced financial markets in the region around the time of the Russian ruble collapse suggests that further financial market liberalization, … and integration may result in higher future financial market comovements"*. Thus the aim of the paper is to investigate and document the changing role of the Russian stock market for the CEE markets and to explore whether its importance for the regional markets has changed after the 1998 crisis. The paper also explores its linkages with the developed markets (US, UK, EMU and Japan), with a special emphasis on the post-crisis period.

Increasing integration of equity markets and capital markets in general can be expected to have three broad sets of implications if the integration spurs greater development of the financial sector (see Pagano, 1993). *First*, the attractiveness of international portfolio diversification will weaken as returns are equalized across countries. *Second*, the more complete are the world's capital market, the more robust will be the economies of individual states. *Third*, household savings rates will consequently change over time. The former two outcomes are in general seen to have positive effects on economic growth while the latter is more uncertain.

International portfolio diversification is justified only if there are gains from it. With increasing integration of international equity markets, the diversification benefits will tend to decline as the correlations become increasingly positive and strengthen. This concept has been well known for at least several centuries, and has been quantified and modeled since at least the early years of the 20th century. Goetzmann et al. (2002) demonstrate, using over 150 years of capital market history that a few key facts keep emerging. *First*, the periods when diversification benefits tend to be of the highest potential (with low correlations between international indices) tend also to be periods that present investors with the greatest difficulty in diversifying. These tend to be periods of war and

significant international tension. *Second*, the periods that have the highest correlations (and thus the lowest diversification benefits) are during the turn of the 19th century, during the Great Depression, and during the late 20th century, - which tend to be periods when markets are generally bearish in tendency. Thus, the *third* finding that diversification benefits are non-constant and may be least available when they are most needed. Interestingly, it is not clear why these shifts in correlations and linkages occur over the long run. Roll (1992) proposes Ricardian specialization, Heston and Rouwenhorst (1994) suggest that national cultures and economic predilections dominate industrial explanations, while Chen and Knez (1995) and Korajczyk (1996) suggest that lack of integration drives the issue, without addressing why this integration has not occurred.

The structure of the paper is the following. The next section presents literature review on the linkages displayed by Russian stock market. Section 3 provides a brief overview of the development of the Russian stock markets since its re-establishment in 1991, including the events of the Russian crisis of August 1998 and its implications for the Russian stock market. Section 4 presents data and methodology used in the study. Section 5 discusses empirical results and Section 6 provides conclusions.

2. Russian equity market integration

Studies that shed light on comovements of Russian and international stock prices are not plentiful and usually they analyze Russia along with other CEE markets. The conclusions of these studies do not necessarily conform to each other, due to differences in sample period, data frequency, stock market indices used and adjustment procedures applied to the indices used. Probably one of the earliest studies is that of Linne (1998). This study sought to investigate whether newly established Eastern European markets (Russia, Poland, Hungary, the Czech Republic and Slovak Republic) display any long-relationships within the group, and with mature markets (Germany, UK, France, Italy, Switzerland, US and Japan). The data set consisted of local stock market indices expressed in US dollars, at weekly frequency, over the period from 1991 to 1997.

The results suggest that during the sample period none of the two most important Russian stock market indices displayed linkages with any of the analyzed markets. Among the CEE markets only Poland displayed comovements with the world portfolio proxied by the MSCI-World index. By contrast, the Slovakian stock market showed cointegration relations with all mature stock markets. The author concludes that at that period CEE markets were mostly driven by the domestic factors. The paper, however, does not attempt to provide explanations of the country-specific patterns of the long-run linkages.

Röckinger and Urga (2001) explored integration of the four emerging stock markets over the period from 1994 to 1997 using an extended Bekaert and Harvey (1997) model for conditional volatility with time varying parameters. Apart from valuable information about the extent and strength of financial integration provided by the time varying parameters, the advantages of this approach are the following. Firstly, accounting for GARCH structure of the residuals, it allows to establish the nature of the GARCH effect in case of the emerging markets (leverage vs. liquidity hypotheses). Secondly, the model incorporates a latent factor, which accounts for information beyond stock market indices. The study uses daily data for the most important local stock market indices expressed in US dollars. The results suggest that Russian stock market differs from the other three markets with regard to sources of shocks spillovers. United States and Germany are important sources of shock spillovers in case of Russia. Czech and Polish stock returns seem to reflect movements in the UK and not in the US. Both Czech and Hungarian stock returns were mostly influenced by German market movements, although in case of Hungary the impact has declined, whereas for Czech Republic it increased. The paper, however, does not comment on the importance of regional shocks for the CEE countries.

Jochum, Kirschgässner and Platek (1998) (JKP) pointed out the importance of political and economic events in Russia for CEE economies (Hungary, Poland and the Czech Republic). As an example, although by the end of 1997 CEE markets had largely recovered from the losses incurred due to Asian crisis, they underwent further losses as domestic Russian economic conditions

worsened over the first half of 1998. Therefore in their analysis the authors take into account the timing of events in Russia when analyzing the impact of the crisis on the extent of predictability and co-movements between CEE markets and between these markets and the US stock market. Assuming a time-varying pattern of market comovements, JKP distinguish between pre-crisis and crisis periods. Basing on the results of the principal component analysis and Hansen and Johansen (1993) tests of the constancy of cointegration vector, they set the latter from 1 September 1997 to 21 September 1998. They find considerable differences both in short-term and long-term linkages between the markets. In line with the evidence for developed markets (Longin and Solnik, 1995) they find significant increase in the values of daily correlations during the crisis period between market returns and absence of cointegration vectors for any of the markets. Before the crisis period the Russian stock market shared bivariate cointegration relations with Hungarian and the US markets, which are no longer detected in the crisis period. JKP explain the absence of cointegration after the crisis by the dominance of the short-run adjustments over the long-run dynamics. Results of the variance decomposition show that before the crisis 95 % per cent of the variance in the Russian stock market was explained by itself after 5 days. During the crisis period the share of foreign markets in explaining variance increased from 5% to 20 %. In both periods most of the impact was due to movements in US markets, with the Polish stock market exerting the smallest impact on fluctuations in the Russian stock market.

Gelos and Sahay (2000b) explore financial spillovers due to various external crises on CEE foreign exchange and stock markets. They find increasing financial market integration since 1993, measured by the change in (unadjusted) stock return correlations. The increase is especially significant around the Russian crisis, what corresponds to the JKP finding. Gelos and Sahay find strong evidence of shock transmission from Russian to CEE markets, especially to the Hungarian one (compare with JKP (1998) finding above). Russian stock returns appear to Granger-cause returns in these markets, which did not seem to be the case before the crisis. They also document evidence that negative shocks in Russia have stronger effect on other emerging markets than

positive ones. A similar study by Baele, Crombez and Schoors (2003), who note that EU equity shocks have increased influence on CEE after 1998, but that the Russian market remains segmented from EU influences.

Jithendranathan and Kravchenko (2004) conclude, albeit using a simple regression analysis at the stock level that Russian equities are more integrated in the aftermath of the 1998 crisis. Finally, Hayo and Kutan (2004) analyzed the impact of US stock returns on Russian stock and bond markets (along with other factors such as oil prices and political news), within a GARCH framework. The study covers the period between 1995 and 2001. The papers findings echo that of Röckinger and Urga (2001) suggesting US stock returns tend to Granger-cause Russian stock returns. Also, higher US returns seem to be associated with lower volatility on the Russian stock market. The paper also points to the link between increased financial liberalization and increased impact of the US returns. Therefore Hayo and Kutan (2004) study implies time varying pattern of the US-Russia relation; however, as opposed to Röckinger and Urga (2001), they utilize a static GARCH model. Finally, Fedorov and Sarkissian (2000) examine the issue of integration at the industry level, finding the not surprising result that integration with the world market proxy is greater the larger and more internationally orientated (through trade) is the typical industry firm.

3. The Russian stock markets

Since published literature on emerging European stock markets usually analyses Russia along with a number of CEE countries, it does not provide much information the organization and development of the Russian stock market. This section aims to fill this gap, focusing in more detail on Russian stock market. Table 1 presents the basic statistics for the CEE markets; recent developments of Polish, Czech and Hungarian markets are analyzed in detail in Schroder (2001).

TABLE 1 ABOUT HERE

3.1. Organization of the Russian stock market

There are a number of stock exchanges in Russia. In terms of value most of stock trading takes place through MICEX (Moscow Interbank Currency Exchange) or through RTS (Russian Trading System). RTS, where trading is in US dollars is dominated by international investors, while Russian traders are concentrated in MICEX (Grigoriev and Valitova, 2002). Moscow Stock Exchange was traditionally a market for shares of Gazprom – the Russian gas monopoly. There are also a number of regional stock exchanges, however their share in stock trading is negligible in comparison with those of MICEX and RTS (see Appendix A for details).

RTS Stock Exchange (Russian Trading System)

RTS Stock Exchange, formerly RTS, was established in the middle of 1995 by leading brokerage companies to organize single regional markets. It is the first and the biggest electronic trading floor in Russia, organized using trading technologies provided by NASDAQ. Initially RTS operated as an OTC market, with settlement in foreign currency only. Nowadays RTS includes the following markets: RTS Classic Market (quote-driven) and RTS Order-driven stock market; FORTS (futures and options trading with ruble settlement); RTS Bonds (bonds trading); RTS Board (the system used for indicative quotation of securities not listed on the RTS); NQS Bills (the system used for indicative quotation of bills issued by Russian companies) (www.rts.ru). Classic market remains the main venue for trading by foreign and domestic investors. Order-driven stock market, established in 2002 in cooperation with Sankt-Peterburg Stock Exchange, aims to develop the ruble stock market segment of RTS. This is an important venue for trading of shares of Gazprom (Russian gas monopoly) and shares of other 200 companies (RTS, 2002).

The official index of the RTS was first calculated on 1 September 1995. It is a market value-weighted index of capitalization of shares on the RTS quoting lists. RTS index is calculated basing on the data from the RTS Classic Market. Since March 1999 RTS index is calculated not only in US Dollars, but also in Russian rubles.

A key feature of the RTS is that trading is concentrated in a small number of companies representing oil and energy sectors. E.g., in 2002 shares of six companies (RAO UES (United Energy Systems), LUKoil, Surgutneftegaz, Yukos and Tatneft) accounted for 72 % of RTS turnover. I.e., in the short term, dynamics of the RTS index is determined by the market leaders. Companies from energy, oil and telecommunication industries account for more than 60 % of RTS capitalization.

RTS is a dynamically developing exchange. By 1999 RTS accounted for about half of the trading volume of the Russian stock market, competing with MICEX. The exchange seeks to expand the range of stocks and other instruments and improve clearing and settlement procedures. In 2002 RTS introduced a market for futures and options, FORTS, although the Austrian Derivatives Exchange had introduced futures and options on RTS as early as 1997. Key indicators of RTS development are presented Table 2 and discussed in the following sub-sections in the context of events of crisis and post-crisis period.

TABLE 2 ABOUT HERE

MICEX (Moscow Interbank Currency Exchange)

MICEX started security trading in March 1997 (FCS, 1997). It is another leading Russian trading floor, where trades are held in stocks of 150 Russian companies, including blue chips RAO UES, LUKoil, Rostelekom and Mosenergo. Total market capitalization is 150 bn USD. 2001 saw a drastic increase in MICEX turnover, as opposed to RTS that saw a decline in its trading in that year. In 2002 volume of transactions in MICEX reached 70 bn US Dollars (www.micex.ru).

MICEX calculates the MICEX Composite Index (market value-weighted index of shares included in MICEX quotation lists) and MICEX10 (arithmetical average of price changes for 10 most liquid stocks), available since 22 September 1997 and 6 January 1998.[1]

[1] See Grigoriev and Valitova (2002) for the analysis of the relationship between RTS and MICEX indices as well as impact of oil and gas prices on their dynamics.

3.2. Development of the Russian stock market

Crises of 1997-1998 and the Russian Stock Market

The crisis in Russian financial markets of 1997-1998 is usually divided into the three periods: October 1997 – January 1998, March – May 1998 and July – August 1998 (IET, 1999; FCS, 1999). During the period to October 1997 RTS was characterized by an increase in trading volume and number of the participants, and the RTS Index displayed an impressive 94 % growth. However, positive tendencies in the stock market were taking place against the background of poor fundamentals of Russian economy (budget crisis, vulnerability of the banking system and high value of short-term government liabilities relatively to the values of the reserves of the Central Bank (IET, 1999), aggravated by instability in international financial markets, in particular, by the events in the South Asian markets in 1997. The latter are seen as those that stipulated the timing of the Russian crisis. As Buchs (1999) elegantly puts it: *"…if the timing as well as the speed of the Russian crisis were definitely linked to the East Asian … events, the underlying vulnerability of Russia was a serious problem which no investor could ignore"*.[2] Under these circumstances, foreign investors that started close monitoring of the economy fundamentals initiated selling government and corporate bonds. Increased demand for foreign currency triggered a sharp decline of the reserves of the Central Bank.[3] These events were reflected in the falling stock market: by January 1998 RTS Index plummeted by 50%.

In March – May 1998 there followed a further 20 % decline in stock market prices. The government crisis, a worsening deficit of the balance of payments and issue of new debt induced

[2] The Asian crisis of the late summer of 1997 saw the meltdown of East Asian currencies that led to further speculative attacks on East Asian financial system components including equity markets, and further spread to the Latin American exchanges. We thus have in our sample two interlinked crises closely following each other that may emerge as potential sources of instability in the relationships.

[3] Buchs (1999) points out, that financial linkages between emerging markets in form of substantial amounts of Russian and Brazilian government debt by Korean banks and Russian short-term bonds (GKO) by Brazilian banks, served as a contagion channel in the course of Asian crisis. Komulainen (1999) indicate another reason behind the spillover effect, namely decline in prices for the row materials stipulated by the decreased demand in Asia.

foreign investors continue selling Russian securities. Despite financial aid provided by IMF and IBRD in July, further decline in prices of the Russian securities took place. The crisis of the Russian banking system provided an additional reason. Russian banks, facing increased claims from the foreign lenders, were induced to sell securities to maintain their currency reserves.[4] As a result, a new wave of price declines took place. On 17 August 1998 the Russian central bank allowed the ruble to devaluate. During August – September 1998 the RTS Index fell by almost 70 %.

Post-Crisis Development

By 1999 international interest in the Russian stock market was very low, reflected in record-low levels of trading activity, which had fallen by 84 % since 1997. Low turnover created pre-conditions for the speculative growth of the market that amounted to 194 % and made RTS the fastest growing market in the world. In the next year, despite the fastest growth of Russian economy since the start of the reforms, the performance of the stock market was disappointing: RTS declined by 20 %. This reflected primarily a decline in price of the Russian blue chips, mostly oil companies depending heavily on the dynamics of the oil prices. However, improving macroeconomic and political situation helped to revive the interest of investors and boost turnover, which more than doubled in 2000 (IET, 2001). During 2001-2003 the Russian market grew, in contrast to the slowdown in the US and EU economies and financial and political instability in Latin American emerging markets. In 2002 RTS grew by one third. In 2003 the political risks of investing in Russian market became important again against the background of the conflict between Yukos and government that resulted in imprisonment of the head of the company M. Khodorkovsky. The market reacted with a 25 % decline during October 2003.[5] However, the overall results of the year were positive due to remarkable increase in prices of the blue chips, stipulated by high oil prices.

[4] See Ippolito (2002) for the excellent review of the state of the Russian banking system during and after the crisis.

[5] See The Economist (2004) about the reaction of the Russian stock market on the development of the Yukos case. RTS plummeted despite soaring oil prices after the rumors about the Yukos bankruptcy strengthened.

Growth of some of the leading companies exceeded 100 % (Norilskij Nikel – 220 %; Mosenergo – 114 %; RAO UES – 112 %).

4. Data and methodology

4.1. Data

Several equity market indices currently exist for Russia. The most widely recognised ones are the RTS Index, the NAUFOR official index, and the MT Index calculated by the Moscow Times newspaper. Other indices include the AK&M information agency and Commersant newspaper indices, with Creditanshtalt-Grant, Russian Brokerage House and CS First Boston all also producing variants of indices. In this paper we use MSCI indices, dollar denominated, on a daily frequency. The indices analyzed are those for Russia, EMU Countries, UK, USA, Japan, Hungary, Czech Republic and Poland. The choice of data reflects a desire to analyze co-movements of the Russian market both with the developed markets and local markets. The data run from December 31, 1994 to October 14, 2004. We use MSCI indices as they are designed to be directly comparable across national exchanges, compiled on a value-weighted basis of freely investible shares. As such they represent here a dataset that is significantly different to the most of the previous studies and are we believe more directly comparable than those used by other studies. Shown in Table 3 are the basic descriptive statistics of the returns of the indices, and in Table 4 the correlation matrix of the returns data. All data in the sample are found to be I(1) in levels of the indices and I(0) in returns using conventional unit root testing procedures of Dickey-Fuller and Phillips-Perron.

FIGURE 1 ABOUT HERE

4.2. Methodology

Johansen Cointegration Tests and VECM Modeling

We are concerned to capture in any modeling both the short run and the long run relationships that may arise. We initially examine the data for cointegration under the Johansen approach. Where we find cointegrating vectors, the parameters of these vectors are then set as constraints in a Vector Error Cointegration Model. This allows us to derive, while addressing long-run equilibrium

relations, the short-run dynamics of the system using impulse response functions (IRF's) and Variance Decomposition Analysis (VDA). We analyze the data in the entire period (December 31, 1994 - October 14, 2004), and in three sub-periods: before 1997, during the 1997-1998 crises period, and from 1999 onward. Thus we first separate crisis and tranquil periods by exogenously defining the duration of these periods, relaying on the market events described in Section 3.2. Since imposing the break dates exogenously may not necessarily reflect the true dynamics of the adjustment process, we proceed with the methodology that allows to estimate the break dates from the data, Gregory-Hansen Residual Based cointegration test.

Gregory - Hansen (1996) Residual Based Cointegration Test

Results of Monte Carlo experiments (Campos, Ericcson, and Hendry, 1996; Gregory and Hansen, 1996) show that when a shift in parameters takes place standard tests for cointegration (like the one of Engle-Granger, 1987) may lose power and falsely signal the absence of equilibrium in the system. A number of tests of unit roots under structural stability are available. In this paper we use the Gregory-Hansen (1996) test. The Gregory-Hansen test assumes the null hypothesis of no cointegration against the alternative hypothesis of cointegration with a single structural break of unknown timing. The timing of the structural change under the alternative hypothesis is estimated endogenously. Gregory and Hansen suggest three alternative models accommodating changes in parameters of the cointegration vector under the alternative. A *level* shift model allows for the change in the intercept only (C):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha' y_{2t} + e_t, \ t = 1,.....,n \quad (1)$$

The second model accommodating a trend in data also restricts shift only to the change in *level with a trend* (C/T):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta t + \alpha' y_{2t} + e_t, \ t = 1,.....,n \quad (2)$$

The most general specification allows for changes both in the *intercept and slope* of the cointegration vector (R/S):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1' y_{1t} + \alpha_2' y_{2t} \varphi_{t\tau} + e_t, \;\; t = 1,.....,n \quad (3)$$

The dummy variable, which captures the structural change, is represented as:

$$\varphi_{t\tau} = \begin{cases} 0, \; t \le [n\tau] \\ 1, \; t > [n\tau] \end{cases}, \quad (4)$$

where $\tau \in (0,1)$ is a relative timing of the change point. The trimming interval is usually taken to be (0.15*n*, 0.08*n*), as recommended in Andrews (1993). The models (1)-(3) are estimated sequentially with the break point changing over the interval $\tau \in (0.15n, 0.85n)$. Non-stationarity of the obtained residuals, expected under the null hypothesis, is checked by ADF and PP tests. Setting the test statistics (denoted as ADF* (Za*, Zt*)) to the smallest value of the ADF (Za, Zt) statistics in the sequence, we select the value that constitutes the strongest evidence against the null hypothesis of no cointegration.

DCC-GARCH Approach

We also use the recent Dynamic Conditional Correlation specification of Multivariate GARCH models (Engle, 2002) to model the main series for which we find significant relationships. Unlike the previous methodologies we analyze the multivariate relationships using returns of the indices. Arising from the Gregory-Hansen and the Johansen-Juselius approach we identify the variables that are related in longterm equilibrium and then model these using the multivariate GARCH model. We use a parsimonious approach, describing the mean and variances as both ARMA(1,1) processes. This is strictly ad-hoc. The data are modeled as a DCC-GARCH(1,1) process, within a four variable system. The major advantage of this formulation is that while it preserves the main features of standard multivariate GARCH models it allows for explicit time variation in the conditional covariance (and correlation) matrix. The extraction of the conditional time varying correlations allows us to examine the short-run dynamics of the series that are linked by a long-run relationship. It also allows to trace the effects attributed to the sequence of crisis events that took place throughout the sample.

5. Results

We examine the data over the entire period and over three sub periods as shown above. We use two techniques, as discussed, the Johansen multivariate method and the Gregory-Hansen approach. We show the results for the Johansen approach in Table 5 and the Gregory-Hansen approach in Table 6, Table 7, and Table 8. We show in Table 9 the variance decomposition for the four periods. Two distinctly different stories emerge from these methods.

5.1. Johansen multivariate cointegration test, VARs and IRFs results

A number of features arise from a Johansen analysis over the entire period (Table 5). Johansen cointegration tests based on a lag length of 2[6] indicates absence of cointegrating vectors. This, if correct, would have important finance implications. The first is that there is no long run stable relationship between the various equity markets. As a consequence, there are potential gains from international diversification, the series all moving separately with no shared common stochastic trend.

TABLE 5 ABOUT HERE

This evidence is relatively unusual. Although earlier studies on cointegration that used bivariate Engle-Granger approach have found little evidence in favour of cointegration, the later papers that used the more sophisticated Johansen multivariate approach generally find stronger evidence of integration. To the former group belong works of Kasa (1992) that finds a single cointegrating vector indicating low levels of integration, Arshanapalli and Doukas (1993) that document similar results for world market. Gallagher (1995) finds no evidence of cointegration between Irish and either German or UK equity markets. Studies that, like the present analysis, have used Johansen multivariate approach, find stronger evidence of integration. Some evidence of integration is found in Chou, Ng et al. (1994) for the G7 countries, Hung and Cheung (1995) for the Asian markets, Kearney (1998) for Irish and European markets, Gilmore and McManus (2002) for US – Central

[6] In all cases and sub-periods we found that a lag of 2 was appropriate for VAR analyses, based on the Hannan-Quinn and Schwartz criteria. Except for Poland in the precrisis period we find, using ADF tests, that the data are I(1).

European markets, and Ratanapakorn and Sharma (2002) and Manning (2002) for Southeast Asian, European and US markets. This is not unanimous however, with Kanas (1988), Chan, Gup et al. (1992) and Allen and Macdonald (1995) finding evidence of segmentation.

Having found no long-term relationship, we proceed to a Vector Autoregression without the need to impose error correction terms. We order the data based on the contemporaneous correlation between the equity indices, giving the ordering shown. Based on Block Exclusion tests we find that all variables apart from EMU and Czech Republic (CZ) have an impact on Russia. An examination of the residual correlation matrix indicates that there is strong remaining correlation between the variables, and thus while Impulse Response Functions (IRF) can be derived we cannot, except in the case of Russia-Japan, ascribe the resulting shocks to the perturbed series. For the Japan (JP) case we find that a positive shock in Japan leads to a rapid and sustained drop in the Russian market return of .4%.

FIGURE 2 ABOUT HERE

Examining the pre-crisis period, December 1994 – December 1996, we again find no long-run relationship present in the data, again indicating that over that period there would have been diversification benefits from investing in the area (see Table 5). There is a different order implied in the VAR model than that for the overall period. In common with the findings for the entire period, we find, based on block exogeneity tests, that all series apart from EMU and CZ have an impact on Russia.

Apart from Poland the residuals are uncorrelated with the Russian market, and so we can examine IRF's. The evidence from the IRF's is mixed with regard to the markets. Local CEE markets provide little stimulus to the Russian market, while it responds strongly positively to rises in US and EMU markets and falls against UK and Japanese markets.

FIGURE 3 ABOUT HERE

During the period around the Russian and Asian crises, defined as 1997-1998 here, we find emerging some evidence of long-run relationships (see Table 5). During the crisis period we find a

single cointegrating vector, between Russia and Japan, emerging. This provides some evidence of weak international integration. However, after the crisis period, while there is increased evidence of integration, with two cointegrating vectors, Russia is not bivariatly correlated with any of the other variables. Again we find that all variables, apart from the Czech and EMU, have a significant impact on Russia. The strong correlations evident between the majority of the variables, apart from RU-JP and RU-CZ, renders interpretation of the IRF's uncertain. Again, the response to the Japanese market is negative, consistently overall, while the response to the EMU is mixed, starting negative and then rising to end positive. The evidence is that, consistently, the Russian market responds negatively to shocks in the Japanese and positively to shocks from the USA with mixed responses to UK and EMU markets and negligible responses to local markets (Poland, Czech and Hungary).

FIGURE 4 ABOUT HERE

Therefore the evidence from Johansen cointegration tests suggests that the Russian equity market remains segmented from the world equity markets. With the exception of the crisis period there was and remains a benefit to international diversification by including holdings of Russian equities for the investors of the other countries examined. Even within a VAR system we find that the market has remained relatively isolated. In particular, Russian equities remain segmented from the EMU markets.

5.2. Gregory-Hansen test results

Turning however to the Gregory-Hansen approach, we find a different situation as regards long-run relationships. For the Russian market the test indicates the presence of a number of bivariate cointegration relations with major markets. In particular, we find that the Russian market was cointegrated with the EMU, UK and USA, albeit with a break in the relationship. In the multivariate setting break is found in the cointegration vector for Russia and two groups of the developed markets (including and excluding Japan). Overall we find a number of unique breakpoints. These are all in the period June-August 1998, corresponding exactly to the etiology of

the crisis. The breaks detected were 01/06/98, 02/06/98, 08/06/98, 06/07/98, 09/07/98, 11/08/98. The final break point was therefore set at 31/7/98, to allow for the gradual adjustment. These results lead us to suggest that despite the serious impact on world markets of the Asian crisis of 1997 we find no evidence here that this crisis had an immediate effect on the stability of relationships between Russia and developed or regional markets.

Using 31/7/98 as the breakpoint in Table 7 and Table 8 we show the results of further Gregory-Hansen analyses. In the 'pre-crisis' period, up to 31/7/98, we find no evidence of bivariate cointegration relations between the Russian market and any other market or group of markets (Table 7). This corresponds to the results of Johansen cointegration tests showing that the Russian stock market remained isolated until 1997. In the 'post-crisis' period, defined relaying on Gregory-Hansen test results as 01/08/98 - 14/10/04, we find evidence of bivariate cointegration relations for all four developed markets, again however with a break (Table 8). This break holds both individually and as a group. In the multivariate setting break is found in the cointegration vector for Russia and two groups of the developed markets (including and excluding Japan). We also find, for the first time, some evidence of increased integration with regional economies, the Gregory-Hansen techniques showing evidence in favour of cointegration with Poland, and very weak evidence for cointegration with Hungary. Therefore Gregory-Hansen test results strengthen weak evidence in favor of increased integration of the Russian stock market provided by the Johansen tests. The test suggest that the long-run market co-movements has strengthened after the major crisis events in the Russian economy have taken place; the test thus indicates the importance of the Russian crisis for the dynamics of the long-run relationships between the Russian and developed stock markets.

5.3. DCC-GARCH results

Whether the pattern of the short-run interdependencies between the Russian and major developed markets has been affected in a similar manner is examined by means of the DCC-GARCH model. The correlations are derived from a quadrivariate ARMA(1,1)-DCC-GARCH(1,1)

model estimated over the 1995-2001 period. Shown in Figure 6 are the estimated daily conditional correlations between Russia and the main developed markets.

FIGURE 6 ABOUT HERE

The marked change in the pattern of conditional correlations in summer of 1997, at the time of the Asian crisis, is evident. As emerges from Figure 6, during the period of Asian crisis the correlations with the major equity indices raised dramatically by mid 1997, especially with EMU markets. In the second half of 1997, as the crisis was unfolding, the strength of the short-term dependencies weakened reflected in falling conditional correlations, especially in the cases of the UK and EMU; correlations with the USA remained relatively stable. Interestingly, correlation level with the USA has remained the lowest of the three correlation series. Second rise in conditional correlations with EMU and UK followed in the first half of 1998, coinciding with the first phase of the Russian crisis. This rise in the extent of short-term relationship preceded the break in the long-term relationships in August 1998 point indicated by the Gregory-Hansen test. Towards the end of 1999, as the crisis was evolving, we again observe a sharp decline in the intensity of the co-movements as the events in the domestic market started to dominate influences from abroad. Simple visual inspection of the Figure 6 suggests presence of the three periods with differing patterns of the conditional correlations: before 1997 (upward trend, low volatility), 1997-1998 (with two major peaks in the series), and since 1999 (no distinct trend, high volatility; higher levels than before 1997). The evidence from conditional correlations provides an indirect support to our exogenous division of the sample in the three sub-periods used in Section 4.1. The DCC analysis suggests, not surprisingly, that short-term interdependencies between the Russian and the developed stock markets underwent major changes in the 1997-98 period and have been generally strengthening afterwards.

5.4. Variance Decomposition results

Shown in Table 9 are variance decompositions, showing the percentage of forecast errors, over a 10-day period, that are attributable to each series. The table reports results using exogenous break

point to separate crisis period. However, the results using the break points suggested by Gregory-Hansen approach lead to the same conclusions.

TABLE 9 ABOUT HERE

An interesting feature that emerges from Table 9 is the changing role of the EMU markets as a source of volatility of the Russian stock market. Whereas movements in the European markets played an important role for the Russian stock market during the crisis, their importance dropped significantly afterwards, therefore leaving the USA a dominant source of influence on the Russian market, albeit the dominance of the latter has also fallen post crisis. During the crisis another dominant market appeared to be the Japanese one. Post-crisis, we find that shocks in EMU or local markets play little role in determining changes in the Russian market.

6. Conclusion

We have examined the relationship between Russian, developed markets, and other Central and Eastern European equity markets over the 1995-2004 period. During this period the Russian crisis of 1997-1998 had major impacts on equity markets worldwide. Using traditional Johansen multivariate cointegration approaches and examining Impulse Response Functions from Vector-Error Correction Models we find that the extent of the relationship differs markedly before and after the Russian crisis of 1998. However, further examination, using the Gregory-Hansen approach, indicates that the effect of the Russian crisis is more complex, and that Russian market shows significantly more evidence of integration with developed markets since, albeit the extent of interdependencies differs in case of the US and European markets. The USA remains the dominant market from which shocks impact on the Russian market A DCC-GARCH model indicates that the conditional relationships between the Russian market and the main developed markets is, as shown by the Gregory-Hansen approach, shifting. No clear effect of the Asian crisis is evident from our analysis, with the DCC measures showing it to have had a major effect, the Gregory-Hansen tests, not.

Acknowledgements

Research assistance of Thomas Lagoarde Segot and Terhi Jokipii is gratefully acknowledged. We wish also to thank the participants in the IIIS Workshop in International Financial Integration, in particular Patrick Geary, Thomas Flavin and Margaret Hurley.

Appendix A. Russian Stock Exchanges

RTS Stock Exchange (www.rts.ru)

Moscow Interbank Curency Exchange (www.micex.ru)

Moscow Stock Exchange (www.mse.ru)

Sankt-Petersburg Stock Exchange (www.spbex.ru)

Rostov Currency and Stock Exchange (www.rndex.ru)

Nizhny Novgorod Stock and Currency Exchange (www.nnx.ru)

Kazan Board of Security Trade (www.kbst.ru)

Ekaterinburg Stock Exchange (www.ese.ru)

Siberian Interbank Currency Exchange (www.sice.ru)

Ural Regional Currency Exchange (www.urvb.ru)

References

Andrews, D.W.K., 1993. Tests for parameter instability and structural change with unknown change point. Econometrica 61, 821–856.

Buchs, T. D., 1999. Financial crisis in the Russian Federation: are the Russians learning to tango? Economics of Transition 7, 687–715.

Baele, L., Crombez J., and Schoors, K., 2003. Are Eastern European equity markets integrated? Evidence from a regime-switching shock spillover model. Working Paper, Ghent University.

Baig, T., Goldfain I., 2000. The Russian default and the contagion to Brazil. IMF Working Paper WP/00/160.

Bekaert, G., Harvey, C. R., 1995. Time-varying world market integration. The Journal of Finance 50, 403–444.

Bekaert, G., Harvey, C. R., 1997. Emerging equity market volatility. Journal of Financial Economics 43, 29–4.

Campos, J., Ericcson, N.R., Hendry, D.F., 1996. Cointegration tests in the presence of structural breaks. Journal of Econometrics 70, 187–220.

Charemza, W. W., Majerowska E., 2000. Regulation of the Warsaw Stock Exchange: the portfolio allocation problem. Journal of Banking and Finance 24, 555–576.

Chen, Z., Knez, P., 1995. Measurement of market integration and arbitrage. Review of Financial Studies 8, 287–325.

Dungley, M., Fry R., Gonzales-Hermosillo B., and Martin V., 2003. Unanticipated shocks and systemic influences: the impact of contagion in global equity markets in 1998. IMF Working Paper WP/03/84.

Engle, R.F., 2002. Dynamic conditional correlation: a new simple class of multivariate GARCH models. Journal of Business and Economic Statistics 20, 339–350.

FCS, 1997. Annual Report 1997, in Russian. www.fcsm.ru.

FCS, 1998. Annual Report 1998, in Russian. www.fcsm.ru.

FCS, 2001. Annual Report 2001, in Russian. www.fcsm.ru.

FCS, 2002. Annual Report 2002, in Russian. www.fcsm.ru.

Fedorov, P., Sarkissian S., 2000. Cross-sectional variations in the degree of global integration: the case of Russian equities. Journal of International Financial Markets, Institutions and Money 102, 131–150.

Gelos, G., Sahay R., 2000a. Financial market spillovers in transition economies. IMF Working Paper WP/00/71.

Gelos, G., Sahay R., 2000b. Financial market spillovers in transition economies. Economics of Transition 91, 53–86.

Gilmor C.G., McManus G.M., 2002. International portfolio diversification: US and Central European equity markets. Emerging Markets Review 3, 69–83.

Gilmore, C. G., McManus, G. M., 2001. Random-walk and efficiency tests of Central European Markets. Paper prepared for presentation at the European Financial Management Association Conference 2001, Lugano, Switzerland

Goetzmann, W., Li, L., Rouwenhorst, K. G., (2000). Long-term global market correlations. Yale ICF Working Paper No. 00-60.

Goetzmann, W. N., M. Speigel and Ukhov A., 2003. Modeling and measuring Russian corporate governance: the case of Russian preferred shares. NBER Working Paper 9469.

Grigoriev, L., Valitova L., 2002. Two Russian Stock Exchanges: analysis of relationships, Russian Economic Trends 113, 44–53

Hall, S., Urga, G., 2002. Testing for ongoing efficiency in the Russian stock market. Manuscript.

Hansen, H., Johansen, S., 1993. Some tests for parameter constancy in cointegrated VAR-models. Manuscript.

Hayo, B., Kutan, A. M., 2004. The Impact of news, oil prices, and global market developments on Russian financial markets. The William Davidson Institute Working Paper Number 656.

Henke, H., 2003. Tax-loss selling and window-dressing: an investigation of the January effect in Poland. Working Paper, European University Viadrina.

Hernández, L. F., Valdés, R. O., 2001. What drives contagion: trade, neighborhood, or financial links? International Review of Financial Analysis 10, 203–218.

Heston, S.L and Rouwenhorst, K.G., 1994. Does industrial structure explain the benefits of international diversification? Journal of Financial Economics 36, 3–27.

IET, 1999. Russian Economy in 1998. Tendencies and Perspectives in Russian. www.iet.ru.

IET, 2000. Russian Economy in 1999. Tendencies and Perspectives in Russian. www.iet.ru.

IET, 2001. Russian Economy in 2000. Tendencies and Perspectives in Russian. www.iet.ru.

IET, 2002. Russian Economy in 2001. Tendencies and Perspectives in Russian. www.iet.ru.

IET, 2003. Russian Economy in 2002. Tendencies and Perspectives in Russian. www.iet.ru.

IET, 2004. Russian Economy in 2003. Tendencies and Perspectives in Russian. www.iet.ru.

Ippolito, F., 2002. The banking sector rescue in Russia. BOFIT Working Paper 2002 No. 12.

Jithendranathan, T., Kravchenko, N., 2004. Integration of Russian equity markets with the world equity markets – effects of the Russian financial crisis of 1998. Working Paper, University of St Thomas.

Jochum, C., Kirchgässner, G., Platek, M., 1998. A long-run relationship between Eastern European markets? Cointegration and the 1997/98 crisis in emerging markets, Weltwirtschaftliches Archiv 1353, 454–479.

Kolodyazhny, G., Medvedev, A., 2002. Microstructure of Russian stock market and profitability of market making. Economic Education and Research Consortium – Russia and CIS Working Paper.

Komulainen, T., 1999. Currency crisis theories – some explanations for the Russian case. BOFIT Discussion Papers 1999 No. 1.

Korajczyk, R., 1996. A measure of stock market integration for developed and emerging markets. The World Bank Economic Review, 267–289.

Linne, T., 1998. The integration of the Central and Eastern European equity markets into the international capital markets. Institut für Wirtschaftsforschung Halle Working Paper 1/1998.

Longin, F., Solnik B., 1995. Is the correlation of international equity returns constant: 1960-1990? Journal of International Money and Finance 141, 3–26.

Mateus, T., 2004. The risk and predictability of equity returns of the EU accession countries. Emerging Markets Review 5, 241–266.

Pagano, M., 1993. Financial markets and growth: an overview. European Economic Review 37, 613–622.

Ratkovicova, M., 1999. Driving Factors of Efficiency of CEE Capital Markets. CASE-CEU Working Paper Series, Warsaw.

Röckinger, M., Urga, G., 2000. The evolution of stock markets in transition economies. Journal of Business and Economic Statistics 191, 73–84.

Röckinger, M., Urga G., 2001. A time-varying parameter model to test for predictability and integration in the stock markets of transition economies. Journal of Business and Economic Statistics 191, 73–84.

Roll, R. 1992. Industrial structure and the comparative behaviour of international stock market indices. Journal of Finance 47, 3–41.

RTS, 1997. Annual Report, in Russian. www.rts.ru.

RTS, 1998. Annual Report, in Russian. www.rts.ru.

RTS, 1999. Annual Report, in Russian. www.rts.ru.

RTS, 2000. Annual Report, in Russian. www.rts.ru.

RTS, 2001. Annual Report, in Russian. www.rts.ru.

RTS, 2002. Annual Report, in Russian. www.rts.ru.

RTS, 2003. Annual Report, in Russian. www.rts.ru.

Scheicher, M., 2001. The comovements of the stock markets in Hungary, Poland and the Czech Republic. International Journal of Finance and Economics 6, 27–39.

Schröder, M., Eds. 2001. The New Capital Markets in Central and Eastern Europe. Springer-Verlag Berlin Heidelberg New York.

The Economist, 2004. That sinking feeling, June 5th 2004.

UNCTAD, 2004a. FDI country profiles: Poland.
http://www.unctad.org/Templates/Page.asp?intItemID=3198&lang=1.

UNCTAD, 2004b. FDI country profiles: Czech Republic.
http://www.unctad.org/Templates/Page.asp?intItemID=3198&lang=1.

UNCTAD, 2004c., FDI country profiles: Hungary.
http://www.unctad.org/Templates/Page.asp?intItemID=3198&lang=1.

Figure 1: MSCI Indices, Russia, CEE and Developed Markets

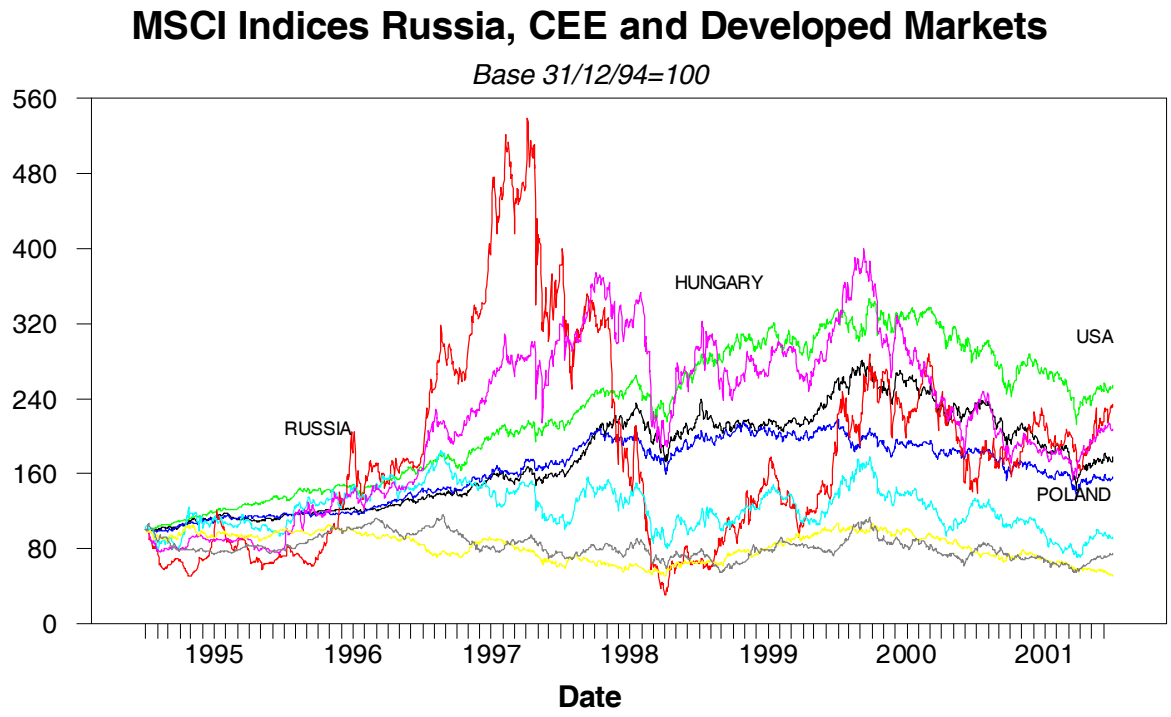

Figure 2: Impulse Response Functions for the Overall Period, 30/12/1994–14/10/2004

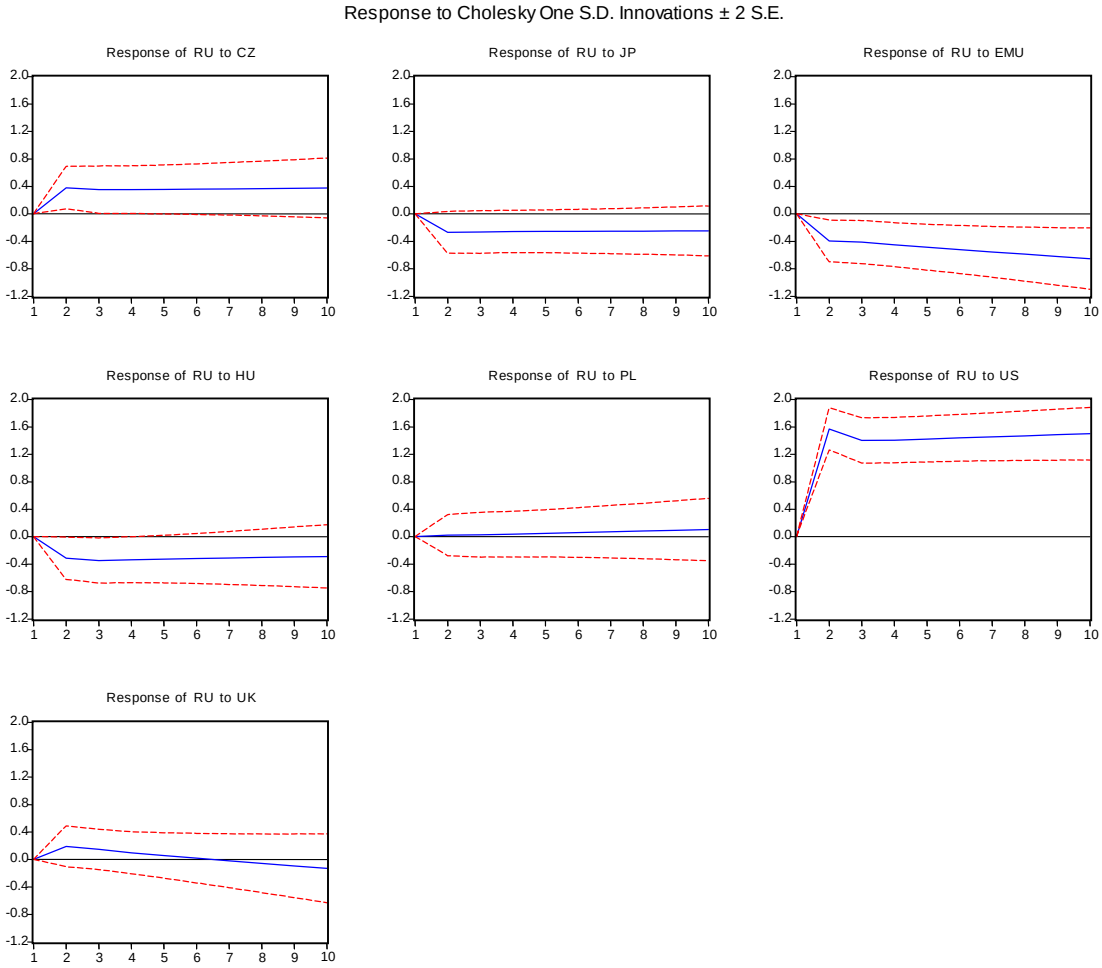

Figure 3: Impulse Response Functions for the Pre-crisis Period

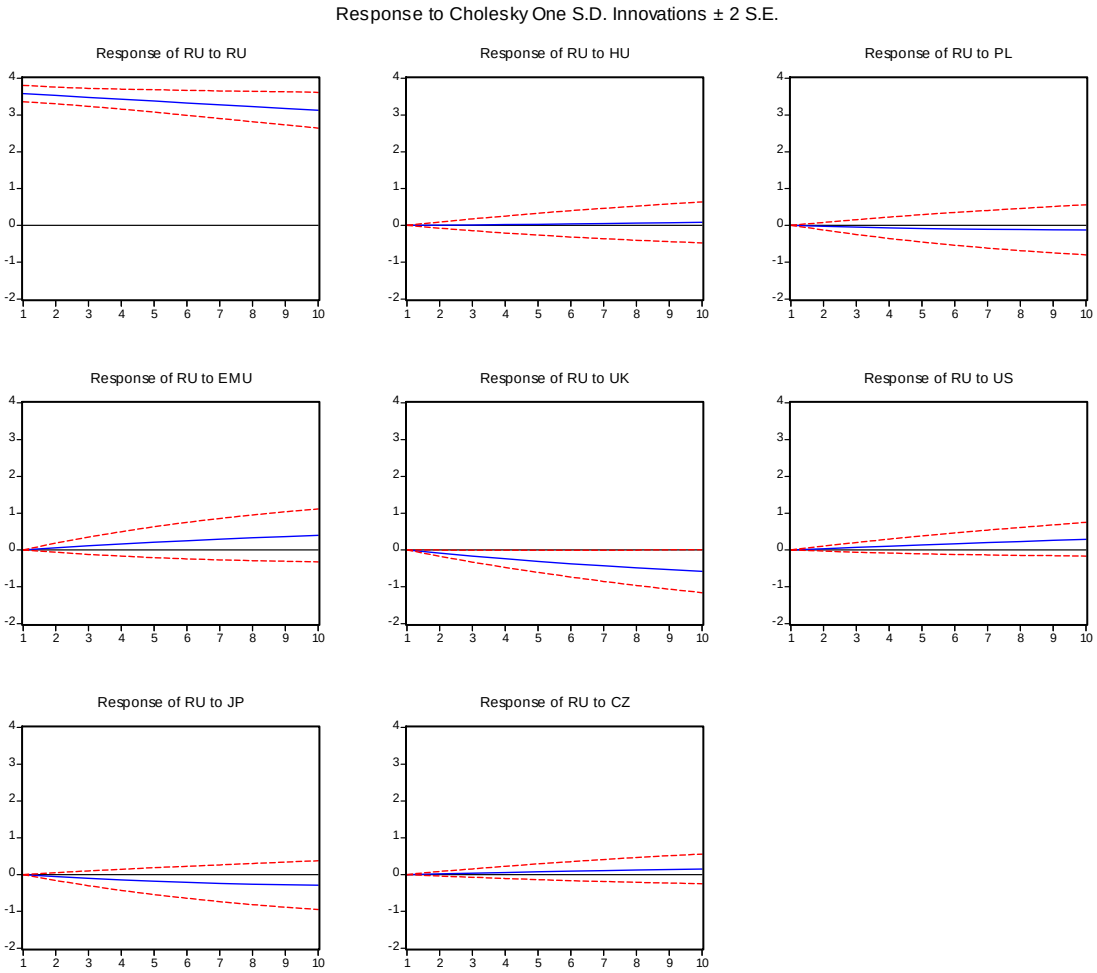

Figure 4: Impulse Response Functions for the Crisis Period 1997–1998

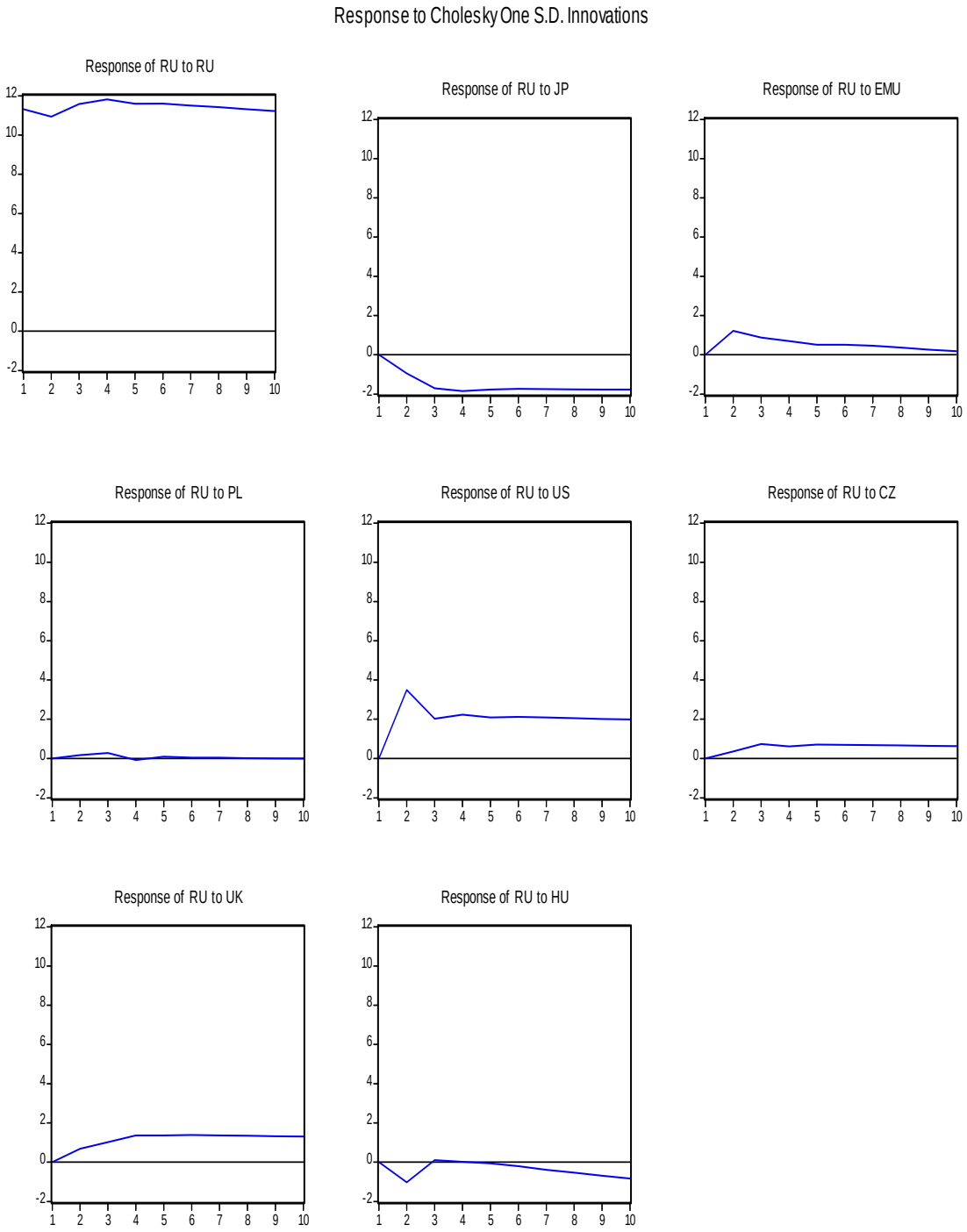

Figure 5: Impulse Response Functions for the Post-crisis Period 1999–2003

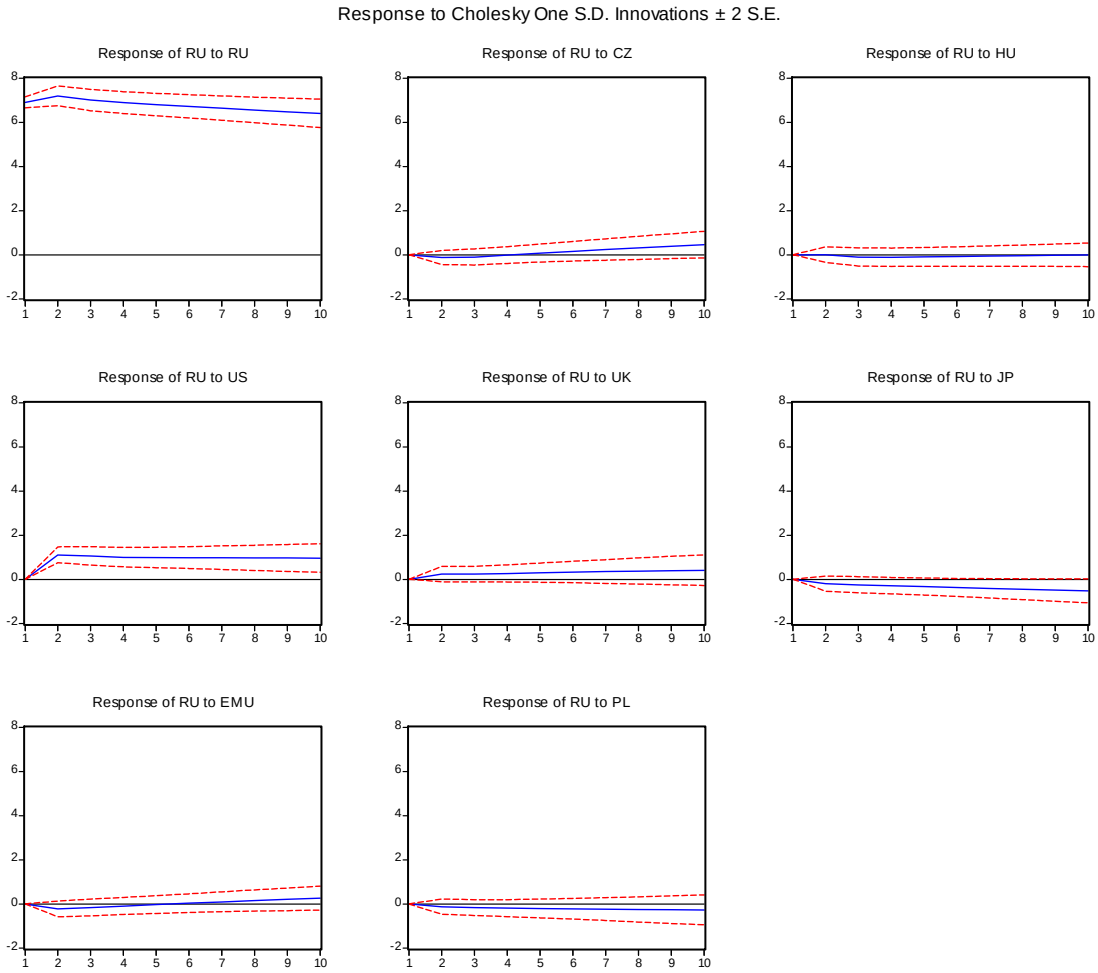

Figure 6: Conditional Correlation Coefficients from ARMA (1, 1) -DCC-GARCH (1, 1) Model

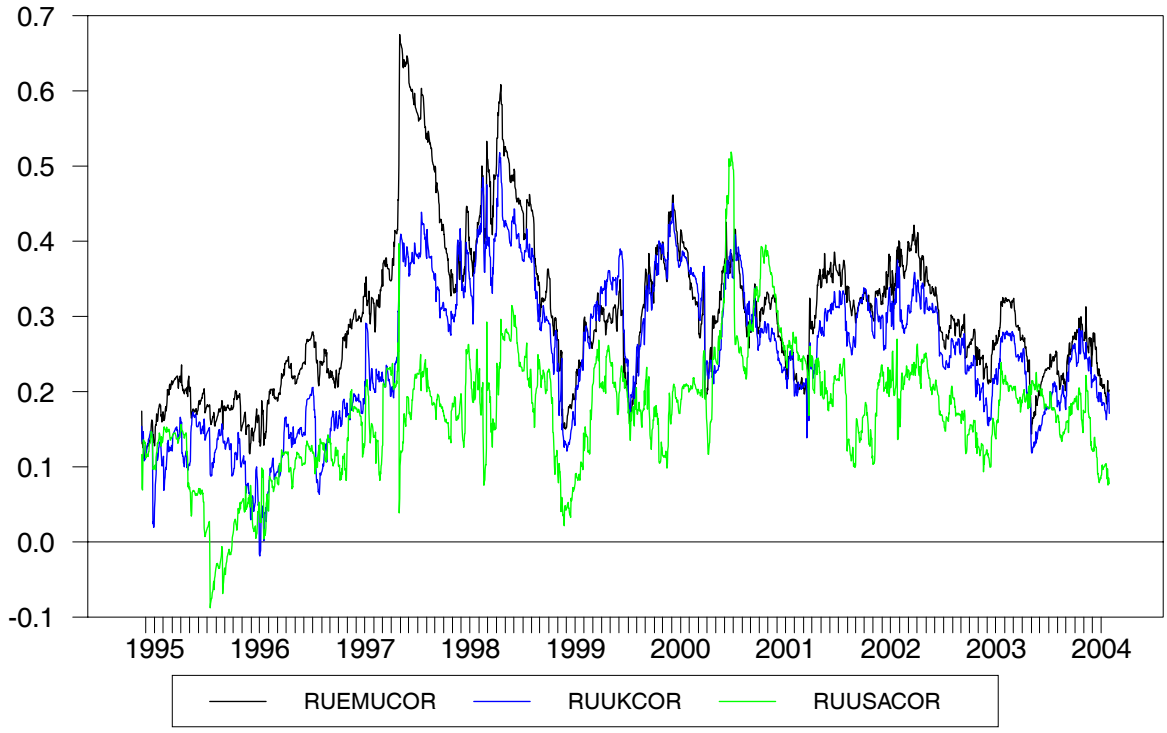

Table 1: CEE Stock Markets as of December 2003

INDICATOR	RUSSIA*	POLAND	HUNGARY	CZECH REPUBLIC
Market capitalization, mn USD	72,210	28,849	12,988	25,122
Value of Share Trading, 2003, mn USD		9,662	8,269	9,187
Number of listed securities	207	203	49	65
Local index, Dec. 2003	RTS	WIG 20,820.07	BUX 9,379.99	PX 50 659
Local index, % change 2002–2003	57 %	44.9%	20.3%	43%
Market capitalization as % of the GDP	22 %	14%	17%	

Source: World Federation of Stock Exchanges (http://www.world-exchanges.org), Prague Stock Exchange (www.pse.cz)

Table 2: Key Indicators for RTS Stock Exchange

	1995*	1996	1997	1998	1999	2000	2001	2002	2003
Market capitalization, bn USD	.	.	.	.	32.4	35	69.2	92.9	72.2
Value of Stock Trading, bn USD	0.22	3.54	15.6	9.3	2.4	5.8	4.9	4.6	6.1
Average Daily Turnover, mn USD	.	.	62.7	36.9	9.5	23.3	19	18	24
Number of listed securities	.	.	324	369	358	391	368	247	312
Stock Exchange Index: RTS	82.92	200.50	396.41	58.9	175.3	143.3	256.8	359.1	567.3
RTS, % change to previous year	-17%	129%	98%	-86%	194%	-20%	96%	34%	57 %

Source: RTS Annual Reports, various issues

Table 3: Basic Descriptive Statistics (% returns data), 1994–2004

	EMU	UK	USA	Russia	Poland	Hungary	Japan	Czech
N	2555	2555	2555	2555	2555	2555	2555	2555
Minimum	-5.84%	-5.27%	-6.97%	-28.10%	-11.59%	-19.01%	-7.16%	-7.39%
Maximum	5.72%	5.26%	5.61%	24.22%	9.02%	13.00%	12.27%	6.76%
Mean	0.03%	0.02%	0.03%	0.07%	0.02%	0.06%	-0.02%	0.03%
Std. Deviation	1.23%	1.09%	1.14%	3.42%	1.96%	1.96%	1.48%	1.52%
Skewness	- 0.1775	- 0.1810	- 0.1200	- 0.3309	- 0.1105	- 0.5793	0.2593	- 0.1349
Kurtosis	2.2533	2.2708	3.2349	8.0672	2.5049	9.9245	3.2632	2.0393

Table 4: Correlation Matrix (% returns data), 1994–2004

	UK	USA	Russia	Poland	Hungary	Japan	Czech
EMU	0.7665	0.4259	**0.3097**	0.3397	0.3984	0.2152	0.3743
UK		0.3722	**0.2576**	0.2730	0.3090	0.1749	0.2927
USA			**0.1574**	0.1278	0.1387	0.0664	0.1168
Russia				**0.2730**	**0.3326**	**0.1336**	**0.2585**
Poland					0.4081	0.2216	0.3329
Hungary						0.2047	0.3569
Japan							0.1764

Table 5: Johansen Cointegration Tests

	Trace =0	Trace=1	Trace=2	Max=0	Max=1	Max=2
Overall	105.3236	70.10955	44.59244	35.21407	25.51711	17.36702
Precrisis	151.1522	92.27682	63.73410	58.87537	28.54272	24.35854
Crisis	151.1522	92.27682	63.73410	58.87537***	28.54272	24.35854
Post Crisis	179.8941***	125.3571*	78.32393	54.53705***	47.03316**	26.91778

Table shows the results of a Johansen-Juselius Multivariate cointegration test . Null hypothesis is that of a specificed or maxiumum number of cointegrating relationships (trace and max statistics respectively) ***, **, * - denotes significance at the 1, 5 and 10 % levels respectively

Table 6: Gregory-Hansen Cointegration Tests: Overall Period

Variables	Model	ADF	Break point/Date	PP Zt	Break point/Date	PP Za	Break point/Date
Russia – EMU	C	-2.62	0.157	-2.39	0.155	-12.73	0.155
Russia – EMU	C/T	-5.24**	0.351 (08/06/'98)	-5.06**	0.349 (01/06/'98)	-49.81**	0.349 (02/06/'98)
Russia – EMU	C/S	-2.73	0.335	-2.63	0.334	-14.86	0.336
Russia – UK	C	-2.79	0.157	-2.56	0.155	-14.44	0.155
Russia – UK	C/T	-4.99*	0.359 (06/07/'98)	-4.85*	0.349 (01/06/'98)	-45.44*	0.349 (01/06/'98)
Russia – UK	C/S	-2.96	0.329	-2.90	0.329	-18.07	0.335
Russia – USA	C	-2.65	0.157	-2.38	0.155	-12.54	0.155
Russia – USA	C/T	-5.74***	0.359 (06/07/'98)	-5.53***	0.349 (01/06/'98)	-57.87***	0.360 (09/07/'98)
Russia – USA	C/S	-2.63	0.157	-2.52	0.234	-12.71	0.234
Russia – Japan	C	-2.28	0.157	-2.17	0.849	-9.42	0.155
Russia – Japan	C/T	-3.86	0.359	-3.74	0.360	-28.33	0.360
Russia – Japan	C/S	-2.60	0.296	-2.41	0.294	-12.79	0.294
Russia – EMU, UK, USA	C	-4.80	0.500	-5.15*	0.509	-52.63*	0.509
Russia – EMU, UK, USA	C/T	-6.01**	0.359 (06/07/'98)	-5.86**	0.360 (09/07/'98)	-64.43**	0.360 (09/07/'98)
Russia – EMU, UK, USA	C/S	-5.29	0.515	-5.52	0.509	-60.29	0.509
Russia – All Developed Markets	C	-5.34*	0.516	-5.49*	0.509	-59.66**	0.509
Russia – All Developed Markets	C/T	-5.99**	0.359 (09/07/'98)	-5.95**	0.369 (11/08/'98)	-65.54**	0.369 (11/08/'98)
Russia – All Developed Markets	C/S	-5.27	0.524	-5.84	0.513	-67.37	0.513
Russia – Poland	C	-3.35	0.652	-3.43	0.652	-22.46	0.652
Russia – Poland	C/T	-4.20	0.360	-4.08	0.360	-33.63	0.360
Russia – Poland	C/S	-3.60	0.649	-3.59	0.637	-25.71	0.636
Russia – Hungary	C	-2.36	0.606	-2.29	0.293	-10.49	0.293
Russia – Hungary	C/T	-4.47	0.359	-4.31	0.360	-37.23	0.360
Russia – Hungary	C/S	-2.45	0.304	-2.36	0.299	-11.13	0.299
Russia – Czech Republic	C	-3.09	0.157	-2.86	0.155	-16.42	0.155
Russia – Czech Republic	C/T	-3.85	0.359	-3.69	0.360	-27.14	0.360
Russia – Czech Republic	C/S	-3.07	0.157	-2.84	0.155	-16.22	0.155
Russia – All CEE Markets	C	-3.16	0.659	-3.12	0.653	-19.65	0.65
Russia – All CEE Markets	C/T	-5.31**	0.360	-5.21	0.349	-51.87	0.35
Russia – All CEE Markets	C/S	-4.78	0.336	-4.79	0.337	-45.55	0.33

Model specifications for the bivariate cointegration relationship: C – level shift (change in constant); C/T – level shift with trend (model with a linear trend and change in constant only); C/S – regime shift (model with change in both constant and slope). Critical values are taken from Gregory and Hansen (1996). ***, **, * - denotes significance at the 1, 5 and 10 % levels respectively.

Table 7: Gregory-Hansen Cointegration Tests: Pre-crisis Period 30/12/1994–31/07/1998

Variables	Model	ADF	Break point/Date	PP Zt	Break point/Date	PP Za	Break point/Date
Russia – EMU	C	-2.59	0.429	-2.47	0.850	-14.19	0.850
Russia – EMU	C/T	-3.37	0.207	-3.47	0.200	-24.38	0.200
Russia – EMU	C/S	-4.10	0.774	.4.08	0.768	-28.06	0.768
Russia – UK	C	-3.48	0.845	-3.53	0.850	-23.26	0.850
Russia – UK	C/T	-3.27	0.850	-3.36	0.850	-20.92	0.850
Russia – UK	C/S	-3.49	0.771	-3.52	0.769	-23.45	0.769
Russia – USA	C	-2.86	0.847	-2.90	0.849	-14.69	0.849
Russia – USA	C/T	-2.86	0.398	-2.85	0.398	-17.07	0.398
Russia – USA	C/S	-3.55	0.670	-3.48	0.679	-20.69	0.679
Russia – Japan	C	-2.87	0.429	-2.53	0.424	-14.16	0.421
Russia – Japan	C/T	-2.81	0.848	-2.73	0.558	-16.79	0.558
Russia – Japan	C/S	-3.15	0.667	-3.10	0.694	-19.75	0.694
Russia – EMU, UK, USA	C	-3.71	0.842	-4.02	0.199	-28.24	0.186
Russia – EMU, UK, USA	C/T	-4.29	0.369	-4.27	0.363	-33.99	0.363
Russia – EMU, UK, USA	C/S	-4.63	0.768	-4.88	0.393	-44.30	0.393
Russia – All Developed Markets	C	-3.80	0.394	-4.01	0.199	-28.19	0.199
Russia – All Developed Markets	C/T	-4.42	0.569	-4.28	0.363	-34.70	0.568
Russia – All Developed Markets	C/S	-4.78	0.768	-5.04	0.393	-46.74	0.393
Russia – Poland	C	-2.87	0.429	-2.56	0.424	-14.36	0.642
Russia – Poland	C/T	-2.72	0.832	-2.55	0.850	-12.95	0.804
Russia – Poland	C/S	-3.03	0.541	-2.76	0.540	-17.13	0.543
Russia – Hungary	C	-3.18	0.845	-3.04	0.850	-21.38	0.839
Russia – Hungary	C/T	-3.28	0.838	-3.12	0.839	-22.53	0.839
Russia – Hungary	C/S	-3.28	0.786	-3.32	0.688	-24.12	0.688
Russia – Czech Republic	C	-3.78	0.379	-3.27	0.382	-21.26	0.382
Russia – Czech Republic	C/T	-2.72	0.848	-2.57	0.382	-14.26	0.382
Russia – Czech Republic	C/S	-3.01	0.363	-3.01	0.395	-19.32	0.395
Russia – All CEE Markets	C	-3.33	0.817	-3.18	0.816	-23.87	0.816
Russia – All CEE Markets	C/T	-3.37	0.817	-3.21	0.816	-24.18	0.816
Russia – All CEE Markets	C/S	-4.44	0.837	-4.23	0.836	-35.97	0.836

Model specifications for the bivariate cointegration relationship: C – level shift (change in constant); C/T – level shift with trend (model with a linear trend and change in constant only); C/S – regime shift (model with change in both constant and slope). Critical values are taken from Gregory and Hansen (1996). ***, **, * - denotes significance at the 1, 5 and 10 % levels respectively

Table 8: Gregory-Hansen Cointegration Tests: Post-crisis Period 01/08/1998–14/10/2003

Variables	Model	ADF	Break point/Date	PP Zt	Break point/Date	PP Za	Break point/Date
Russia – EMU	C	-2.94	0.510	-2.86	0.507	-16.43	0.507
Russia – EMU	C/T	-4.83**	0.848 (05/11/03)	-4.99**	0.846 (31/10/03	-40.90	0.848
Russia – EMU	C/S	-3.36	0.427	-3.42	0.426	-23.99	0.426
Russia – UK	C	-2.91	0.843	-2.78	0.841	-15.18	0.841
Russia – UK	C/T	-4.78**	0.847 (03/11/03)	-4.92**	0.846 (31/10/03)	-39.57	0.846
Russia – UK	C/S	-2.84	0.246	-3.04	0.248	-18.78	0.248
Russia – USA	C	-3.07	0.508	-2.98	0.529	-17.78	0.529
Russia – USA	C/T	-5.80***	0.848 (05/11/03)	-5.85***	0.846 (31/10/03)	-48.72**	0.846 (31/10/03)
Russia – USA	C/S	-3.80	0.424	-3.74	0.425	-26.19	0.425
Russia – Japan	C	-3.63	0.502	-3.62	0.502	-24.99	0.502
Russia – Japan	C/T	-5.88***	0.846 (31/10/03)	-5.94***	0.846 (31/10/03)	-50.73***	0.846 (31/10/03)
Russia – Japan	C/S	-3.67	0.502	-3.67	0.483	-25.51	0.502
Russia – EMU, UK, USA	C	-5.09**	0.841	-6.09***	0.830	-69.23***	0.830
Russia – EMU, UK, USA	C/T	-7.32***	0.574	-7.36***	0.519	-53.14***	0.591
Russia – EMU, UK, USA	C/S	-7.29***	0.604 (01/05/02)	-8.04***	0.602 (26/04/02	-110.63***	0.602 (26/04/02)
Russia – All Developed Markets	C	-5.35*	0.843	-6.26***	0.830	-72.44***	0.830
Russia – All Developed Markets	C/T	-7.61***	0.549	-7.52***	0.542	-84.11***	0.542
Russia – All Developed Markets	C/S	-7.25***	0.604 (01/05/02)	-8.01***	0.602 (26/04/02)	-109.75***	0.602 (26/04/02)
Russia – Poland	C	-3.42	0.457	-3.49	0.450	-24.19	0.450
Russia – Poland	C/T	-4.85**	0.200 (28/10/99)	-4.80*	0.217 (06/12/99	-41.80	0.217
Russia – Poland	C/S	-3.66	0.446	-3.74	0.447	-27.54	0.447
Russia – Hungary	C	-3.84	0.270	-3.76	0.266	-28.34	0.266
Russia – Hungary	C/T	-4.58	0.218	-4.50	0.150	-36.98	0.217
Russia – Hungary	C/S	-4.56	0.293	-4.64	0.291	-42.49*	0.291 (22/05/00)
Russia – Czech Republic	C	-1.44	0.248	-1.19	0.849	-3.70	0.245
Russia – Czech Republic	C/T	-4.66	0.568	-4.41	0.568	-38.97	0.568
Russia – Czech Republic	C/S	-1.57	0.827	-1.41	0.823	-4.19	0.823
Russia – All CEE Markets	C	-3.89	0.823	-3.82	0.823	-29.41	0.823
Russia – All CEE Markets	C/T	-5.27	0.456	-5.13	0.462	-51.80	0.462
Russia – All CEE Markets	C/S	-4.32	0.743	-4.34	0.575	-37.60	0.575

Model specifications for the bivariate cointegration relationship: C – level shift (change in constant); C/T – level shift with trend (model with a linear trend and change in constant only); C/S – regime shift (model with change in both constant and slope). Critical values are taken from Gregory and Hansen (1996). ***, **, * - denotes significance at the 1, 5 and 10 % levels respectively

Table 9: Variance Decompositions: 10 day horizons, % Terms

	Period	RU	CZ	HU	JP	PL	UK	US	EMU
Overall									
	1	100.00	-	-	-	-	-	-	-
	2	97.56	0.12	0.08	0.06	0.00	0.03	2.02	0.13
	3	97.02	0.15	0.12	0.08	0.00	0.03	2.42	0.18
	4	96.73	0.16	0.14	0.09	0.00	0.03	2.63	0.22
	5	96.53	0.17	0.15	0.09	0.00	0.02	2.78	0.25
	6	96.37	0.18	0.15	0.09	0.00	0.02	2.90	0.29
	7	96.24	0.19	0.15	0.10	0.00	0.02	2.99	0.32
	8	96.11	0.19	0.15	0.10	0.00	0.02	3.08	0.35
	9	96.00	0.20	0.15	0.10	0.01	0.02	3.15	0.39
	10	95.88	0.20	0.15	0.10	0.01	0.02	3.22	0.42
Precrisis									
	1	100.00	-	-	-	-	-	-	-
	2	99.94	0.00	0.00	0.01	0.00	0.03	0.00	0.01
	3	99.80	0.01	0.00	0.04	0.01	0.09	0.02	0.04
	4	99.59	0.01	0.00	0.07	0.02	0.19	0.03	0.09
	5	99.33	0.02	0.00	0.11	0.02	0.31	0.06	0.14
	6	99.03	0.03	0.00	0.15	0.03	0.45	0.09	0.21
	7	98.69	0.04	0.01	0.20	0.04	0.61	0.13	0.28
	8	98.31	0.05	0.01	0.25	0.05	0.79	0.17	0.37
	9	97.92	0.06	0.01	0.30	0.06	0.98	0.22	0.46
	10	97.50	0.08	0.02	0.34	0.07	1.18	0.27	0.55
Crisis									
	1	100.00	-	-	-	-	-	-	-
	2	93.83	0.05	0.40	0.34	0.01	0.18	4.62	0.57
	3	93.69	0.16	0.26	0.93	0.03	0.37	4.00	0.56
	4	93.40	0.19	0.19	1.29	0.02	0.60	3.82	0.49
	5	93.31	0.22	0.15	1.47	0.02	0.74	3.65	0.43
	6	93.25	0.24	0.13	1.58	0.01	0.84	3.56	0.39
	7	93.20	0.25	0.13	1.66	0.01	0.91	3.49	0.35
	8	93.16	0.26	0.13	1.73	0.01	0.95	3.43	0.32
	9	93.12	0.27	0.16	1.79	0.01	0.99	3.38	0.29
	10	93.08	0.27	0.19	1.84	0.01	1.02	3.33	0.27
Post Crisis									
	1	100.00	-	-	-	-	-	-	-
	2	98.60	0.02	0.00	0.04	0.01	0.06	1.23	0.05
	3	98.19	0.02	0.01	0.07	0.03	0.07	1.57	0.05
	4	98.02	0.01	0.01	0.09	0.04	0.09	1.69	0.04
	5	97.90	0.01	0.01	0.12	0.05	0.11	1.76	0.03
	6	97.80	0.02	0.01	0.14	0.06	0.13	1.81	0.03
	7	97.68	0.03	0.01	0.17	0.06	0.15	1.85	0.03
	8	97.57	0.05	0.01	0.20	0.07	0.17	1.89	0.03
	9	97.44	0.08	0.01	0.24	0.08	0.19	1.92	0.04
	10	97.31	0.12	0.01	0.27	0.09	0.21	1.94	0.05

Institute for International Integration Studies
The Sutherland Centre, Trinity College Dublin, Dublin 2, Ireland