INTEGRATION OF THE EUROPEAN FRONTIER EMERGING STOCK MARKETS: EFFECTS OF THE 2008/2009 FINANCIAL CRISIS

Jussi Nikkinen [a], Vanja Piljak [a*], Timo Rothovius [a]

[a] Department of Accounting and Finance, University of Vaasa, Finland

March 1, 2011

Abstract

This study investigates the financial integration of the European frontier emerging stock markets (Croatia, Estonia, Romania, Slovakia and Slovenia) in two time periods: before and during the recent financial crisis. Of the markets analyzed, Croatia, Estonia and Slovenia show a considerable degree of financial integration with respect to the world market portfolio and the three largest European stock markets, whereas the stock market of Slovakia appears to be segmented. Romania seems to be partially integrated. Our results demonstrate the significant interdependence between the Croatian and Slovenian markets in both periods. Estonia seemed to have a considerable impact on the other frontier markets before the crisis. Interestingly, our analysis reveals only limited interactions between the frontier emerging and developed markets investigated before the crisis. Although these linkages were strengthened during the crisis, considerable variation across markets is found. For example, the impact of the world market returns on Croatian market returns increased from 4% before the crisis to 42% during the crisis. By contrast, the corresponding figure for Slovakian market remained unchanged, staying at a level of less than 1% during the crisis. These results collectively suggest that investors may benefit from international portfolio diversification into the frontier emerging stock markets in Europe both during normal and crises periods.

JEL classification: F36; G11; G15

Keywords: Frontier emerging market, Market integration, Diversification benefits, Financial crisis

[*] Corresponding author: *Address:* University of Vaasa, Department of Accounting and Finance, P.O. Box 700, FI-65101 Vaasa, Finland; Tel. +358 6 324 8262; Fax: +358 6 324 8344; E-mail address: vanpil@uwasa.fi

1. Introduction

Emerging markets finance has evolved into a challenging research issue over the past two decades (see e.g. Bekaert and Harvey, 2003 for a survey; Barclay et al., 2010; Cuadro-Saez et al., 2009). The significance of the emerging markets is reflected in the fact that they have become a relevant driver of the global economic growth in the recent years, providing high returns for investors at the same time. The degree of the financial market integration is important because of its implications for international capital budgeting and investments (see Kearney and Lucey, 2004). Such financial markets that are not integrated into the world capital markets may provide opportunities for international investors in obtaining the benefits of diversification.

The global financial crisis of 2008/2009 has generated increased interest in investigating how a financial crisis may affect the stock market integration and linkages among international equity markets. Bartram and Bodnar (2009) provide evidence of high correlations and transmission of price-relevant information among the markets around the globe due to the global nature of the recent financial crisis. Increased co-movement among the stock markets during the volatile periods, such as financial crises, is documented in many studies (Longin and Solnik 1995, 2001), but there is still debate whether the strengthening effect of stock market linkages exists in the post-crisis period[1]. Since the financial crisis affects the degree of co-movement among stock markets and consequently the level of potential international diversification opportunities, it is of great importance to investigate the impact of the crisis on the strategy of global investing.

---

[1] Several studies suggest that there is no long-term post crisis effect of strengthened emerging market linkages (for example, King et al. (1994) demonstrate that (short term) correlation between national stock market returns increases only temporarily during the periods of market turbulence such as the 1987 market crash; Tuluca and Zwick (2001) find only temporary strengthening effects of the Asian financial crisis on global stock market relationships). By contrast, Yang et al. (2006) report strengthened stock market linkages (long and short-run) after the 1997-1998 global emerging market crisis.

In this study, we examine the question of financial integration by focusing on a special subcategory of emerging markets - namely frontier emerging markets[2]. By so doing, we first investigate whether the European frontier emerging stock markets have become integrated into the world capital markets by examining the sensitivity of the stock returns to the world-wide market risk factor, and second, we study the interdependences across these markets and their linkages to the three largest developed stock markets in Europe. Third, by using two sample periods: before the financial crisis (September 22, 1997- September 15, 2008) and during the crisis (September 15, 2008 - December 31, 2009), we also analyze how the financial crisis affected the integration of the frontier emerging markets.

Research into emerging market stock returns emphasizes the importance of the features of those markets for the investment purposes. To start with, emerging markets exhibit higher expected returns, as well as higher levels of volatility compared to the developed markets. However, the inclusion of emerging market assets in the investment portfolio significantly enhances portfolio opportunities as a result of low correlations between emerging and developed equity markets (see Harvey, 1995). This finding has generated a growing body of literature that investigates the features of emerging market equity returns including two important research areas: 1) the risk–return tradeoff within emerging markets (Bekaert and Harvey, 1997; Harvey, 1991) and 2) international portfolio diversification through combining investments in emerging stock markets with investments in developed stock markets (Barry et al., 1998; Bekaert and Urias, 1996; Divecha et al., 1992; Li and Majerowska, 2008).

---

[2] This subcategory represents markets characterized by thin trading activity, short history and higher risk levels compared to developed markets. The attractiveness of the frontier stock markets stems from high returns provided in the past. The first fully investable index for frontier equity markets (S&P/IFCG Extended Frontier 150 Index) was launched by Standard & Poor's in 2007. In the following year, there have been a few other index providers (including MSCI Barra and FTSE), who started to track and maintain index data on the frontier stock markets as a reflection of an increased interest of global investors towards those markets.

The main focus of research on the risk-return relationship within the emerging markets is on the global market risk and currency risk (Bailey and Chung, 1995; De Santis and Imrohoroglu, 1997; Mateus, 2004; Pajuste et al., 2000), but particular attention is also paid to certain specific risk factors such as political risk (Diamonte et al., 1996) and country risk (Erb et al., 1996a, 1996b).

In the literature on the financial integration between the emerging and developed markets less attention is paid to the frontier emerging markets. Recent studies by Jayasuriya and Shambora (2009) and Speidell and Krohne (2007) document the promising diversification potential of the frontier markets, showing that diversification into frontier markets results in improvement in portfolio risk and returns.

Empirical evidence on the integration and diversification potential of the frontier emerging markets in Europe includes the following studies. Mateus (2004) provides evidence about the partial integration of five European frontier stock markets[3] (Bulgaria, Estonia, Lithuania, Romania and Slovenia) with respect to the world market. Dvorak and Podpiera (2006) suggest that a dramatic rise in stock prices observed in the eight EU accession countries[4] after the announcement of EU enlargement towards those countries was due to the integration of accession countries into the world market. Baltic equity markets are investigated in the study by Maneschiöld (2006). The results indicate that the Estonian, Latvian and Lithuanian markets can provide diversification benefits for international investors on a long-term investment horizon.

---

[3] The full sample covers 13 European Union accession countries.
[4] The sample of the accession countries includes eight European countries. Five of them are classified as frontier emerging markets (Estonia, Latvia, Lithuania, Slovakia and Slovenia), while the remaining three represent the emerging markets (Czech Republic, Hungary and Poland).

Further evidence of potential benefits from diversifying into the emerging markets in Central and Eastern Europe is provided in Middleton et al. (2008), who show that the optimal portfolio consisting of stocks from eight European emerging markets[5] significantly outperformed its developed market counterparts in UK and the US over the period 1998-2003. In this study, we aim to extend the existing literature by examining the stock market integration of five European frontier emerging markets.

We hypothesize that the European frontier emerging markets, represented by five selected countries (Croatia, Estonia, Romania, Slovakia and Slovenia), are not yet fully integrated into the world capital markets. This is to be expected, given that those markets are relatively small and illiquid, with relatively short histories. Regarding the issue of interdependences among the frontier emerging markets, it is expected that there are certain linkages among these markets, given their geographical connections (see e.g., Pajuste et al., 2000, who emphasize the importance of geographic proximity in explaining the level of a country's financial integration). Furthermore, there are similarities in the process of transition from centrally-planned to market-oriented economy which took place at the beginning of the 1990s after the collapse of the Soviet Union and the termination of the communist era in Central and Eastern Europe. The transition process included a broad set of economic reforms to liberalize the financial sector and eliminate restrictions on foreign investments in order to facilitate equity market integration. In addition, we hypothesize that the recent financial crisis had a significant impact on the integration of the frontier emerging markets in Europe. However, the extent of the linkages between the frontier emerging markets and developed markets should be still sufficiently low, suggesting potential benefits for international portfolio diversification.

---

[5] The sample includes eight countries located in Central and Eastern Europe. Four of them are classified as frontier emerging markets (Croatia, Estonia, Latvia and Romania), while the remaining four are emerging markets (the Czech Republic, Hungary, Poland and Russia).

Our study contributes to the literature by investigating one special subcategory of emerging markets - frontier stock markets, with special reference to the effects of the 2008/2009 financial crisis. The frontier markets are worth researching taking into consideration the diminished potential for international portfolio diversification resulting from increased interdependence among the developed international stock markets[6]. There is also recent evidence of increased integration of the emerging markets into the world markets (for example, Tai, 2007), which suggests that an alternative to any future benefits of international diversification could be in the subcategory of the frontier markets. The promising diversification potential of the frontier markets is documented by Berger et al. (2011), who examine a set of frontier markets worldwide and find that those markets exhibit low levels of integration with the world market and subsequently offer significant diversification benefits.

The frontier emerging stock markets in Europe are of particular research interest, given their potential for accelerated economic growth and the attribute of regulated markets linked to the advantages of EU membership. Additionally, the use of the European frontier emerging markets in this study is motivated by the fact that relatively few studies have examined these stock markets. Therefore, that area of research is ripe for exploration.

The remainder of the paper is organized as follows. Section 2 describes the market environment and introduces the data. The econometric framework of analysis is given in Section 3. Section 4 reports the empirical results and discusses their implications. Finally, Section 5 provides conclusions.

---

[6] Several studies show that the international stock markets have become increasingly interdependent since the 1987 U.S. Stock Market Crash, implying decreased benefits of international diversification (Berben and Jansen, 2005; Bessler and Yang, 2003; Chelley-Steeley, 2000; Wong et al., 2004; Wongswan, 2006).

2. Market environment and data description

The sample of the European frontier emerging markets is selected according to Standard and Poor's classification of the frontier emerging markets. The selected stock markets (Croatia, Estonia, Romania, Slovakia and Slovenia) are five out of nine European countries classified as frontier emerging markets representing a constituent universe for the S&P/IFCG Extended Frontier 150 Index[7]. This index is designed to meet the increasingly sophisticated needs of global investors seeking to expand into markets less known but with a potential for return similar or greater than other better known emerging markets counterparts.

The selection of only five countries is dictated by availability of data based on the chosen time period of at least ten years. The time period under study extends from September 22, 1997 to December 31, 2009, the longest common time period over which data are available. The sample is divided into two subsamples (the period before the financial crisis and during the crisis), where the Lehman Brothers collapse on September 15, 2008 marks the starting date of the financial crisis. All the index data used in the study are extracted from the Thomson Datastream database. The data consist of daily observations of the stock price indices and the Morgan Stanley Capital International (MSCI) World equity market index, which is the widely accepted benchmark index used to proxy the world market portfolio. In addition, the stock market indices of the United Kingdom, France and Germany are used to serve as proxies for the developed stock markets in Europe since these countries are considered to be the three largest European stock markets.

The following stock exchanges and stock indices are used to represent investigated frontier emerging markets: the Zagreb Stock Exchange and index CROBEX (Croatia), the Tallinn Stock Exchange and index OMXTallinn (Estonia), the Bucharest Stock Exchange and index BET

---

[7] The remaining countries included in the Index are Bulgaria, Latvia, Lithuania and Ukraine.

(Romania), the Bratislava Stock Exchange and index SAX (Slovakia) and the Ljubljana Stock Exchange and index SBI20 (Slovenia). The developed markets in Europe are represented by the Stock Exchanges in London, Paris and Frankfurt and their major stock market indices FTSE100, SBF250 and CDAX respectively. The daily returns in each market are computed as the natural logarithmic differences: $ln\ (p_t\ /p_{t-1})$ where p_t is either the stock index of the frontier emerging or developed market or MSCI World Index at time t. Following Li and Majerowska (2008) and Rua and Nunes (2009), we use returns denominated in the home currency of each respective country, in order to avoid potential distortion caused by the currency devaluations.

Table 1 shows market highlights and some important dates related to the stock market liberalization process in the five European frontier emerging markets investigated in this study. Panel A provides information about the years of the stock market establishment, as well as the stock market capitalization at the end of December 2009. Panel B includes dates on the removal of legal restrictions on foreign investments with additional footnotes indicating that the legal restrictions on foreign investments were lifted gradually. The third column indicates dates when the Emerging Markets Database (EMDB) as a premier source for reliable and comprehensive information on the emerging stock markets maintained by the Standard & Poor's started to provide data for each of the markets. The starting dates of the first issuing of the American Depositary Receipts (ADR) for each country are also included in the table.

(Insert Table 1 about here)

Table 2 shows the main economic indicators for the year 2009 for all investigated markets (Panel A - the developed markets in Europe; Panel B - the European frontier emerging markets). In general, the degree of economic development in the frontier emerging markets, as

measured by GDP per capita, is much lower compared to the three developed markets. Additionally, there are big differences within the group of the frontier emerging markets. For instance, Slovenia has the highest GDP per capita (24,111 U.S. $), while Romania exhibits the lowest level with only 7,523 U.S. $. Similarly to GDP per capita, level of inflation rates varies considerably, ranging from -0.08 % in Estonia up to 5.6 % in Romania. The inflation rates of Estonia[8], Slovakia and Slovenia are lower than in Croatia and Romania, indicating higher level of monetary stability associated with membership of the European Economic and Monetary Union (EMU). Table 2 also reports current account balance expressed in billions of U.S. $, as well as percent of GDP. The current account balance is negative for the frontier emerging markets (except for Estonia); generally indicating that level of the import exceeds level of the export in foreign trade activity.

(Insert Table 2 about here)

Figure 1 presents the time plots of the index series during the period September 22, 1997 – December 31, 2009. In the period before the crisis the indices of the frontier emerging markets follow a relatively similar movement, while MSCI World index and indices of the developed European markets exhibit different pattern. The main difference is that the frontier emerging markets started to have an upward trend in the middle of 2001, while the world market and the developed European markets were moving downwards, bottoming out at the end of 2002 and the first quarter of 2003. The upward trend in the stock indices of the frontier emerging markets could be a result of increased interest on the part of foreign investors after the announcements of European Union (EU) enlargement towards Estonia, Slovenia and Slovakia

---

[8] Estonia joined the EMU on January 1, 2011.

(joined the EU in 2004); Romania (joined in 2007). Croatia still has candidate status, but the ongoing political and economic reforms should facilitate fast accession to the EU and enhance economic integration. During the period of the crisis there is a change in the pattern of the frontier markets indices, where all of them (except Slovakia) follow the same trend as the MSCI World index and the developed markets' indices.

(Insert Figure 1 about here)

Table 3 presents descriptive statistics for the returns series in the period before and during the crisis (Panel A - MSCI World index and the developed markets; Panel B - the frontier emerging markets; Panel C – pairwise returns correlations for all stock market pairs).

(Insert Table 3 about here)

As can be seen from Table 3, in the period before the crisis the frontier emerging markets (except Estonia) have higher average daily returns than the world market, but also higher volatility (except Slovenia) measured by the standard deviation. Relative to the developed European markets all frontier emerging markets have higher average daily returns than the UK and Germany (except Estonia which has the same level of the return). Compared to France, only Estonia exhibits slightly lower average returns, but all the other frontier emerging markets still have higher returns.

The volatility levels of the frontier emerging markets are in general higher than those of the developed markets (with the exception of Slovenia). During the crisis period the performance of the frontier emerging markets (except Romania) measured by the average return is worse

compared to the world and the developed markets. In terms of volatility, only Romania and Croatia exhibit higher levels relative to the world and the developed markets.

The correlations of the frontier markets with the world and developed European indices are very low in the period before the crisis, while by contrast the returns of the developed European markets are extremely highly correlated with the world returns, and also with each other. During the crisis there is a significant increase in the correlations of the frontier markets with both the world and the developed markets. For instance, before the crisis the highest correlation coefficient with the world is 0.15 (Croatia), while in the crisis period the corresponding coefficient is 0.65. The correlations within the group of the frontier emerging markets are also drastically increased.

3. Econometric framework of analysis

In order to analyze interdependences among the investigated stock markets and gain insights into the causal dynamics of index returns, vector autoregressive methodology (VAR) is used (see, e.g., Lutkepohl, 2005, p.41-66; Sims, 1980). The VAR framework in our paper includes two techniques: 1) Granger causality test (see Granger, 1969) as a technique for determining whether one time series is useful in forecasting another and 2) variance decomposition, which measures how much of the movements in one stock market can be explained by innovations in other markets. Different forms of VAR analysis have been used in the literature on international stock market linkages (for example, Bessler and Yang, 2003; Chelley-Steeley, 2005; Chen et al., 2002).

VAR modeling is appropriate methodology in the case of the stationarity of all index returns time-series. The stationarity of time-series is examined by conducting the augmented

Dickey-Fuller (Dickey and Fuller, 1979, 1981) and Phillips-Perron unit root tests (Phillips and Perron, 1988). Both unit root tests are performed with and without a time trend and results regarding stationarity remain unchanged. The lag length for the unit root tests is determined by the Schwarz information criterion. Given that the unit root tests confirm the stationarity of the index returns time-series,[9] VAR modeling is used to examine the causal dynamics of the index returns. Thus it is assumed that the index returns of Croatia, Estonia, Romania, Slovakia, Slovenia and the world index returns are described by the following unrestricted VAR(p) model (in the following text denoted as Model 1):

$$\mathbf{X}_t = \alpha + \sum_{i=1}^{p} \Phi_i \, \mathbf{X}_{t\text{-}i} + \varepsilon_t \,,$$

(1)

where $\mathbf{X}_t = (\mathrm{X}_{WORLD,t} \,, \mathrm{X}_{CROATIA,t} \,, \mathrm{X}_{ESTONIA,t} \,, \mathrm{X}_{ROMANIA,t} \,, \mathrm{X}_{SLOVAKIA,t} \,, \mathrm{X}_{SLOVENIA,t})´$ is a covariance stationary 6×1 vector of index returns X_t, α is a 6×1 vector of intercepts, $\{\Phi i, i= 1, 2,\ldots, p\}$ is a 6×6 matrix of autoregressive coefficients, ε_t is a 6×1 vector of random disturbances with zero mean and positive definite covariance matrix, and p indicates the lag length, i.e. the order of the system.

Similarly, for purposes of examining linkages between the frontier emerging and the developed markets in Europe, the unrestricted VAR(p) model given in Equation (1) is employed. The only difference in the model setup is that the vector of index returns now includes returns of the United Kingdom, Germany and France in addition to the returns of the frontier markets,

---

[9] The table of results of unit root tests is not shown here in order to save space; it is available upon request.

where $\mathbf{X}_t = (X_{UK,t}, X_{FRANCE,t}, X_{GERMANY,t}, X_{CROATIA,t}, X_{ESTONIA,t}, X_{ROMANIA,t}, X_{SLOVAKIA,t}, X_{SLOVENIA,t})'$. This model is referred to as Model 2 in the following text.

The order of the VAR is determined by applying Akaike's, Schwartz's, Hannan-Quinn's information criteria, final prediction error and modified likelihood ratio test for the selection of appropriate lag length. The adequacy of the lag length is confirmed by residual test. For Model 1 in the period before the crisis the LM tests of the residuals of the VAR (1) and VAR (2) models indicate significant serial correlation, while residuals of the VAR (3) model are not significantly correlated. Thus a lag length of three is chosen, which means that further analysis in the study is based on the VAR system described by Equation (1) with p=3. During the period of the crisis the appropriate lag length is two, thus p=2.

For Model 2 in the period before the crisis the LM tests of the residuals indicate a significant serial correlation for the first two lags, while the residuals of the VAR(3) model are not highly significantly correlated. Hence, VAR (3) is a suitable model for Equation (2). For the time period during the crisis a corresponding model is VAR (2).

4. Empirical results

In this section, the empirical results are reported separately for the VAR model describing the causal dynamics between returns of the frontier emerging markets and returns of the world index (referred to as Model 1) and for VAR model describing causal dynamics between returns of the frontier emerging and the developed markets in Europe (denoted as Model 2).

The results from the Granger causality tests are presented in Table 4 (Panel A: the world market and the frontier emerging markets; Panel B: the developed markets and the frontier emerging markets; Panel C: the developed markets; Panel D: the frontier emerging markets -

only for those combinations that reveal significant causality relations). The returns of Croatia, Estonia, Slovenia and Romania are Granger caused by the returns of the world market at 1 % level of significance, while by contrast the returns of Slovakia are not Granger caused by the returns of the world market. These results indicate that the stock markets of Croatia, Estonia, Romania and Slovenia appear integrated with respect to the world market, while the Slovakian market appears segmented. Furthermore, the returns of Croatia, Estonia and Slovenia are highly significantly Granger caused by returns of all three developed markets (France, Germany and the UK). The returns of Romania are Granger caused by returns of France (only at 10% level), but not with the returns of the UK and Germany, indicating partial integration. It is interesting to observe that the returns of Slovakia are not Granger caused by either of the developed markets. This finding confirms that the Slovakian market is segmented relative to both the world market and the developed European markets.

Panel C shows that the developed European markets exhibit significant causalities with the exception of the UK → Germany and France → UK direction, providing evidence of increasing interdependences among the developed markets, which is consistent with findings of Berben and Jansen (2005), Bessler and Yang (2003), Chelley-Steeley (2000), Wong et al. (2004) and Wongswan (2006).

The significance of the causalities between the world and the frontier emerging markets remained unchanged in both time periods, before and during the crisis. The results with respect to the developed markets are also in general the same with the exception of Croatia, which showed no signs of significant causality relations during the crisis time period.

When causalities among the group of the frontier emerging markets are examined in the period before the crisis, it is notable that Estonia seems to be the dominant market Granger causing the returns of Croatia, Slovenia and Romania at the 1% significance level. Bidirectional

causality at 1% level of significance is observed only in the case of Croatia and Slovenia. There is also bidirectional causality between Estonia and Slovenia; Slovenia and Romania, although the directions Slovenia → Estonia and Slovenia → Romania are somewhat less significant. Unidirectional causality at the 5% level is observed in the case Croatia → Romania. Slovakia is not Granger caused by either of the frontier emerging markets and moreover Slovakia does not Granger cause any of the markets, providing strong evidence that the Slovakian market is segmented with respect to the other frontier emerging markets in Europe. During the crisis, Croatia appears to have become a dominant market in the group instead of Estonia. In addition, Slovakian returns started to be affected (at the 5% level) by the returns of Slovenia and Romania during the crisis, indicating an initial stage of the integration with respect to the other frontier emerging markets in the group.

(Insert Table 4 about here)

In order to further examine the interdependence among the stock markets investigated in terms of return, variance decomposition analysis is used. The use of variance decomposition enables us to ascertain the proportion of forecast variance in each of the return series caused by innovations in the other return series in the system. Table 5 provides information about return linkages between the frontier emerging markets and the world market (Model 1) in the period before and during the crisis, showing results of 1-day, 2-day, 5-day and 10-day ahead forecast error variances of each frontier emerging market's stock index return series.

The results in the period before the crisis demonstrate that returns of the world market have no substantial impact on the returns of the frontier emerging markets. For instance, the greatest impact of the world market returns on the frontier emerging markets returns appeared to

be in the case of Estonia, where the world market returns explain approximately 6% of the forecast variance of returns starting from two days ahead up to ten days ahead. In the case of Croatia, the fraction of variance explained by the world market returns is about 4%, while the corresponding figure in the case of Slovenia is about 3%.

Given the very low level of these figures it seems that the world market returns make only a minor contribution to the total variances of Estonian, Croatian and Slovenian returns. In the case of Slovakia and Romania the results show that the fraction of variance explained by the world market returns is about 1% (for Slovakia even less than 0.5%) during the whole 10-day period, demonstrating that the forecast variance is caused solely by innovations in itself. This finding clearly indicates that the Slovakian market is unique in the sense that it is not at all affected by returns of the world market, confirming earlier findings that this market is segmented with respect to the world market.

Entries in the brackets in Table 5 show the corresponding figures for the period during the crisis. The main difference compared to the period before the crisis is that the percent of the frontier emerging markets' returns explained by the world market returns has increased drastically, indicating a significant impact of the crisis on the acceleration of the financial integration. For instance, the impact of the world market returns on the frontier emerging markets returns increased from 4% before the crisis to 42% during the crisis in the case of Croatia; from 3% to 39% for Slovenia and from 6% to 21% for Estonia. Romania also showed a huge change (from 1% to 31%). By contrast, the corresponding figure for Slovakian market remained unchanged, staying at a level of less than 1% during the crisis.

(Insert Table 5 about here)

The results regarding variance decomposition for Model 2 in the period before and during the crisis are given in Table 6. In the pre-crisis period, only 6% of variance forecasts of the Croatian returns are attributable to innovations in the returns of the three developed markets. For Estonia the fraction of variance explained by the developed markets is about 5%, while for Slovenia it is only about 3%. The case of Romania reveals that almost all the forecast variance of Romanian returns is caused by its own innovations, suggesting that the returns of the other markets (either the developed or the frontier emerging) do not have any significant impact on the Romanian returns. A similar pattern is also discernible in the case of Slovakia, where the results demonstrate that neither of markets examined has an impact on Slovakian returns with the individual contribution of each market to the variance of returns being much lower than even 1 %.

In general, from the results regarding variance decomposition in the period before the crisis it can be stated that the developed markets make only a minor contribution to the total variance of Croatian, Estonian and Slovenian returns. Furthermore, in the case of Romania and Slovakia not even a minor contribution of the developed markets to the variance of Romanian and Slovakian returns is discernible. Therefore, the extent of influence of the developed markets on the returns of the frontier emerging markets, as well as the extent of mutual influence among the group of the frontier emerging markets is very low. These results provide evidence of weak linkages not only between the developed and the frontier emerging markets, but also among the group of the frontier emerging markets in the period before the crisis.

Entries in the brackets in Table 6 show the corresponding figures for the period during the crisis. Similarly to Model 1 there is also a substantial increase in the percentage of the fraction of variance explained by the developed market returns. The greatest change of percentage is observed for Croatia (from 6% before the crisis to 46% during the crisis), followed by Romania

(from 1% to 37%), Slovenia (from 3% to 33%) and Estonia (from 5% to 21%). The Slovakian market shows no signs of changes in the behavior during the crisis period.

(Insert Table 6 about here)

5. Conclusions

In this study we examine return linkages between the frontier emerging and developed stock markets in Europe, with special reference to the impact of the 2008/2009 financial crisis on the integration of the frontier emerging markets. For this purpose, we use vector-autoregressive (VAR) methodology and specifically examine the sensitivity of stock returns to the global market risk factor, the interdependences across the frontier emerging markets and their linkages to the three largest developed stock markets in Europe.

We hypothesize that the European frontier emerging markets, namely Croatia, Estonia, Romania, Slovakia and Slovenia exhibit low levels of integration with the developed equity markets and thereby offer significant diversification benefits. The arguments in favor of our hypothesis are based on the common characteristics of the frontier markets, such as low correlations with developed markets, less exposure to global economy shocks and high returns in the past. Despite small market capitalization and short history, the frontier equity markets investigated attracted the attention of foreign investors after implementation of a broad set of economic reforms and liberalization of stock markets in relation to EU accession.[10] The transition

---

[10] Statistics on major FDI indicators (source: UNCTAD Handbook of Statistics 2009) show that some of the countries in the region experienced a significant increase in inward FDI during the period 2000-2008. For instance, the level of FDI in Romania has risen more than 12 times, from $1.05 billion in 2000 to $13.30 billion in 2008.

process has led to an improved economic environment, which, in addition to regional connections among those markets, is anticipated to accelerate financial integration with developed markets. Furthermore, in a situation in which the level of integration is gradually increasing, the recent financial crisis is expected to have a significant impact on market integration. In particular, we expect that the degree of integration will tend to change due to increased co-movement among markets in the turbulent period of the global financial crisis.

In general, the results of this study indicate that the stock markets of Croatia, Estonia and Slovenia show a considerable degree of financial integration with respect to the world market portfolio and the three largest stock markets in Europe (the UK, France and Germany). By contrast, the stock market of Slovakia appears to be segmented relative to the world and the developed markets. The Romanian market seems to be partially integrated. During the financial crisis the linkages of the frontier emerging markets with the world and the developed European markets are strengthened, as demonstrated by a substantial increase of the share of variation in the frontier emerging markets returns explained by the world and the developed market returns. The financial crisis significantly affected the integration of the frontier stock markets by rapidly increasing the degree of interdependence between the frontier and the developed stock markets.

The following two conclusions can be drawn regarding interdependences within the group of the frontier emerging markets. First, the results reveal a significant interdependence between the Croatian and Slovenian markets in both periods, before and during the crisis. This relationship could be explained by their historical and regional links as they are adjacent countries which were parts of the same country (the former Yugoslavia) for more than 40 years and have strong industrial and economic relationships. Second, among the frontier emerging markets in the period before the crisis Estonia seems to have a considerable impact on the other

markets in the group. This finding reveals that Estonia can be seen as a leading market among the European frontier emerging markets investigated.

The empirical findings of this study have important implications for international investors, who are continuously in quest of new challenging markets that may provide higher returns for their portfolios. In light of the finding that the Slovakian market is still segmented it is logical to conclude that global investors may benefit from international portfolio diversification by adding stocks of this market to their portfolios. In general, the rest of the frontier emerging stock markets in Europe also provide scope for portfolio diversification internationally, given their low correlations with the world and the developed markets. Since the extent of the linkages among the frontier emerging markets investigated and the developed markets is weak, it can be concluded that the country-specific risk would be the main factor determining expected returns on investments in those stock markets.

Acknowledgements

References

Bailey, W., Chung, Y.P., 1995. Exchange rate fluctuations, political risk, and stock returns: some evidence from an emerging market. *Journal of Financial and Quantitative Analysis* 30:4, 541-561.

Barclay, R., Fletcher, J., Marshall, A., 2010. Pricing emerging market stock returns: An update. *Emerging Markets Review* 11, 49-61.

Barry, C.B., Peavy, J. W. III, Rodriguez, M., 1998. Performance characteristics of emerging capital markets. *Financial Analysts Journal* 54:1, 72–80.

Bartram, S. M., Bodnar, G.M., 2009. No place to hide: The global crisis in equity markets in 2008/2009. *Journal of International Money and Finance* 28, 1246-1292.

Bekaert, G., Harvey, C.R., 1997. Emerging equity market volatility. *Journal of Financial Economics* 43:1, 29–77.

Bekaert, G., Harvey, C.R., 2003. Emerging Markets Finance. *Journal of Empirical Finance* 10:1, 3–55.

Bekaert, G., Urias, M.S., 1996. Diversification, integration and emerging market closed-end funds. *The Journal of Finance* 51:3, 835-869.

Berben, R., Jansen, W.J., 2005. Co-movement in international equity markets: a sectoral view. *Journal of International Money and Finance* 24:5, 832–857.

Berger, D., Pukthuanthong, K., Yang, J.J., 2011. International diversification with frontier markets. *Journal of Financial Economics,* Article in press, doi: 10.1016/j.jfineco.2011.02.009.

Bessler, D., Yang, J., 2003. The structure of interdependence in international stock markets. *Journal of International Money and Finance* 22, 261-287.

Chelley-Steeley, P. L., 2000. Interdependence of international equity market volatility. *Applied Economics Letters* 7:5, 341-345.

Chelley-Steeley, P. L., 2005. Modeling equity market integration using smooth transition analysis: a study of Eastern European stock markets. *Journal of International Money and Finance* 24, 818-831.

Chen, G., Firth, M., Rui, O., 2002. Stock market linkages: evidence from latin America. *Journal of Banking and Finance* 26, 1113-1141.

Cuadro-Saez, L., Fratzscher, M., Thimann, C., 2009. The transmission of emerging market shocks to global equity markets. *Journal of Empirical Finance* 16, 2-17.

De Santis, G., Imrohoroglu, S., 1997. Stock returns and volatility in emerging financial markets. *Journal of International Money and Finance* 16:4, 561-579.

Diamonte, R. L., Liew, J.M., Stevens, R.C., 1996. Political risk in emerging and developed markets. *Financial Analysts Journal* 52:3, 71–76.

Dickey, D. A., Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74, 427-431.

Dickey, D. A., Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* 49, 1057-1072.

Divecha, A., Drach, B., Stefek, J., 1992. Emerging markets: A quantitative perspective. *Journal of Portfolio Management* 19:1, 41–50.

Dvorak, T., Podpiera, R., 2006. European Union enlargement and equity markets in accession countries. *Emerging Markets Review* 7:2, 129-146.

Erb, C. B., Harvey, C.R., Viskanta, T.E., 1996a. Expected returns and volatility in 135 countries. *Journal of Portfolio Management* 22, 46–58.

Erb, C. B., Harvey, C.R., Viskanta, T.E., 1996b. Political risk, economic risk and financial risk. *Financial Analysts Journal* 52:6, 29–46.

Granger, C. W. J., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica* 37:3, 424-438.

Harvey, C. R., 1991. The world price of covariance risk. *Journal of Finance* 46:1, 111–157.

Harvey, C. R., 1995. Predictable risk and returns in emerging markets. *Review of Financial Studies* 8:3, 773–816.

Jayasuriya, S., Shambora, W., 2009. Oops, we should have diversified! *Applied Financial Economics* 19, 1779-1785.

Kearney, C., Lucey, B.M., 2004. International equity market integration: theory, evidence and implications. *International Review of Financial Analysis* 13, 571-583.

King, M., Sentana, E., Wadhwani, S., 1994. Volatility and links between national stock markets. *Econometrica* 62, 901-933.

Li, H., Majerowska, E., 2008. Testing stock market linkages for Poland and Hungary: A multivariate GARCH approach. *Research in International Business and Finance* 22:3, 247-266.

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

Longin, F., Solnik, B., 2001. Extreme correlation of international equity markets. *Journal of Finance* 56:2, 649-676.

Lutkepohl, H., 2005. *New Introduction to Multiple Time Series Analysis*. Berlin: Springer.

Maneschiöld, P., 2006. Integration between the Baltic and international stock markets. *Emerging Markets Finance and Trade* 42:6, 25-45.

Mateus, T., 2004. The risk and predictability of equity returns of the EU accession countries. *Emerging Markets Review* 5:2, 241-266.

Middleton, C. A. J., Fifield, S. G. M., Power, D.M., 2008. An investigation of the benefits of portfolio investment in Central and Eastern European stock markets. *Research in International Business and Finance* 22:2, 162-174.

Pajuste, A., Kepitis, G., Högfeldt, P., 2000. Risk factors and predictability of stock returns in Central and Eastern Europe. *Emerging Markets Quarterly (Summer)*, 4:2, 7-25.

Phillips, P. C. B., Perron, P., 1988. Testing for a unit root in time series regression. *Biometrika* 75, 335-346.

Rua, A., Nunes, L., 2009. International comovement of stock market returns: A wavelet analysis. *Journal of Empirical Finance* 16, 632-639.

Sims, C. A., 1980. Macroeconomics and reality. *Econometrica* 48, 1-48.

Speidell, L., Krohne, A., 2007. The case for frontier equity markets. *Journal of Investing* 16, 12-22.

Tai, C.-S., 2007. Market integration and contagion: Evidence from Asian emerging stock and foreign exchange markets. *Emerging Markets Review* 8:4, 264-283.

Tuluca, S. A., Zwick, B., 2001. The effects of the Asian crisis on global equity markets. *Financial Review* 36, 125-142.

Wong, W. K., Penm, J., Terrell, R.D., Ching, K.Y., 2004. The relationship between stock markets of major developed countries and Asian emerging markets. *Journal of Applied Mathematics & Decision Sciences* 8:4, 201–218.

Wongswan, J., 2006. Transmission of information across international equity markets. *Review of Financial Studies* 19:4, 1157-1189.

Yang, J., Hsiao, C., Li, Q., Wang, Z., 2006. The emerging market crisis and stock market linkages: further evidence. *Journal of Applied Econometrics* 21, 727-744.

Figure 1. Stock indices in the period September 22, 1997 - December 31, 2009
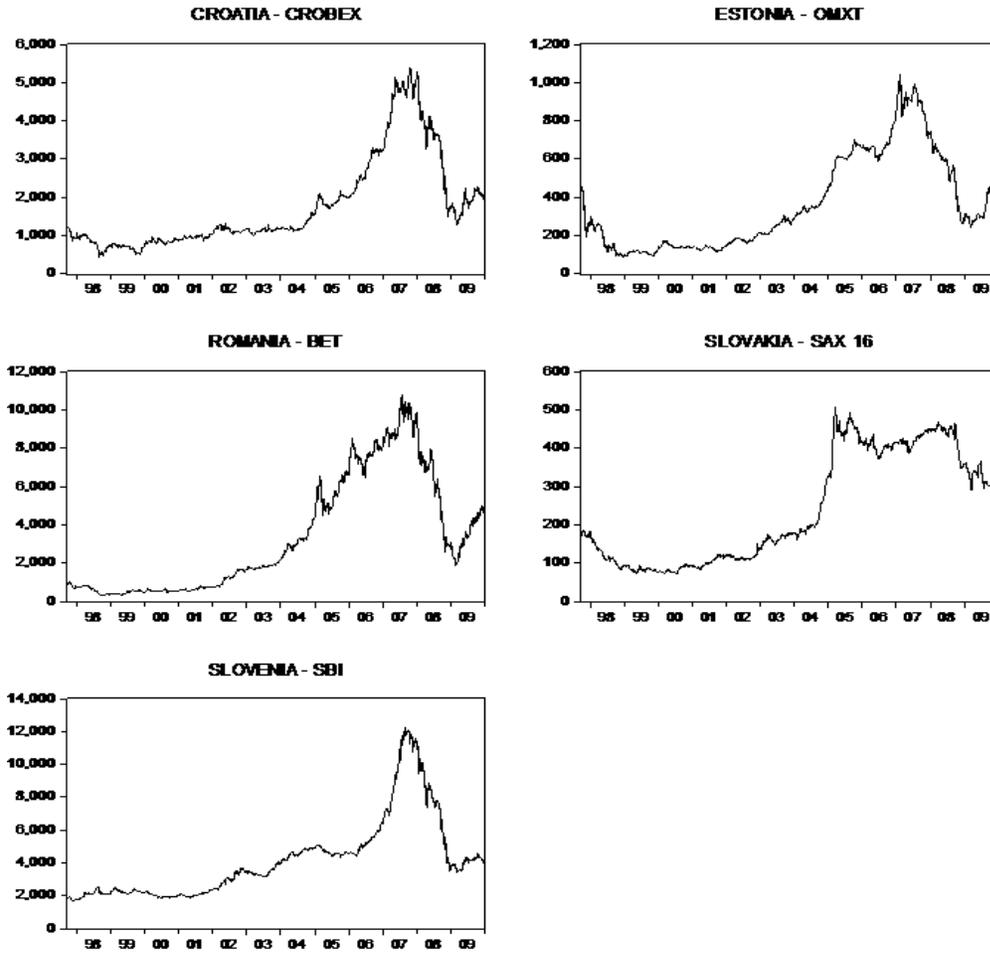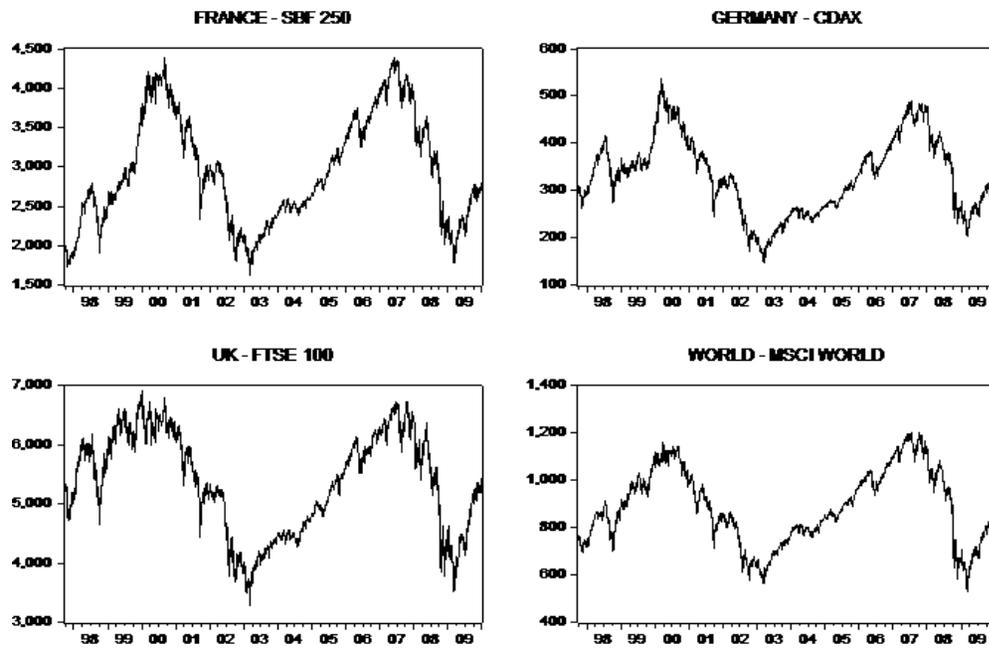
Panel A: Frontier emerging markets

Figure 1.

Panel B: Developed markets

Table 1. Market highlights and relevant dates in the stock market liberalization process

Panel A: Market highlights

Country	Index	Stock market established	Market capitalization [a]
Croatia	CROBEX	1991	18.55 bill.EUR
Estonia	OMXTallinn	1995	1.85 bill.EUR
Romania	BET	1995	19.05 bill.EUR
Slovakia	SAX	1991	2.41 bill.EUR
Slovenia	SBI 20	1989	8.46 bill.EUR

Panel B: Relevant dates in the stock market liberalization process

Country	Removal of restrictions	Inclusion to EMDB	ADR effective date
Croatia	1998[b]	January 1998	April 1996
Estonia	1996[c]	April 1998	December 1997
Romania	NA	January 1998	April 1998
Slovakia	1998[d]	January 1996	April 1996
Slovenia	1999[e]	January 1996	June 1997

Notes:

[a] Stock Market capitalization at the end of December 2009.

[b] FDI, inward portfolio investments and profit transfers abroad are not restricted; new laws passed in 2002 to boost investments in tourism, research and manufacturing.

[c] The foreign investment code was further liberalized in 2000; restrictions on certain industries (forestry, energy, water, transportation, gas supply, telecommunication and medicine).

[d] More controls on capital and money market instruments lifted in 2000.

[e] Restrictions: foreign portfolio investors who sold shares bought in the Slovenian capital market to the local market participants within 1 year (reduced from 7 years from September 1999) had incurred excessive 8-12% annual custody charges; foreign investors can acquire 25% or higher share in the equity capital of the companies.

[f] Source for Panel A - websites of the stock exchanges:

http://www. zse.hr (the Zagreb Stock Exchange),

http://www.baltic.omxgroup.com (the Tallinn Stock Exchange),

http://www. bvb.ro (the Bucharest Stock Exchange),

http://www. bsse.sk (the Bratislava Stock Exchange) and

http://www. ljse.si (the Ljubljana Stock Exchange).

Source for Panel B: Bekaert and Harvey's chronology of Economic, Political and Financial Events in Emerging Markets, and Bank of New York list of depository receipts (Dvorak & Podpiera, 2006).

Table 2. Economic indicators for the year 2009

Panel A: Developed markets

	Germany	France	UK
GDP[a]	3,338.67	2,656.37	2,178.85
GDP/capita[b]	40,831	42,412	35,257
Inflation rate[c]	0.23	0.10	2.12
Current account balance[d]	163.25	-51.28	-24.25
Current account balance[e]	4.89	-1.93	-1.11

Panel B: Frontier emerging markets

	Croatia	Estonia	Romania	Slovakia	Slovenia
GDP[a]	67.69	19.30	161.52	88.20	48.60
GDP/capita[b]	15,283	14,402	7,523	16,281	24,111
Inflation rate[c]	2.35	-0.08	5.60	0.92	0.85
Current account balance[d]	-3.61	0.88	-7.21	-2.81	-0.73
Current account balance[e]	-5.34	4.52	-4.64	-3.19	-1.50

Notes:

[a] GDP is expressed in billions of U.S. dollars

[b] GDP/capita is expressed in U.S. dollars

[c] Inflation rate is expressed as percent change based on the average consumer prices for the year

[d] Current account balance is expressed in billions of U.S. dollars

[e] Current account balance is expressed as a percent of GDP (current account balance is defined as a balance on current transactions excluding exceptional financing)

[f] Source: International Monetary Fund (World Economic Outlook Database, October 2010)

Table 3. Descriptive statistics for stock market returns

Panel A: World and developed markets

	World	Germany	France	UK
Period before crisis				
Mean	0.0000	0.0000	0.0001	0.0000
Median	0.0005	0.0005	0.0002	0.0000
Maximum	0.0460	0.0685	0.0626	0.0590
Minimum	-0.0477	-0.0748	-0.0744	-0.0588
Standard Deviation	0.0091	0.0139	0.0128	0.0117
Skewness	-0.1692	-0.2448	-0.2029	-0.1695
Kurtosis	5.40	5.87	5.69	5.46
Crisis period				
Mean	-0.0003	-0.0003	-0.0002	-0.0000
Median	0.0012	-0.0000	0.0000	0.0005
Maximum	0.0872	0.1064	0.1022	0.0938
Minimum	-0.0715	-0.0755	-0.0926	-0.0926
Standard Deviation	0.0192	0.0224	0.0227	0.0214
Skewness	-0.2667	0.2456	0.1559	-0.0532
Kurtosis	6.29	6.33	6.83	7.19

Panel B: Frontier emerging markets

	Croatia	Estonia	Romania	Slovakia	Slovenia
Period before crisis					
Mean	0.0003	0.0000	0.0005	0.0003	0.0004
Median	0.0000	0.0003	0.0000	0.0000	0.0000
Maximum	0.1747	0.1287	0.1154	0.0957	0.1102
Minimum	-0.1338	-0.2157	-0.1190	-0.1148	-0.1134
Standard Deviation	0.0169	0.0166	0.0171	0.0126	0.0090
Skewness	0.0283	-1.4420	-0.0725	-0.4662	-0.0858
Kurtosis	17.63	30.02	8.92	11.16	26.73
Crisis period					
Mean	-0.0015	-0.0008	-0.0002	-0.0014	-0.0015
Median	0.0000	0.0000	0.0000	0.0000	-0.0001
Maximum	0.1477	0.1209	0.1009	0.1188	0.0768
Minimum	-0.1076	-0.0705	-0.1311	-0.0957	-0.0830
Standard Deviation	0.0258	0.0189	0.0288	0.0154	0.0170
Skewness	0.1153	0.4037	-0.4951	-0.1594	-0.7000
Kurtosis	7.51	8.57	5.46	22.31	8.53

Table 3. *Continued*

Panel C: Correlation coefficients of stock market returns for all markets

	World	Germany	France	UK	Croatia	Estonia	Romania	Slovakia
Period before crisis								
Germany	0.76							
France	0.76	0.86						
UK	0.73	0.76	0.84					
Croatia	0.15	0.19	0.19	0.20				
Estonia	0.13	0.15	0.16	0.13	0.07			
Romania	0.06	0.08	0.08	0.06	0.08	0.04		
Slovakia	0.03	0.01	0.01	0.03	0.02	0.00	-0.02	
Slovenia	0.08	0.09	0.07	0.06	0.13	0.09	0.15	0.00
Crisis period								
Germany	0.86							
France	0.84	0.93						
UK	0.81	0.89	0.95					
Croatia	0.65	0.65	0.65	0.62				
Estonia	0.32	0.33	0.36	0.34	0.39			
Romania	0.52	0.55	0.55	0.55	0.61	0.43		
Slovakia	0.00	-0.05	-0.04	-0.03	0.04	0.13	0.08	
Slovenia	0.39	0.39	0.44	0.43	0.43	0.51	0.46	0.05

Table 4. Granger causality tests

Markets	F-statistics		p-value	
Time period	before crisis	(crisis)	before crisis	(crisis)
Panel A: The world and the frontier emerging markets (Model 1)				
World → Croatia	23.360	(6.990)	0.000	(0.001)
World → Estonia	33.844	(22.759)	0.000	(0.000)
World → Romania	4.980	(11.564)	0.001	(0.000)
World → Slovakia	0.982	(0.082)	0.399	(0.920)
World → Slovenia	28.201	(67.231)	0.000	(0.000)
Panel B: Developed markets and the frontier emerging markets (Model 2)				
France → Croatia	6.830	(0.774)	0.000	(0.461)
France → Estonia	13.558	(7.264)	0.000	(0.000)
France → Romania	2.384	(2.783)	0.067	(0.063)
France → Slovakia	0.773	(0.243)	0.508	(0.783)
France → Slovenia	15.722	(16.761)	0.000	(0.000)
Germany → Croatia	5.806	(1.703)	0.000	(0.183)
Germany → Estonia	10.409	(10.820)	0.000	(0.000)
Germany → Romania	1.586	(5.443)	0.190	(0.004)
Germany → Slovakia	1.143	(0.035)	0.329	(0.965)
Germany → Slovenia	14.365	(25.502)	0.000	(0.000)
UK → Croatia	5.910	(1.156)	0.000	(0.315)
UK → Estonia	10.132	(6.858)	0.000	(0.001)
UK → Romania	1.823	(1.413)	0.140	(0.244)
UK → Slovakia	0.829	(0.376)	0.477	(0.686)
UK → Slovenia	16.124	(16.210)	0.000	(0.000)
Panel C: The developed markets (Model 2)				
UK → France	2.139	(1.086)	0.093	(0.338)
UK → Germany	0.603	(2.295)	0.612	(0.102)
France → Germany	4.786	(7.070)	0.002	(0.000)
France → UK	1.851	(1.172)	0.135	(0.310)
Germany → France	10.144	(12.252)	0.000	(0.000)
Germany → UK	2.835	(3.011)	0.036	(0.050)
Panel D: The frontier emerging markets (Model 2)				
Croatia → Romania	3.495	(4.452)	0.014	(0.012)
Croatia → Slovenia	11.268	(29.680)	0.000	(0.000)
Croatia → Estonia		(11.361)		(0.000)
Estonia → Croatia	9.101	(5.373)	0.000	(0.005)
Estonia → Romania	4.508		0.003	
Estonia → Slovakia		(2.454)		(0.087)
Estonia → Slovenia	4.022		0.007	
Romania → Estonia		(2.687)		(0.069)
Romania→ Slovakia		(3.468)		(0.032)

Table 4. *Continued*

Panel D: Frontier emerging markets (Model 2) *(continued)*

Markets Time period	F-statistics before crisis (crisis)		p-value before crisis (crisis)	
Romania→ Slovenia	3.242		0.021	
Slovakia → Estonia		(2.924)		(0.055)
Slovenia→ Croatia	9.233	(5.481)	0.000	(0.004)
Slovenia→ Estonia	2.246		0.080	
Slovenia→ Romania	2.313		0.074	
Slovenia→ Slovakia		(3.352)		(0.036)

Note: Panel D reports only those combinations that reveal significant causality relations among the frontier emerging markets (total number of tests is 20 in each period, while the number of significant tests is 9 in the period before the crisis and 10 during the crisis).

Table 5. Variance decomposition (Model 1)

Country	Percentage of forecast error variance in					
Days	World	Croatia	Estonia	Romania	Slovakia	Slovenia
Croatia						
1	2.04 (40.03)	97.95 (59.97)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	4.06 (42.59)	95.59 (55.89)	0.08 (0.03)	0.06 (0.49)	0.00 (0.37)	0.18 (0.61)
5	4.42 (41.55)	93.98 (52.92)	0.61 (2.71)	0.10 (0.61)	0.00 (0.59)	0.86 (1.59)
10	4.42 (41.55)	93.95 (52.91)	0.63 (2.72)	0.10 (0.61)	0.00 (0.59)	0.86 (1.59)
Estonia						
1	1.57 (9.60)	0.03 (2.87)	98.39 (87.51)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	5.61 (21.97)	0.12 (2.98)	94.13 (72.70)	0.05 (0.28)	0.00 (1.09)	0.06 (0.95)
5	5.58 (21.81)	0.15 (3.06)	93.73 (72.22)	0.11 (0.47)	0.21 (1.13)	0.19 (1.27)
10	5.58 (21.82)	0.15 (3.07)	93.73 (72.21)	0.11 (0.47)	0.21 (1.13)	0.19 (1.27)
Romania						
1	0.37 (25.83)	0.39 (11.05)	0.01 (2.31)	99.21 (60.79)	0.00 (0.00)	0.00 (0.00)
2	1.00 (31.11)	0.39 (10.09)	0.12 (2.11)	98.54 (55.58)	0.00 (0.89)	0.03 (0.17)
5	1.01 (30.82)	0.74 (10.50)	0.57 (2.33)	97.33 (54.91)	0.83 (0.89)	0.24 (0.52)
10	1.02 (30.82)	0.74 (10.50)	0.58 (2.33)	97.30 (54.91)	0.08 (0.89)	0.24 (0.52)
Slovakia						
1	0.11 (0.00)	0.01 (0.05)	0.00 (1.67)	0.08 (0.55)	99.78 (97.73)	0.00 (0.00)
2	0.22 (0.01)	0.01 (0.86)	0.04 (1.65)	0.08 (1.16)	99.63 (96.22)	0.00 (0.10)
5	0.22 (0.97)	0.03 (1.21)	0.23 (2.50)	0.11 (2.32)	99.37 (92.56)	0.01 (0.44)
10	0.22 (0.97)	0.03 (1.21)	0.23 (2.52)	0.11 (2.33)	99.37 (92.53)	0.01 (0.44)
Slovenia						
1	0.32 (15.58)	1.13 (2.18)	0.35 (6.52)	1.35 (1.28)	0.00 (0.00)	96.82 (74.44)
2	2.98 (39.44)	1.20 (2.40)	0.35 (5.08)	1.59 (1.56)	0.00 (0.67)	93.85 (50.82)
5	3.52 (38.59)	1.87 (2.60)	0.61 (6.80)	1.62 (1.71)	0.00 (0.91)	92.35 (49.39)
10	3.52 (38.60)	1.87 (2.61)	0.61 (6.80)	1.62 (1.71)	0.00 (0.91)	92.35 (49.37)

Notes: This table reports results from variance decomposition for the frontier emerging markets and the world market in the period before and during the crisis. Entries in brackets correspond to the values during the crisis period.

Table 6. Variance decomposition (Model 2)

Country	Percentage of forecast error variance in							
Days	UK	France	Germany	Croatia	Estonia	Romania	Slovakia	Slovenia
Croatia								
1	4.47 (40.27)	0.19 (3.28)	0.20 (1.75)	95.14 (54.69)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	4.72 (39.22)	0.40 (3.27)	0.20 (3.85)	94.30 (52.47)	0.13 (0.04)	0.08 (0.37)	0.00 (0.34)	0.17 (0.44)
5	5.00 (38.34)	0.48 (3.27)	0.21 (3.73)	92.56 (49.36)	0.73 (2.84)	0.13 (0.40)	0.01 (0.55)	0.88 (1.51)
10	5.00 (38.29)	0.48 (3.28)	0.21 (3.80)	92.54 (49.30)	0.75 (2.87)	0.13 (0.40)	0.01 (0.54)	0.88 (1.52)
Estonia								
1	2.22 (13.33)	1.03 (0.73)	0.04 (0.01)	0.02 (2.48)	96.69 (83.45)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	3.67 (17.79)	1.62 (1.03)	0.04 (2.30)	0.13 (4.29)	94.41 (72.85)	0.05 (0.15)	0.00 (0.95)	0.08 (0.64)
5	3.73 (17.92)	1.64 (1.06)	0.06 (2.33)	0.15 (4.25)	93.90 (72.37)	0.11 (0.21)	0.21 (0.99)	0.20 (0.87)
10	3.73 (17.92)	1.64 (1.07)	0.06 (2.33)	0.15 (4.24)	93.90 (72.37)	0.11 (0.21)	0.21 (0.99)	0.20 (0.87)
Romania								
1	0.57 (32.44)	0.15 (0.31)	0.05 (1.15)	0.36 (7.95)	0.01 (2.00)	98.86 (56.15)	0.00 (0.00)	0.00 (0.00)
2	0.84 (31.95)	0.27 (1.98)	0.07 (3.43)	0.37 (7.61)	0.01 (1.87)	98.41 (52.27)	0.00 (0.78)	0.03 (0.11)
5	0.85 (31.36)	0.30 (2.15)	0.10 (3.69)	0.69 (8.46)	0.54 (2.03)	97.19 (51.14)	0.08 (0.78)	0.25 (0.39)
10	0.86 (31.35)	0.30 (2.16)	0.10 (3.70)	0.69 (8.47)	0.55 (2.03)	97.16 (51.12)	0.09 (0.78)	0.25 (0.39)
Slovakia								
1	0.10 (0.05)	0.03 (0.12)	0.00 (0.33)	0.02 (0.27)	0.00 (1.62)	0.08 (0.69)	99.77 (96.92)	0.00 (0.00)
2	0.17 (0.06)	0.04 (0.57)	0.00 (0.33)	0.02 (0.66)	0.05 (1.61)	0.08 (1.31)	99.64 (95.15)	0.00 (0.31)
5	0.18 (0.58)	0.07 (0.63)	0.26 (0.73)	0.04 (0.90)	0.24 (2.48)	0.11 (2.37)	99.08 (91.73)	0.02 (0.58)
10	0.18 (0.58)	0.07 (0.63)	0.26 (0.73)	0.04 (0.90)	0.24 (2.49)	0.11 (2.38)	99.08 (91.73)	0.02 (0.58)
Slovenia								
1	0.53 (19.43)	0.07 (1.87)	0.19 (0.14)	1.24 (1.97)	0.44 (7.21)	1.34 (1.05)	0.00 (0.00)	96.19 (68.33)
2	2.15 (26.28)	0.23 (1.81)	0.19 (4.41)	1.30 (5.32)	0.44 (6.32)	1.61 (1.54)	0.00 (0.55)	94.08 (53.77)
5	2.54 (25.56)	0.25 (2.52)	0.45 (4.82)	1.98 (5.67)	0.72 (7.44)	1.64 (1.49)	0.00 (0.65)	92.42 (51.85)
10	2.54 (25.58)	0.25 (2.52)	0.45 (4.83)	1.98 (5.67)	0.73 (7.44)	1.64 (1.49)	0.00 (0.65)	92.41 (51.82)

Notes: This table reports results from variance decomposition for the frontier emerging markets and the developed markets in the period before and during the crisis. Entries in brackets correspond to the values during the crisis period.