CO-MOVEMENTS OF EUROPEAN STOCK MARKETS USING THE UNIVARIATE MARKOV REGIME SWITCHING MODEL

Radu LUPU, PhD
Institute for Economic Forecasting, Romania

Adrian Cantemir CALIN, PhD
Institute for Economic Forecasting, Romania,
cantemircalin@ipe.ro

Abstract:
The connections among the European stock market indices are considered as an important element in the study of the integration of these markets. Our paper suggests the analysis of these connections by means of analyzing the simultaneity of regime shifts in the dynamics of a set of Western and Eastern European equity market indices. We measure this simultaneity phenomenon and we present evidence in support for its future consideration as a step in the study of stock market integration in Europe.

Keywords: *co-movements, Markov regime switching, European stock markets, stock market integration*

JEL classification *C58, G17, G15*

Introduction

The study of the co-movements of stock markets is a topic that captured the attention of international finance literature, especially given the impact of the theory of portfolio diversification. The benefits that derive from diversification are clear and have been profoundly analyzed. The financial literature and practice have shown that the dynamics of a portfolio is not only based on the level of the return and the risk parameters of the assets held, but also on the correlations that exist between the mentioned assets. A low correlation between various international markets makes the process of diversification an efficient tool in portfolio management.

Therefore, given this logic and the phenomena of globalization, integration and convergence that characterize the modern financial

environment, the study of the linkages between international financial markets has become a crucial aspect.

This lead to the formation of a consistent literature that focuses on the co-movement of international markets. Key contributions have been brought by studies such as Hamao and *al*. (1990), Richards (1995), Johnson and Soenen (2003), Bekaert and *al*. (2005), Bonfiglioli and Favero (2005), Syriopoulos (2007), Arouri et al (2010), or in more modern approaches such as Levišauskaitė et al (2014) or Dewandaru et al (2014). The study of co-movement does not rely only on modeling the existing correlations, incorporating also elements like volatility, contagion or spillovers.

The purpose of this paper is to contribute to the existing literature by studying the level of integration of European stock markets. We consider the co-movements in terms of simultaneity of regime shifts and try to explain their dynamics.

The remainder of the paper is organized in the following way. The second section presents several elements of the existing literature. Section III discusses the data used the methodology employed. Section IV exhibits the results, while the last section concludes.

Literature review

Hamao and *al*. (1990) analyze the financial markets of US, UK and Japan and show solid spillover effects using an ARCH model. Heston and Rouwenhorst (1994) study the co-movements of twelve European financial markets and observe that though industry correlations are high, the international volatility and return co-movements are influenced by country specific factors.

Longin and Solnik (1995) use a GARCH model and report a significant correlation for international stock markets during the 1958-1985 period. In a similar approach, Karolyi and Stulz (1996) document some changes in the dynamics of correlations in terms of daily returns in the cases of US and Japan indices.

In an ample analysis, Choudry (1997) uses a battery of statistical tools such as co integration tests, error correction models or simply unit root tests in order to document a potential link between the US market and other six Latin American markets. In another study that focuses on South American markets, Chen and al (2002) observe a strong level of co-movement for countries such as Venezuela, Argentina, Chile, Mexico, Columbia and Brazil.

Bonfiglioli and Favero (2005) build on the distinction between contagion and interdependence as firstly explained by Rigobon, (2003) in order to explain market co-movements in the cases of US and Germany. The authors investigate the long term interdependence between the two markets

and also focus on any potential contagion effects. Though they do not find signs of long term interdependence, they find evidences of contagion. Gallo and Otranto (2008) use a Markov Switching bivariate model for the investigation of co-movements, interdependence, or spillovers. The authors distinguish co-movement effects between Hong-Kong and Singapore and a spillover effect from the former to Korea. Other relevant Markov Switching approaches can be found in Beaupain (2010) or Idier (2011). Boyer et al. (2006) also use the Markov switching model, but in addition to this they incorporate an analysis based on the extreme value theory. The authors remark an enhanced co-movement in times characterized by high volatility.

Lupu and Lupu (2009) study the presence of stock market contagion by comparing the evolution of Central and Eastern European markets with that of Western European states, US and Japan. The authors consider that contagion lies in any potential increase in financial co-movements after a certain event, and succeed in demonstrating the phenomenon.

Lupu (2011) brings forth an analysis of correlation coefficients between pairs of fourteen stock market index return series. Using as modeling tools a GARCH – DCC model, a volatility model and a jump diffusion model, the author documents on the nature of the investigated linkages.

Levišauskaitė et al. (2014) seek to determine the co-movements present between the bond and the stock markets for all the EU states. The authors report small and insignificant correlations for the countries included in the study except for Romania[1], Greece, Hungary and Lithuania.

Albu et al (2014a) and Albu et al (2014b) demonstrate the existence of stock market co-movements focusing on the effects generated by quantitative easing. The authors present an effect of contagion of US, British, Japanese and European policies on a set of nine CEE sovereign CDSs.

In a very recent contribution, Dewandaru et al (2014) discuss the market co-movements in classic and Islamic markets aiming to expose possible contagion signs during nine sets of relevant economic crises. The authors report a state of incomplete market integration that is more potent in the case of the Islamic markets.

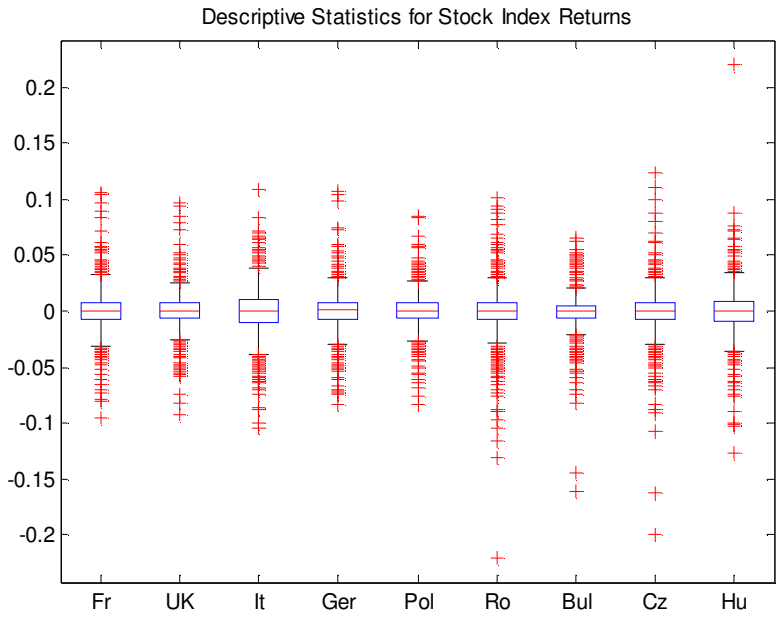
We consider that the process of financial integration is driven in general by the evolution of macroeconomic indicators. Albu, Lupu and Calin (2014) explore the linkages between GDP per capita and market capitalization through the use of a non-linear approach that simulates the convergence process.

[1] For a detailed view of the Romanian financial sector see Horobet and Lupu (2005)

Data and methodology

We are using daily prices for stock market indices from the following countries: France, United Kingdom, Italy, Germany, Poland, Romania, Bulgaria, Czech Republic and Hungary. We are covering the period ranging from September 2007 until December 2014. The data was organized in a common sample of log-returns covering 1665 realizations from September 5th 2007 until December 5th 2014. A brief presentation of the statistical properties of these assets is shown in Figure 1.

Figure 1 – Boxplots of stock market indices



We notice that the stock market returns have similar statistical properties, with means and standard deviations that are situated at approximately the same levels and with large probabilities in the tails. We notice large outliers on one hand especially in the case of Romania, Bulgaria and Czech Republic with a negative skewness and on the other hand in the case of Hungary with a positive skewness.

Our methodology relies on the logic of the Markov Switching modeling as portrayed by Hamilton (1994), Tsay (2002) or Wang (2003).

We thus assume a process given by the subsequent equation:

$y_t = \mu S_i + \epsilon_t$

Where $S_i = 1 \dots k$ and ϵ_t is assumed to follow a normal distribution.

Considering a two state approach, the model is characterized by the following set of equations:

$$state\ 1:\ y_t = \mu_1 + \epsilon_t \quad \epsilon_t \sim (0, \sigma_1^2)$$

$$state\ 2:\ y_t = \mu_2 + \epsilon_t \quad \epsilon_t \sim (0, \sigma_2^2)$$

The Markov Switching modeling background can be estimated with the maximum likelihood method in the following manner:

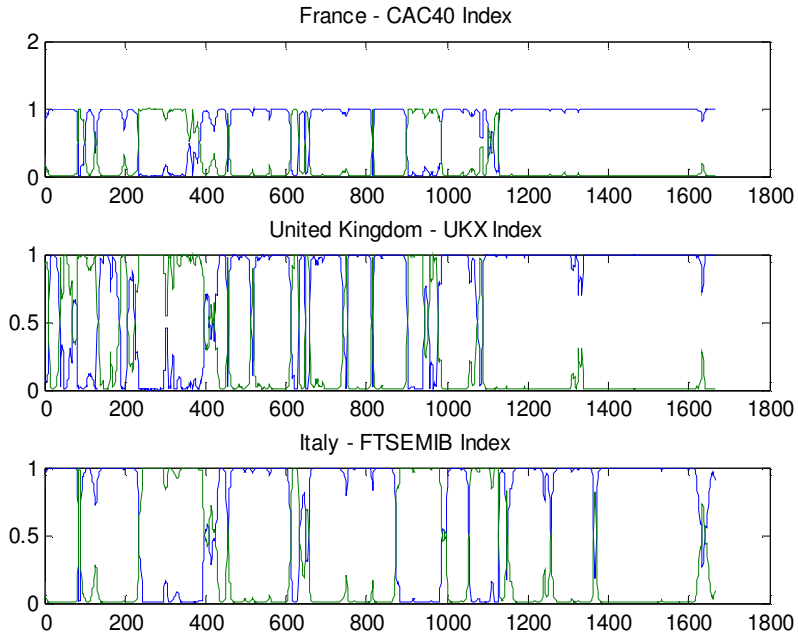
$$\ln L = \sum_{t=1}^{T} ln\left(\frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{y_t - \mu S_i}{2\sigma^2}\right)\right)$$

Results

The fitting of these particular models to our series of data generated the results that present the general dynamics of the probabilities of two possible states, with shifts in both the mean and the volatility of these returns, treated at the univariate levels.

We organized the results in three different charts, each summarizing the cases of three countries (three stock market indices) in Figures 2, 3 and 4.[1]

Figure 2 – Dynamics of Probabilities for the two states at the univariate approach for France, UK and Italy



[1] *All computations were performed in Matlab using the code developed by Marcelo Perlin.*

The OX axis presents the time span of the series of stock market index log-returns. We notice that there is a larger co-movement, in terms of regime shifts, for the case of UK and Italy especially in the last quarter of the series that we used in our analysis, and a larger co-movement for the case of France and UK in the first part of our data. The FTESEMIB Index, on the other hand, seems to move less between the two states – situation that could be interpreted as a good fit for the use of two-state Markov Switching model. The UKX Index seems to move a lot between the two states, especially in the first part of our analysis.

A situation approximately similar with the one in Figure 2 can be observed in Figure 3, where the DAX Index and the WIG Index seem to have a larger similarity, while the Romanian index seems to move less between the two states established in the model. The second half of our time series seems to be more fitted to the two-state model and the three stock index returns move from one regime to another in approximately the same moments.

Figure 3 – Dynamics of Probabilities for the two states at the univariate approach for Germany, Poland and Romania

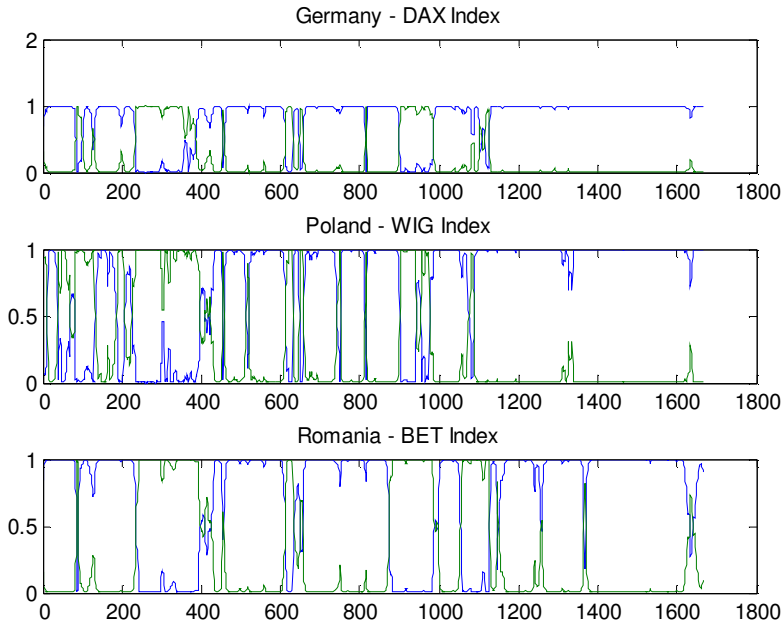
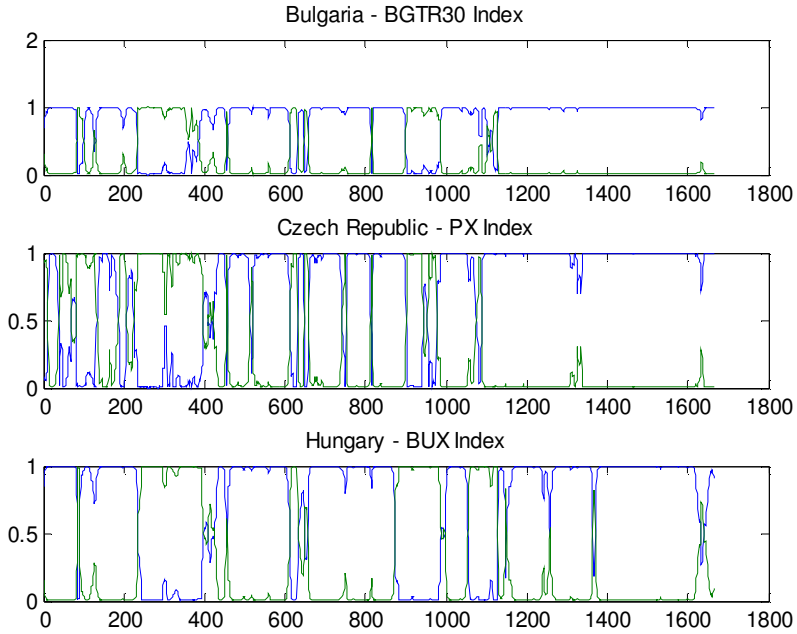


Figure 4 presents the dynamics of the changing probabilities for the Bulgarian, Czech and Hungarian stock market indices. We can notice that these returns exhibit the same structure of changing regimes in the first part

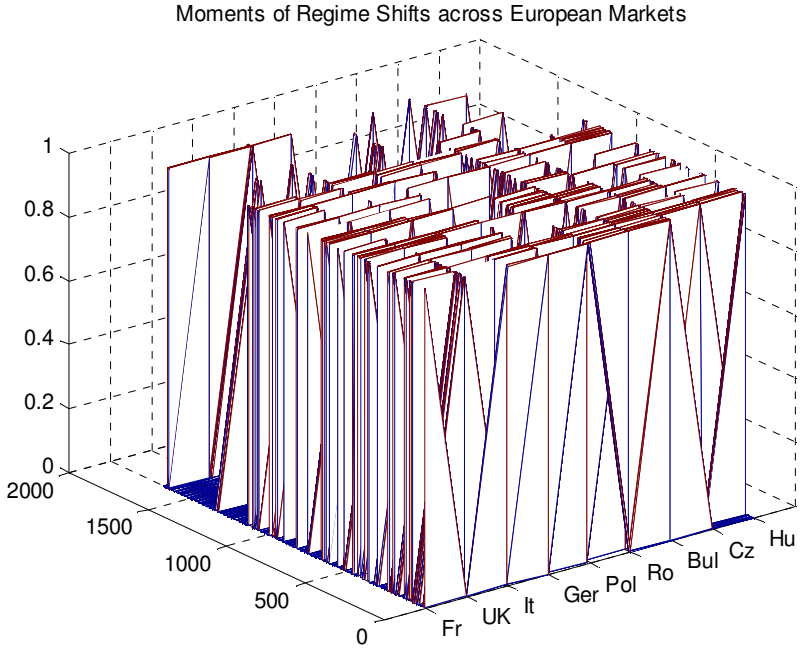
of the series and they show very few changes in the second part, as in the cases observed in Figures 2 and 3. The Hungarian and the Bulgarian indices show more stability, they move less between the two regimes.

Figure 4 – Dynamics of Probabilities for the two states at the univariate approach for Bulgaria, Czech Republic and Hungary



In order to measure the similarities of the series across all the countries in our analysis, we determined all the moments when the probabilities move from one state to another for each stock market index. Figure 5 presents a three dimensional chart with the regime shifts for all the countries across all the moments of our analysis.

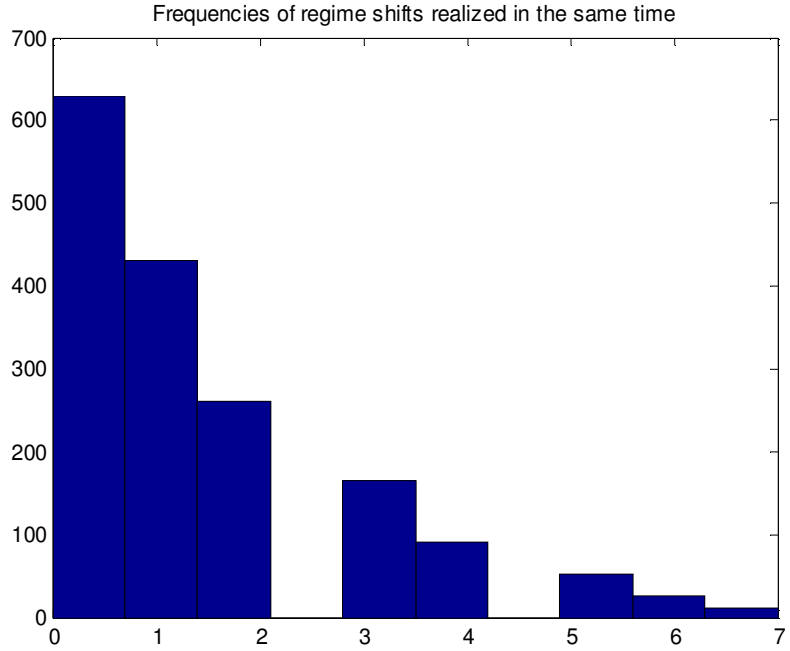
Figure 5 – Structure of Regime Shifts for all the series in our sample



We notice the fact that the chart tends to exhibit blocks of dynamics at the same moment in time, which is evidence of the fact that the changes take place usually in the same time – the block are constructed along the axis of countries.

In order to measure this pattern a bit better, we decided to count the number of regime shifts that occur in the same time for all the moments (days) in our sample. Figure 6 presents the map of frequencies (histogram) of all these appearances. We notice the fact that there is a large number of regime shifts that took place in the same time, sometimes covering 7 countries. There is also a large amount of individual shifts – as we can see by the large size of the first column in the histogram.

Figure 6 – Histogram of appearances of common regime shifts at the European level



Concluding Remarks

We are using a set of nine stock market indices with daily frequency to study the simultaneity of the regime shifts that occurred in a time interval of seven years.

Our results show that there is important evidence in support of regime changes that appear in the same time across all the nice stock market indices. This can be considered as evidence in support of stock market integration as result of co-movement. The Romanian stock market index exhibits less similarities with the rest of the European developed markets but larger similarities with the Central and Eastern European markets.

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