Correlation of International Stock Markets Before and During the Subprime Crisis

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Abstract

This study analyses the correlation between the Romanian stock market and some other representative markets from Central and Eastern Europe, namely from the Czech Republic, Poland and Austria. The correlation will be studied in two distinct time intervals, the first prior to the 2007 financial crisis, and the second covering the crisis period, until now. This split brings into focus the change of the correlation between the respective markets after the start of the crisis. This change in correlation is explained by specific characteristics of each market, or by the particular structure of the market indices considered as a synthetic indicator of the respective markets evolution. Explanations are offered also where the mentioned correlations do not change, or are very low from the very start.

I have proved that these indices, in their general form, affect the normality coefficients, and that, in most of the cases, correcting the general form brings these coefficients to normal values.

The conclusions also prove that the Romanian market, as well as of other emergent markets, is not moving in the same direction as the majority of the markets included in the considered selection.

1. Introduction

Interdependence means the normal transmission of shocks between different markets, following commercial exchanges and policies and geographical position, leading to a certain
degree of dependence of each market on its’ neighbours, as well as on other countries worldwide, in variable proportions.

Contagion, on the other hand, represents a dependence which is not manifest in normal periods, but appears only when financial markets experience strong shocks. More than this, as opposed to interdependence, this specific dependence cannot be linked to macroeconomic or financial variables’ changes.

The correlation coefficients are conditioned by the market volatility. As a consequence, during crisis situations, when markets are most volatile, the estimations of the correlation coefficients tend to increase.

The mechanism of shock transmission between markets remains though unchanged. As volatility is bound to grow during financial crises, an increase in correlation during swift price falls, as a single sign, is not enough to indicate a phenomenon of “shift-contagion”. Forbes and Rigobon (2002).

2. Literature Review – critical analysis of previous research

As an example, Ilhan and Gulser Meric (1997) investigate if movements of the international capital markets differ in the period preceding the 1987 capital markets crash and the one after the crash. The tests indicate that the movements of the respective markets have changed significantly after the crisis. Their research indicates that the correlations between 12 European markets and the North-American market have increased substantially.

Mun (2005) analyses both the yield and the volatility contagion effects on the majority of the markets following the September 2011 terrorist attacks by using the GARCH model, Mun presents proof that these significant correlations of the North-American market reflect a contagion from the US, and that the attacks led to a volatility contagion (as opposed to a yield contagion) from the US towards the UK and German markets.

In the same direction, Charles and Darn (2006) study the effect of the September 2001 attacks on 10 stock market indexes, using a method of detecting the spread of the effects. They show that the international regulated markets suffered strong shocks following the attacks.

Another study by Kamel, Seifallah and Naoufel (2010) on 10 stock market indices between January 2005 – and July 2010 show that there is a significant correlation between
emerging markets and the American market during the subprime crisis. Using a GARCH model, they demonstrated that there is evidence which explains contagion among markets during the crisis. The coefficients of correlation between emerging markets and markets in America are higher in the period 2008-2009. A remarkable example is that the correlation coefficient for Latin American countries, which was around -0.4 before the crisis, reached a value of 0.8 during the crisis, in Argentina’s case. This result suggests that the effect of contagion between emerging markets and the US one is primarily influenced by the financial crisis which significantly impacted the conditional correlation.

**Mark Mink and Jochen Mierau (2009)** wrote an article that studied the definition of financial crisis contagion, focusing on "contagion changing", which is defined as an increase in the transmission power of stock market shocks from a specific stock market to another. In conclusion, while market returns during financial crises in many countries are generally considered volatile and negative, over a long period, the model used assumed that this phenomenon can happen without the shock transmission between markets to increase. The empirical results support this explanation, suggesting that for the two time periods analysed no such increases have in fact occurred.

**Markwat, Thijs & Kole, Erik & van Dijk, Dick, (2009)** analysed the transmission mechanism of markets crashes throughout the world. The study was conducted on daily indices of stock markets in America, Europe and some emerging countries in Latin America and Asia, for the period July 1996 - July 2007. They concluded that the emergence and evolution of the crashes is driven by both interdependences and contagion.

**Forbes and Rigobon (2002)** wrote an article based on the traditional definition of contagion as expressed in literature: a strong interrelationship between markets after a shock to one country or group of countries. It also focuses on a conventional method for testing contagion: analyse whether the correlation coefficients of interdependent markets increase significantly after the crisis.

3. **Case study – correlation of stock markets – research methodology**

To test the interdependence of capital markets indices we considered the representative indices of stock markets in Central and Eastern Europe, namely the Romanian Stock Exchange index (BET), the Czech Republic Stock Exchange Index (PX50), the Poland Stock Exchange
index (WIG) and the Austrian stock exchange one (ATX). We chose these specific stock market indices because on the one hand, they are the most representative stock markets in the chosen geographical region, and secondly, because they reflect the situation of economies with different degrees of development and European integration, offering thus a fertile ground for testing different scenarios.

3.1. Description of the data base

The research is based on the daily values of the four indices in the period January 2003 - March 2012, which was divided it into two intervals:

- January 2003 – December 2006, the period prior to the crisis;
- January 2007 – March 2012, the beginning and continuation of the crisis, until the present time.

3.2. Data analysis Methodology

The data were modeled using multiple regression techniques, and each of the four indices was expressed as a function of the other three for each time interval separately. The equations are the following:

- \( dl_{atx} = a \times dl_{wig} + b \times dl_{px50} + c \times dl_{bet} + \varepsilon_1 \)
- \( dl_{bet} = d \times dl_{wig} + e \times dl_{px50} + f \times dl_{atx} + \varepsilon_2 \)
- \( dl_{wig} = g \times dl_{px50} + h \times dl_{bet} + i \times dl_{atx} + \varepsilon_3 \)
- \( dl_{px50} = j \times dl_{wig} + k \times dl_{bet} + l \times dl_{atx} + \varepsilon_4 \)

4. Statistical Analysis of the Stock Market Indices

In this chapter we tested the stationarity of the data series to ensure that the model used is a valid one. Unit Root testing has been shown that these series are stationary at first difference.
5. Multiple Regression Analysis of the Stock Market Indices

By applying regression analysis on data collected for the period before the crisis I obtained the following results (estimated coefficients for the exogenous variables are found below):

\[
\begin{align*}
\text{dl\_atx} &= 0.172431 \times \text{dl\_wig} + 0.374188 \times \text{dl\_px50} + 0.015213 \times \text{dl\_bet} \\
\text{dl\_wig} &= 0.349983 \times \text{dl\_atx} + 0.370701 \times \text{px50} + 0.02582 \times \text{dl\_bet} \\
\text{dl\_px50} &= 0.452171 \times \text{dl\_atx} + 0.220701 \times \text{dl\_wig} + 0.030653 \times \text{dl\_bet} \\
\text{dl\_bet} &= 0.044037 \times \text{dl\_atx} + 0.036822 \times \text{dl\_wig} + 0.073428 \times \text{dl\_px50}
\end{align*}
\]

For the data series during the crisis I obtained the following results (estimated coefficients for the exogenous variables are found below):

\[
\begin{align*}
\text{dl\_atx} &= 0.25156 \times \text{dl\_px50} - 0.17033 \times \text{dl\_wig} + 0.51484 \times \text{dl\_bet} \\
\text{dl\_px50} &= 0.15529 \times \text{dl\_atx} + 0.70979 \times \text{dl\_wig} - 0.02836 \times \text{dl\_bet} \\
\text{dl\_wig} &= 0.66652 \times \text{dl\_px50} - 0.09873 \times \text{dl\_atx} + 0.03032 \times \text{dl\_bet} \\
\text{dl\_bet} &= 0.53474 \times \text{dl\_atx} - 0.04772 \times \text{dl\_px50} + 0.05433 \times \text{dl\_wig}
\end{align*}
\]

6. Regression Analysis Results:

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>BET</th>
<th>WIG</th>
<th>ATX</th>
<th>PX50</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BET</strong></td>
<td>0.03682</td>
<td>0.04403</td>
<td>0.07342</td>
<td></td>
</tr>
<tr>
<td><strong>WIG</strong></td>
<td>0.0258</td>
<td>0.34998</td>
<td>0.37070</td>
<td></td>
</tr>
<tr>
<td><strong>ATX</strong></td>
<td>0.01521</td>
<td>0.17243</td>
<td>0.37418</td>
<td></td>
</tr>
<tr>
<td><strong>PX50</strong></td>
<td>0.03065</td>
<td>0.22070</td>
<td>0.45217</td>
<td></td>
</tr>
</tbody>
</table>

The table above contains the summarized multiple regression results for all indices considered, each being taken in turn as the dependent variable, while the other three were considered as independent variables.
**Rules for filling in the table:**

- Each cell contains the regression coefficient in the regression equation.
- With red were marked the coefficients of the indices which do not influence the dependent variable (probability was greater than 5%, and therefore the null hypothesis could not be rejected, meaning that the respective index does not influence the dependent variable).
- With black were marked the coefficients of the indices which do influence the dependent variable (probability was lower than 5%, and therefore the null hypothesis was rejected, meaning that the respective index does influence the dependent variable).

**Conclusion 1:** Before the crisis, the BET index was not influenced by any other index.

**Conclusion 2:** Before the crisis, the BET index influenced no other index

**Conclusion 3:** Before the crisis, any of the other three indexes was influenced by the other two, in various proportions.

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>BET</th>
<th>WIG</th>
<th>ATX</th>
<th>PX50</th>
</tr>
</thead>
<tbody>
<tr>
<td>BET</td>
<td>0.05433</td>
<td>0.53474</td>
<td>-0.04772</td>
<td></td>
</tr>
<tr>
<td>WIG</td>
<td>0.03032</td>
<td>-0.0987</td>
<td>0.66652</td>
<td></td>
</tr>
<tr>
<td>ATX</td>
<td>0.51484</td>
<td>0.25156</td>
<td>-0.17033</td>
<td></td>
</tr>
<tr>
<td>PX50</td>
<td>-0.0283</td>
<td>0.70979</td>
<td>0.15529</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion 4:** During the crisis, the BET index was influenced by the ATX index

**Conclusion 5:** During the crisis, the BET index influenced the ATX index

**Conclusion 6:** During the crisis, any of the other three indexes was influenced by the other two, in various proportions.

7. **Conclusion and proposal**
Conclusion no.1: The results of the regressions above lead to the conclusion that there was no significant correlation between the Romanian market and the three European markets before the crisis.

This situation is explained by the existence of two categories of factors which differentiate the Romanian stock exchange from the others presented in this study: factors related to the development of the Bucharest Stock Exchange and factors related to the behavior of the Romanian investor.

A. Factors related to the development of the Bucharest Stock Exchange
- The fact that the stock market was recently funded makes us consider that there is a direct link between the establishment date and its development level. Our stock has had less time to develop, and this low level of development combined with the economic situation in which Romania is significantly reduce the chances of our market to grow at a much faster rate, as other economically more developed countries do. As a conclusion to this, we can deduce that at this stage Romania cannot aspire to a mature market anytime soon.
- The small number of companies listed on the Bucharest Stock Exchange, determines a very small number of companies included in the building of BET. This strongly reduces the significance of this index as a general state of the economy of the country, and reflects rather punctual events, speculative decisions and the impact of certain legislation and fiscal measures. It is believed that the stock market generally reflects the economy of a country. In this case, if the economic situation will not progress significantly, nor the performance of our stock market will evolve or will be at the level that we want.
- Romania is an insignificant player both on the East-European stock exchange market and generally speaking on the financial stage. The development level is a lower one. This lower level is determined mostly by Romania’s economical problems. The fiscal consolidation measures imposed at the beginning of the crisis have done nothing else but to extend the recession during all this period. In the meanwhile the developed markets have undergone constant economic growth.

B. Factors related to the investor behavior in Romania
A study of the investors behavior in Romania, done by Mitrică and Dragotă shows that the evolution of the BET index and its distortion, so that it no longer represents a good barometer of the Romanian economic situation, is due to some specific aspects of the Romanian financial market, such as: unpleasant experiences in which the involvement of the local authorities was ambiguous, the ability of investors to make proper assessments of the assets and certain characteristics of the investors on the BSE. The most important such factors are:

- The Romanian investors’ reduced experience regarding the investments and other specific aspects of the national capital market is reflected in various scientific studies: in investment decisions investors seek for revenues resulting from the positive variation of the asset prices on short term, the sources of information being represented by the financial statements, articles and news from specialized newspapers and TV programs, internet and daily action price.

- A study realized by Prognosis.ro discusses about the type of inexperienced investor. This study shows that the Romanian investor is a young, university graduate (usually economic studies) person, with just a few years of experience in trading on BSE, working in the banking system, who takes decisions based on a personal analysis of the market, still considering the broker’s advice as well. So the lack of experience is accompanied by a reduced ability to access and analyze all the data available in the market, sometimes from uncertain sources. Moreover their increased confidence in their own abilities is based on their personal skills, academic studies followed, and their working environment.

Conclusion no. 2: During the crisis, the Romanian market presented a positive correlation with that of Austria.

Although the correlation between the indexes of the countries within the same region is expected to increase during the crisis, the emergence of such a strong correlation between BET and ATX should be investigated more carefully. Here are the following possible explanations:

- The existence of a company listed in both countries, which has a significant participation in the composition of both indices. It is about OMV AG, which participates in the composition ATX index, accounting for 12.67%, and which, by buying
Petrom, is part of the composition of BET through OMV Petrom. In Romania, OMV Petrom participates to the BET index with a 20% share, being the second largest share in the composition of BSE. This situation is unique, as in no other country is there a company which participates to both indices, and yet with such an important share. This common presence is likely to significantly increase the correlation of the evolutions of those indices of the two countries. OMV AG owns 51% of Petrom, the 2004 acquisition being the largest in the history of OMV AG.

- **The atypical behavior of the oil companies during the crisis**: both Petrom and OMV AG had significant increases in performance during the crisis. In 2010, OMV Group revenues increased by 30% compared to 2009, much of which was made in Romania, by Petrom. This evolution, which comes against the general behavior of the remaining industries in the countries of the region, during the crisis, has strengthened the influence of the tandem AG OMV / Petrom in the synchronization of the evolution of the two indices.

- **Strong representation of the banking / investment sectors in the BET and ATX indices.** In both countries, banking and investment sectors are strongly represented in the composition of the two indices. In Romania, the BET index includes Banca Transilvania the first position, with a share of 22.21%, and BRD on the third position, with 19.62%. Together, the banking sector controls 42% of BET, and together with OMV Petrom, the share of companies that have a similar financial evolution in both countries is about 62% in BET. In Austria, banks and insurance companies participate with a rate of over 50% in the composition of ATX; together with OMV, they reach a combined share of about 63%, very similar to the situation regarding BET.

**Conclusion 3: During the crisis, the correlation between the PX50 and WIG increased**

Correlations in both directions increased during the crisis, compared to pre-crisis situations, both for the PX50 determining the WIG, and vice-versa. This demonstrates a significant link between the two countries’ economies, or at least a very similar composition or synergy of the two indices. Arguments in favor of a similar behavior of the economies of both countries are:
• The two countries are in similar economic development stages, following Austria, and preceding Romania.
• For both countries, trade with Germany decisively influences economic performance
• Both indices were launched in the same period: 1991 - 1994
• Both countries have negotiated EU accession in the same wave: 2002 - 2003, unlike Romania and Austria.
• Both countries are still in the Eurozone.
• Both countries are part of the Central European area, an area with similar economic, industrial and commercial characteristics, and whose economies are closely linked.

Conclusion 4: During the crisis, the ATX on one side, and the PX50 and WIG indexes on the other side did not show significant correlation

While the PX50 and WIG indices showed similar behavior during the crisis, ATX did not comply to the trend, and made it clear that it does not belong to the same group. Differences can be explained by the different characteristics of Austria, compared with Poland and the Czech Republic.

• Austria joined the EU before the other two countries, namely in 1989, as opposed to 2002 to 2003, thus having an advance of more than 10 years, which translated into higher economic growth, and increased stability to crisis.
• Austria has much closer ties with Germany, developed during a long history, as opposed to the Czech Republic and Poland, which have developed these links mostly after 1989.
• Austria belongs to the Euro Zone, while the other two countries not yet. This probably influenced the behavior of the Austrian economy during the crisis.

Possibilities to use the results for economic purposes

The predictive value of multiple regressions. In principle, using multiple regression, applied to a set of coefficients well correlated, one could obtain a set of expected values of that index, whose chances to occur in reality increase when a greater proportion of dependent variable evolution is explained by the evolution of the independent variables. Using estimates
of indices of other countries, in that context, we can predict the evolution of BET, with both
direct implications on, say, investment on the BSE and indirect, as far as BET evolution is seen
as a reflection of economic development in Romania in general. Unfortunately, this work
showed poor correlation, both under stress conditions and under normal conditions, of the BET
index with other indices; thus, we expect that its future behaviour would not be predicted very
precisely based the evolution of the other countries surveyed, except Austria.

**The significant BET - ATX connection.** The significant correlation between the BET
and the ATX indices during the crisis offers exciting prospects while the crisis continues.
During this period, significant events in the Austrian market, especially those directly affecting
companies involved in the determination of ATX will likely have a significant influence of the
BET. In this context, any stock investor should observe not only the events on the Romanian
market, but also those on the Austrian market, both to prevent any adverse developments in the
two markets as well as for possibly taking advantage of positive trends.

**The significant Austrian and Romanian economies’ connection.** Let’s not forget that
stock market indexes provide a measure, even if mediated, of the economic situation in the
respective countries. Their coherent evolution reflects a consistent common trend of the
economies of both countries, with modifications introduced by factors specific to each
economy. The Austrian economic recovery, which is probably ahead of the one in Central
European countries, and clearly ahead of the Mediterranean area, may signal the revival of the
Romanian economy before the ones in close proximity, namely the Balkan countries or the
former Soviet area.

**Lack of correlation of the BET index with the indices in Poland and the Czech Republic.** The correlation of the BET index with ATX and the lack of correlation with the other
indices signify that the Romanian economy is aligned to the Austrian one to a greater extent than
to the economies of the other two countries, which together represent the characteristic trend for
the Central European area. We could say therefore that the investor or analyst in Romania must
pay more attention to trends in Austria than to the ones in Central Europe, and that exit scenarios
from the crisis must be aligned not so much to Central and Eastern European areas, as is the
usual general approach to economic analysis of the Romanian market, as to German-speaking
countries, which will probably present slightly different developments.
8. Bibliography


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18. Validarea statistică a seriilor de timp pentru gestiunea portofoliului


