

## MANAGING CONTAGION RISK DURING ECONOMIC, FINANCIAL AND POLITICAL SHOCKS

*Daniel Stefan ARMEANU<sup>1</sup>*

*Carmen Emilia PASCAL<sup>2</sup>*

*Sorin-Iulian CIOACA<sup>3</sup>*

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### ABSTRACT

*The present article tackles on a current issue, namely that of financial contagion of the capital markets, a result of instability or financial shocks, such as financial crisis. Moreover, we study the way financial contagion occurs, a phenomenon facilitated by the connections between countries, based on the economic relations, commerce and common lenders. The study object is the Romanian capital market and PIIGS countries markets. We calculate a spillover index, we find which countries are vulnerable, which shocks lead to contagion, as well as their persistence, and also we find moments of crowd effect in the investment community. The investors' behaviour, their reaction to shock and information asymmetry can fuel shock spreading. We find that the contagion issue is more profound, as it expands through many regions, and, therefore, it is important to find correlations between the countries, in order to reduce contagion effects, proving that the financial markets have underestimated this type of risk generated by the interconnections between countries. This information is necessary to define an efficient management style in view of reducing the contagion risks.*

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**KEYWORDS:** *capital markets, contagion, dynamic correlations, financial shock, risk management*

**JEL CLASSIFICATION:** *C58, D53, G01, G15*

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### 1. INTRODUCTION

The economy of a country is a complex mechanism that depends on internal, as well as external factors. So, it is important to assess a country not as an individual item, but in relation with other countries, as these connections will shape the reaction of a country's capital market to shocks, the unbalances and the timeline for an expected stabilization.

Managing the contagion risk, the possibility of surpassing the negative effects of financial shocks, is an interesting issue, frequently analyzed and came into focus as a result of the occurrence of the sovereign debt crisis. This phenomenon captured the analysts' interest, in their quest to find the most efficient methods to understand the causes of this negative phenomenon in order to reduce its impact on the capital markets. An efficient contagion risk management means, on the one hand, finding the causes, the generators of this phenomenon, and, on the other hand, to reduce its effects. This article intends mainly to research the first step, namely that of identifying, distinguishing between interconnection and contagion, as well as delineating the crowd effect. Understanding these differences can lead to proper reactions and decisions meant to optimally manage the situation. Considering that no crisis is unique, we can search former crisis for common characteristics of the markets' and investors' behaviour. It is important to use these findings in order

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<sup>1</sup> Bucharest University of Economic Studies, Romania, darmeanu@yahoo.com

<sup>2</sup> Bucharest University of Economic Studies, Romania, carmen.pascal@yahoo.com

<sup>3</sup> Bucharest University of Economic Studies, Romania, cioaca\_sorin@yahoo.com

to create early warning systems, anticipating the impact the shocks (all types of shocks - economical, social, political) on the markets.

One of the contribution of this article to the financial literature dealing with the contagion risk is that it studies this phenomenon by finding the impact European market as a whole has on the Romanian market and on those of the PIIGS group. Moreover we focuss on more than one crisis, looking at all the main events that occurred during the analyzed timeframe: the Lehman Brothers collapse, deepening of the sovereign debt crisis, US downgrade and the Ukrainean conflict, in order to find which shock was strong enough to generate contagion.

## 2. AN OVERVIEW OF THE MAIN THEORETICAL FINDINGS

The contagion on the financial markets is especially important because of its consequences on the global economy in terms of monetary policy, risk management and optimal asset allocation.

Financial crisis occur regularly and are not unique, being marked by common characteristics, such as the increased volatility that leads to a spillover affecting other markets. So, it is important to assess the spillover effects in order to find them from the early stages and to monitor their progress. In an article written in 2008, Diebold and Yilmaz define a spillover index based on the decomposition of the variance errors using autoregressive vectors, a measure that has some limits, derived from the order in which variables are used in VAR, using a Cholesky-type factoring, and from the fact that the analysis does not permit the directional spillover assessment (from/to a certain market), but to/from al studied markets, limits that were overcome in their 2010 study. In order to overcome the heteroskedasticity problem without dividing the analyzed time-frame in 2 sub-intervals (ante and ex crisis), in this article we will estimate a multivariate GARCH model, using a BEKK representation.

The causes and effects of the financial contagion were analyzed by Upper and Worms (2004), Degryse and Nguyen (2004), Cifuentes, Ferrucci and Shin (2005). All studies proved that financial integration can lead to contagion. As the markets became integrated, information from one market will become more and more important to the others. Understanding the nature of these connections is essential to find the limits of portfolio diversification and optimal asset allocation. When a financial shock hits the market, the correlations' volatility can vary widely, so the diversification benefits will be reduced (Muñoz, Márquez and Chuliá, 2010). The main causes of contagion are international macroeconomic shocks, as well as local shocks, propagated through commercial connections, competitive devaluations and financial ties. So, it is necessary to find and evaluate appropriate measures to reduce the contagion negative effects. Countries must improve their own economic state and control all financial sources available, to gradually liberalize financial market and to support international cooperation in order to avoid crisis and their contagion effect (Yang, 2012). A different contagion cause comes from imperfect information and gaps between investors' expectations. In the absence of better information, investors can believe that a financial crisis in a country can lead to similar crisis in other countries. This theory implies that investors are bad-informed about the real characteristics of countries and, therefore, take decisions based on some indicators, including those from other countries that can or cannot reflect the vulnerability state of the respective country. Information that investors use can include other investors' actions, indicating the effects of information asymmetry (Dornbusch, Park, Claessens, 2000).

It is necessary to distinguish between interconnection and contagion: Forbes and Rigobon (2002) define contagion as a significant increase of the correlations between the markets and interconnection as being the existence of some strong and continuous correlations between the markets (Muñoz, Márquez, Sánchez, 2011). Sibel Celik (2012) considers that it is necessary to compare the correlation between to financial markets in normal, stable times, as well as during the crisis episodes. If there is a moderate correlation between the two markets during the economic stability and a shock in a market can induce a significant increase in the markets, this might generate contagion. If there is a significant interdependence between the markets and that

correlation remains strong during a crisis, this is not necessarily a contagion. The amplitude of financial contagion depends on how sensitive the market is to risks and on information asymmetry, because it is considered that these induce larger fluctuation on the market (Celik, 2012).

One type of contagion classification is: mechanical contagion – given by the financial connections between the economies, and psychological or pure contagion – caused by the investors' behaviour (Marais, Bates, 2006). The latter, together with information asymmetry (the distortions that occur in the markets, imperfect and poor quality information) and financial and commercial international flows (the lack of market monitoring and supervision, the lack of regulation limiting the exposure to volatile foreign capitals) are ways to spread a crisis, all of them inducing an increased contagion effect. But Frankel and Schmukler, cited by Wafia (2012), consider that is not necessarily clear whether information asymmetry, as related to investors and the cost to obtain information regarding a market, can be seen as a financial connection based on fundamentals. Commercial ties, regional models and macroeconomic similarities make the countries vulnerable to volatility. Volatility can be passed from a country to the others by common lenders and investors' actions that operate on financial international centers. Little is known about the importance of macroeconomic conditions and institutional factors in crisis spreading. The spreading of a crisis depends on the market's degree of financial integration. If a country is integrated in the global financial market or if the financial markets from a region are strongly integrated, the price of assets and other economic variables will have a common pattern of evolution. The higher the integration degree, the larger the contagion effects for the country. Viceversa, the countries that are not financially integrated, because of capitals control and the difficult access to international funding, are, by definition, immune to contagion. Therefore, financial markets facilitate shock spreading, without generating them.

In his PhD. thesis, Kalbaska (2013) studies the systemic risk and the spreading of the contagion risk for the interval 2006-2011, starting with an analysis of 8 countries (PIIGS, France, Germany, UK) and adding an analysis of 20 banking systems, making simulations and stress-testing. Regarding the first analysis, whose methodology is close to the one used in this paper, proved that a shock in a PIIGS country is not enough to generate the bankruptcy of the banking system of another country. On the other hand, a combined collapse of several banking systems (in countries such as Italy or Spain) will be far more dangerous. This is a confirmation of the results obtained in this article, stating that Italy is the country generating the largest spillover and Spain is the main "receiver" of the spillover.

The present paper is divided as follows: section 3 describes the methodology applied, the methods and models used, as well as the database, section 4 includes the results of the research and section 5 presents the conclusions.

### 3. METHODOLOGY

The main purpose of this paper is to study the contagion effect on European financial markets, considering the most affected countries by the financial crisis shock, in order to prove the existence of the contagion phenomenon and the effects of shock spreading over the analyzed markets. To this purpose, we calculate a contagion index using an autoregressive variable, such as developed by Diebold and Yilmaz in their paper „Measuring financial asset return and volatility spillovers, with application to global equity markets” (2008). Measuring the spillover means estimating some VAR models, in which we decompose the variance, finding, at the end, which percent of the estimation errors variation is caused by the shocks in the respective market and, which percent is generated by the shocks in the other markets.

We use representative indexes from the capital markets in Romania, France, Germany, Portugal, Italy, Ireland, Greece, Spain, as well as the European market index S&P 350 Europe. We use daily data, expressed as returns, for September 15<sup>th</sup>, 2008 – August, 13<sup>th</sup>, 2014. The data are provided by Google Finance, Investing.com, Wsj.com, Spindices.com.

By finding the dynamic correlations between the European market and each of the other considered markets, using a BEKK (1,1) diagonal model, we test, using dummy variables, which financial event, of those under analysis, lead to contagion and, as a consequence, to spreading the shock. We consider 4 dummy variables: dummy1 – that reflects the collapse of Lehman Brothers with value equal to 1 for the period September, 15<sup>th</sup>, 2008 – December 31<sup>st</sup>, 2008; dummy2 – reflects the increased sovereign debt crisis (March 2010 – December 2011, the period when the analyzed countries requested financial aid from the International Monetary Fund or European Central Bank and adopt budgetary and fiscal consolidation measures); dummy3 – reflects the US credit rating downgrade in order to see the impact on the European markets (August 2011 – June 2013, when the credit rating was downgraded to AA+ with a negative outlook); dummy4 – reflects the Ukrainean conflict (November 2013 – to date), in order to find whether it is strong enough to generate contagion. These 4 dummy variables have been chosen based on the correlation graph, looking at the moments of the increased correlation between the analyzed markets.

According to Munoz (2010), tests are based on the following equations:

$$\rho_{ij,t} = \mu + \phi \cdot \rho_{ij,t-1} + \alpha_k \cdot dummyk + e_{ij,t} \quad (1)$$

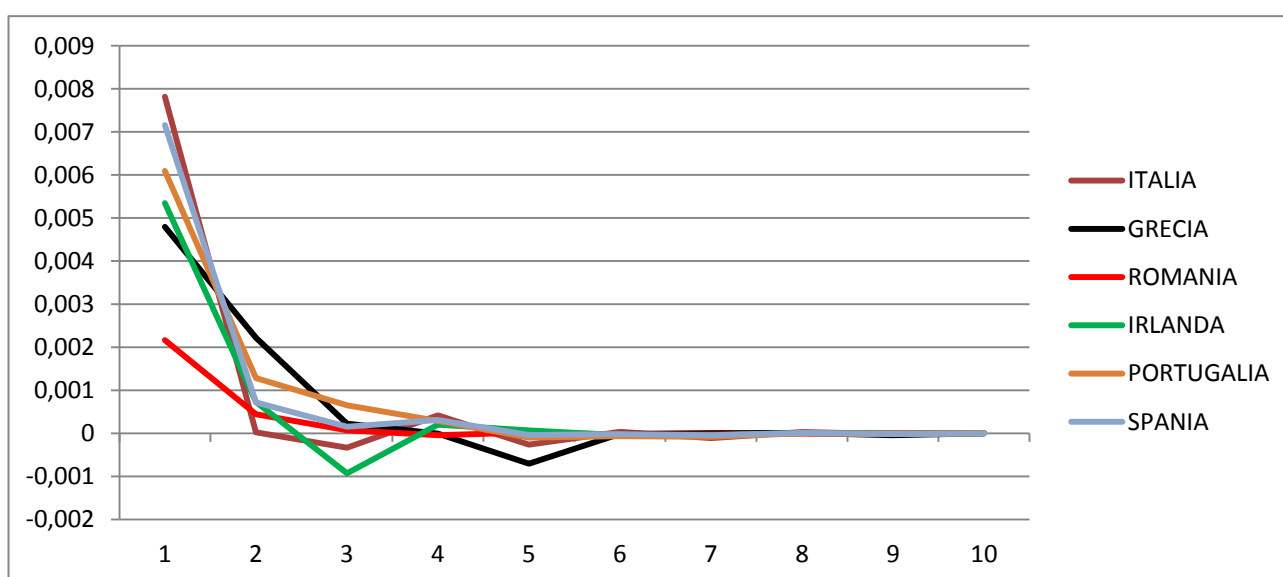
$$h_{ij,t} = \omega_0 + \omega_1 \cdot \varepsilon_{ij,t-1}^2 + \beta_1 \cdot h_{ij,t-1} + \delta_k \cdot dummyk, \quad k = 1,4 \quad (2)$$

where  $\rho_{ij,t}$  are corelations, i = Europe, j = Romania, Portugal, Italy, Ireland, Greece, Spain.

In order to say that contagion occurred, all the coefficients of the dummy variables must be positive and statistically significant for all the analyzed markets.

#### 4. THE RESULTS

As a starting point, by using Granger causality test, we find that Romania does not Granger cause any other country, but all the other countries Granger cause Romania, even though these causalities can be considered having a low intensity, as the static correlations between the Romanian capital market and the other European markets are very weak. Another finding is that developed countries, with strong economy, such as Germany and France, have stronger correlations than the emerging economies.



**Figure 1: Action-Reaction analysis**

Source: Google Finance, Investing.com, Wsj.com, Spindices.com

Using an action-reaction analysis, we tried to find the European markets reaction to a generalized shock over the standard deviation of S&P 350 Europe index. We observe that this shock affects the entire system, the effect persisting for approximately 6 days, and then converge to the initial status. According to the graph, the most affected countries are Greece and Ireland, and the less affected is Romania.

The contagion index is a tool used to measure the extent to which the spillover effect is generated by internal shocks or by shocks from the other markets.

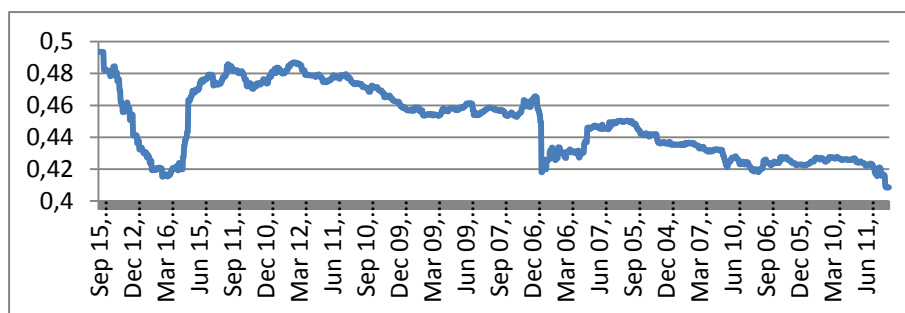
**Table 1: Static spillover index**

	ITALY	GREECE	ROMANIA	IRELAND	PORTUGAL	SPAIN	Effects FROM other markets
ITALY	95.58	1.59	0.73	0.14	1.00	0.96	4.42
GREECE	20.37	75.73	0.89	1.27	0.95	0.79	24.27
ROMANIA	8.20	1.34	89.03	0.35	0.34	0.74	10.97
IRELAND	36.95	1.04	1.66	57.77	1.48	1.10	42.23
PORTUGAL	42.79	1.92	0.46	4.80	49.19	0.84	50.81
SPAIN	68.79	1.51	0.86	1.43	3.69	23.73	76.27
Effects TO other countries	177.10	7.40	4.60	7.99	7.46	4.42	208.97
Total effects	272.68	83.12	93.63	65.77	56.64	28.16	600.00
							<b>34.83%</b>

Source: Google Finance, Investing.com, Wsj.com, Spindices.com

We can observe that, in the case of Romania, the external shocks' influence over the economy is close to 11%, the smallest influence as compared to the other countries, meaning that Romania "receives" very little spillover from the other markets (the main contributors being Italy and Greece) and the spillover generated by Romania is insignificant. The analysis shows that Spain is the most vulnerable, highly dependent on the Italian market, as Italy is the main spillover source for all the analyzed markets.

Considering the spillover effects among the countries and calculating a single index for the entire interval based on the variance decomposition, we find that approximately 35% of the estimation errors variance is given by the spillover effect, but subsequently the return evolution changes, requiring the calculus of a dynamic index. This reflects the magnitude and the persistence of shocks, as shown in the following graph, that presents the reaction of the markets to main events: Lehman Brothers collapse, sovereign debt crisis started in 2010 and inflated in 2011, which lead to a larger variation of the spillover index, as well as the Ukrainean crisis, started in November 2013, with a lower intensity.

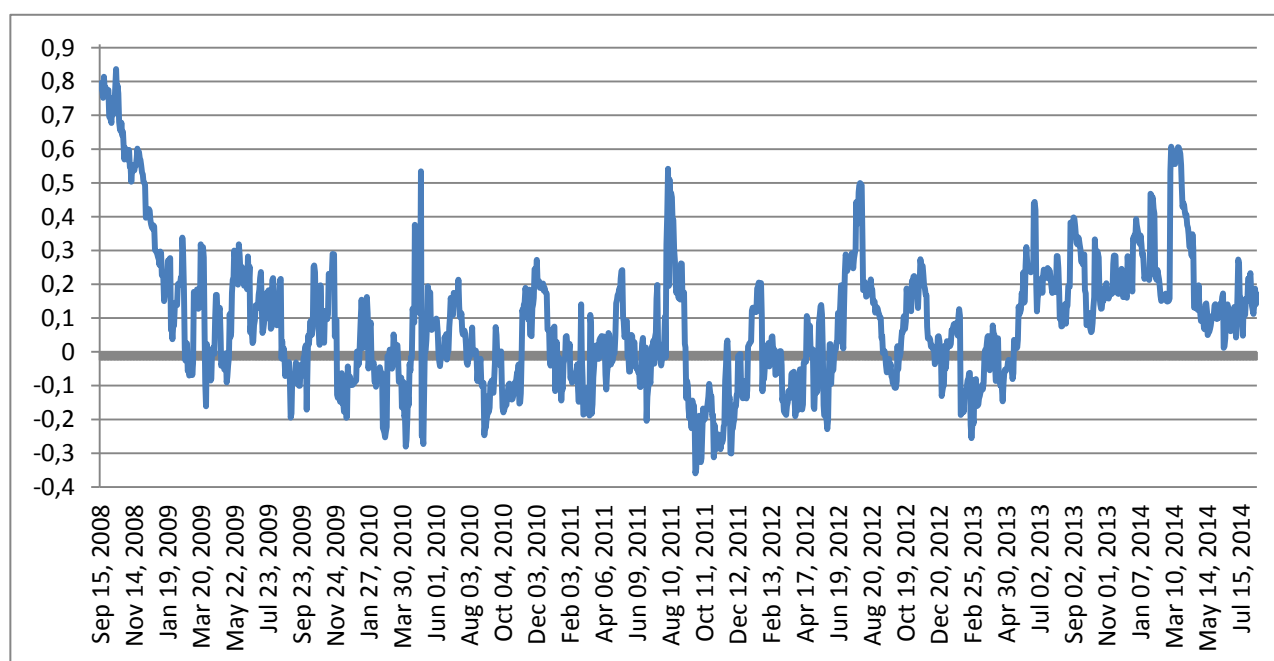


**Figure 2: Dynamic spillover index**

Source: Google Finance, Investing.com, Wsj.com, Spindices.com

The spillover calculated on a return basis does not show gaps in its evolution that are easy to be considered as reactions to financial shocks, unlike the one calculated on a volatility basis. But also in the spillover calculated on a volatility basis is obvious a divergent pattern of the markets, as shown by an increased trend.

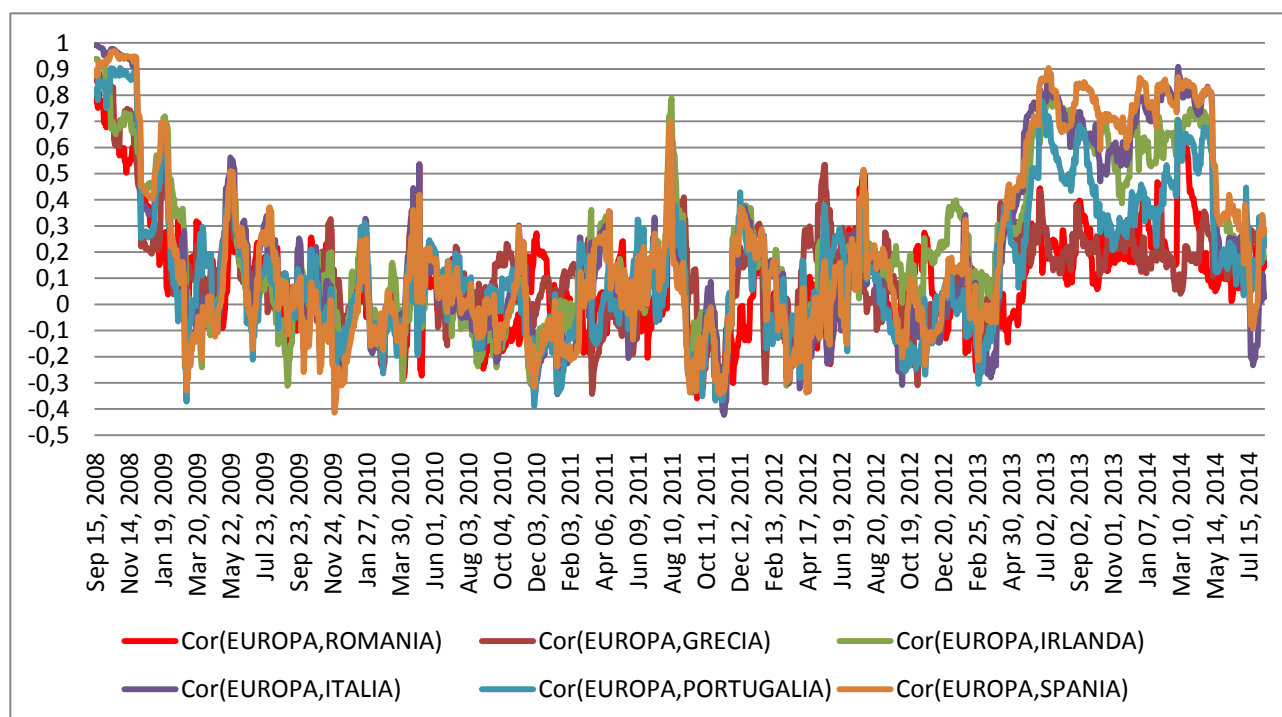
The dynamic correlations add accuracy to this study. We focus on the correlation between the Romanian and the European market and based on the following graph, we find the moments in which the correlations are larger than 0.50, each of them corresponding to a specific financial shock. In September 2008, following the Lehman Brothers collapse, the correlation reached the highest value, in the following two months the average values being in the range 0.6 – 0.7. On May 5<sup>th</sup> 2010, the correlation is 0.53, the moment corresponding to the sovereign debt crisis occurrence in Greece, that led to a depreciation of the local stock exchange indices and an increase of the volatility. On August 5<sup>th</sup> and August 9<sup>th</sup> 2011, correlations are 0.54 and, respectively, 0.51, on August 5<sup>th</sup> Standard & Poor's announcing the US credit rating downgrade.



**Figure 3: Dynamic correlations of S&P 350 Europe - BET**

*Source: Google Finance, Investing.com, Wsj.com, Spindices.com*

Although there are reasons within the market for these increased correlations, these should be considered as necessary, but not sufficient to prove the contagion. In order to claim the presence of contagion, it is necessary that these events produce similar reactions on the other markets, spreading the shocks.



**Figure 4: Dynamic correlations between Romania, PIIGS - Europa**

Source: Google Finance, Investing.com, Wsj.com, Spindices.com

The dynamic correlations prove more clearly the markets sensitivity and can show the reaction to shocks by testing the dummy variables significance, in relation to every major financial event from the interval. The results are shown below:

**Table 2: Testing dummy variables significance**

	S&P350-BET	S&P350-ASE	S&P350-ISEQ20	S&P350-MIB40	S&P350-PSI20	S&P350-IBEX35
<b>DUMMY1</b>	<b>0.0245</b>	<b>0.0184</b>	<b>0.0014</b>	<b>0.0026</b>	<b>0.0121</b>	<b>0.0019</b>
p-value	0.02%	0.63%	1.33%	0.00%	0.00%	0.37%
<b>DUMMY2</b>	<b>-0.0031</b>	<b>0.0005</b>	<b>0.0009</b>	<b>0.0013</b>	<b>0.0029</b>	<b>0.0013</b>
p-value	6.53%	2.30%	1.85%	0.00%	0.00%	0.05%
<b>DUMMY3</b>	<b>-0.0045</b>	<b>-0.0007</b>	<b>0.0033</b>	<b>-0.0007</b>	<b>-0.0007</b>	<b>-0.0005</b>
p-value	16.52%	81.45%	25.72%	7.60%	13.67%	27.64%
<b>DUMMY4</b>	<b>0.0068</b>	<b>-0.0005</b>	<b>-0.0004</b>	<b>-0.0033</b>	<b>-0.0022</b>	<b>-0.0025</b>
p-value	10.69%	12.26%	49.33%	0.00%	3.26%	0.00%

Source: Google Finance, Investing.com, Wsj.com, Spindices.com

We obtain positive and significant coefficients for dummy1, related to the Lehman Brothers collapse and for dummy2, related to the sovereign debt crisis. Only in the case of Romania dummy2 is negative, but the graph shows that the shock effect is present, but delayed, such that we can claim the presence of contagion, because the financial shocks caused by the two events are spread in all the analyzed markets.

We find also that the US credit rating downgrade is not significant to any of the analyzed markets. For example, during this interval, Romania issued 10-year bonds sold on the US-financial markets, taking advantage of the low interest rates and hedging against an eventual worsening of the

sovereign debt crisis. The Ukrainian conflict, located in a neighbouring country, is not significant for Romania, although the expectations would have been the opposite.

The 2008 crisis had two phases: the first one is that of contagion, proved by tests made on the dummy variable, followed by the crowd effect. There is an important difference between the two phases: contagion describes the shock spreading from one market to another by a significant increase of the correlations between the respective markets, while the crowd effect shows the similar behaviour of the investors, when the correlations remain high and do not sharply decrease as in the case of contagion. This phenomenon occurred in September – November 2008 and also in June 2013 – November 2014, related to the Ukrainian conflict (even though not strong enough to cause contagion, it induced worry among investors, as the crowd effect occurred). Investors behaviour, the way they react to shock, is highly important in anticipating the effects induced by this shock.

#### **4. CONCLUSIONS**

Considering the effect the contagion has on the entire economic system stability, a contagion risk management is needed. The present paper aims at identifying and explaining the contagion phenomenon, by analyzing the main economic and social events during 2008-2014, focusing on the contagion spreading effects, markets reaction to shocks and measuring their persistence and intensity.

As regarding the capital markets analyzed here, we show that Italy and Spain are the most sensitive to the financial shocks, the former causing the largest spillover and the latter being the most affected by the spillover generated by the shocks in the other markets. By calculating the dynamic spillover index, we find the divergent behaviour of the markets, and the dynamic correlations support the results by testing the dummy variables significance associated to each major shock. It is proved that the Lehman Brothers collapse, as well as the sovereign debt crisis, generated contagion in all the analyzed markets, and during the Ukrainian conflict, a crowd effect occurred. The Lehman Brothers collapse and the sovereign debt crisis are highly severe shocks, as their spreading is generalized, affecting mainly the countries with weaker economies and with inefficient policies.

The investors` behaviour, the way they react to a shock, is extremely important in anticipating the effects such a financial shock can induce. This paper can be of real interest also to investors looking for portfolio diversification, because knowing the most sensitive markets, they can hedge against these risks, as they understand that the high coefficient of correlation means diminishing their profit when they choose to invest in the countries affected by contagion. Moreover, the governments should develop policies in order to prevent crisis spreading, to contain the risk of contagion, to manage its impact and support the markets recovery.

Proving the existence of contagion, we stress the importance of this issue and the fact that every shock in the market should not be underestimated, but taken into consideration and analyzed in terms of the dependence degree and correlations between the markets (during the crisis, these correlations increased and remained at high levels). Understanding this fact, solutions can be designed to diminish the shock spreading effects. Close supervision and assessment are needed to contain the contagion risk, both regionally and globally.

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