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Modeling Transmissions of Volatility Shocks: Application to CDS Spreads during the Euro Area Sovereign Crisis

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ABSTRACT

This paper tests empirically the contagion and the transmission mechanism of shocks in volatility between the peripheral Eurozone countries. We use the sovereign CDS spreads and the asymmetric model of dynamic conditional correlation GARCH DCC. We investigate the effects of positive and negative shocks over the long term. We investigate the systemic nature of the crisis in Europe. We implement testing of the non-linearity of propagation mechanisms of shocks through a long-term interdependence VECM model (Johansen co-integration). The generated results show that changes in the index of sovereign CDS have a very significant effect on changes in stock indexes in Europe. This is especially true in the case of Germany and France and the PIIGS countries.

JEL Classifications: *C5, G15*

Keywords: *sovereign debt crisis; DCC GARCH; cointegration; transmission; volatility shocks*

I. INTRODUCTION

In the last decade, adverse events have characterized the international financial sphere and in particular the Europe. Indeed, the subprime crisis had impacted financial markets in the world and also Europe, which is seen as the most affected. In 2010, economists start talking about a new outbreak of sovereign debt crisis in Greece. This country shows a growth rate of 4.2% recorded from 2000 to 2007 and became the most indebted country with a huge public debt reaching 152% in 2011. Greece officially began to suffer from the crisis of sovereign debt following the lowering of its sovereign credit rating.

The peripheral Eurozone countries have been affected following a fault overpayment. Thus, a new risk adds to the global economy: the sovereign debt crisis. This extends the global economy into recession, coupled with serious political and social issues. Economists are interested in studying the importance of contagion and its implications for the stability of financial markets. Missio and Watzka (2011) have estimated a model of dynamic conditional correlation (DCC) to analyze the correlation structure of Greek, Portuguese, Spanish, Italian, Dutch, Belgian and Austrian yield spreads bonds on the German yield study contagion in the euro zone. Alter and Beyer (2014) presented an empirical framework to quantify the spillovers. The study is based on technical standards VAR generalized impulse response functions to calculate the indices of infection in Spanish sovereign CDS shock. It shows a high impact on both sovereign CDS in the euro zone and banks during the first half of 2012 compared with 2011.

This article is based on an extension of this stream of the literature and fits into the same perspective. The goal is to test empirically the contagion as the transmission mechanism of shocks in volatility between the peripheral countries of the euro area, based on changes in sovereign CDS spreads. We analyze the transmission of shocks to sovereigns in those markets for the same country indices. We refer in the first time to the modeling of the conditional variance of GARCH multi varied (MGARCH) to empirically test the contagion of sovereign risk among the major countries of the European Union using sovereign CDS spreads. This model has the flexibility of univariate GARCH models associated with parsimonious parametric models for the correlations. The model allows reduction through heteroscedasticity responsible for the persistence of shocks to volatility and the overestimation of cross-correlations.

We present the concept of systemic risk with an empirical test. This allows to better understand its effects and testing transmission market sovereign shock to the financial system of Europe, via the cointegration model. Finally, we test the nonlinearity of propagation mechanisms of shocks estimated through a model of long-term interdependence VECM. The model is based on the cointegration test (Johansen test).

II. SOVEREIGN DEBT: FROM CRISIS TO CRISIS:

Sovereign debt is defined by Cohen (2012) as “all debts held by the State to its creditors who may be natural persons (companies, banks, individuals, etc.), countries or other organizations (central banks, Reserve Federal...) especially the one held in bonds denominated in foreign currencies.” The management of sovereign debt presents economic aspects and political issues. Several states around the world are plunged into a sovereign debt crisis following a bad management and have been victims of significant consequences. Western sovereign debt crisis of 1980 led to political instability and crisis or war. The Mexican crisis of 1982 affected Mexico, Brazil and Argentina. The crisis in Argentina and the speculative attacks experienced by the Argentine peso led to higher interest rates and unemployment, loss of confidence and a rapid rise in public finances due to the increase in debt service.

In 2010, we observe a birth of another sovereign debt crisis in Greece. It is observed as a direct effect of the subprime crisis, which was triggered in the United States in 2007 and has particularly affected Greece at its two main economic sectors: tourism and shipping. The crisis emerge with the ECB decision to no longer accept bonds as collateral for loans from private banks. The decision increases the risk premium and the rates. The rescue plans adopted by the European Central Bank includes among other things: accepting sovereign debt delisted, putting bilateral loans amounting to 110 billion Euros, the establishment of a European financial Stability Fund (EFSF) (750 billion Euros) by the Ministers of finance the twenty-seven in 2010, setting a new aid in 2001 to € 110 billion from the IMF. The situation in Greece worsens increasingly following a fault overpayment. The sovereign debt crisis in Greece has quickly affected other peripheral countries of the European Union, such as Italy whose debt reached 120% of GDP or € 1.9 trillion. Also, the crisis in Spain has tripped due to a budget deficit of 11.2% recorded in 2010 and the deterioration of its rating by the rating agency Standard and Poor's because of its low growth prospects. For Ireland, the subprime crisis has severely affected the banking sector. Then, a significant increase was observed in its public deficit reaching 32% of GDP in 2011. The Portuguese crisis has increased at the beginning of 2011, following a downgrade of its sovereign debt rating of A+ to A- by Standard and Poor's. This caused an increase in the borrowing rate. It is the fear of contagion from the Greek crisis in the whole area that eventually cast doubt on the sustainability of the euro. This is the goal of our next step to review the literature on the effect of contagion.

III. THE CONTAGION EFFECT: DEFINITIONS AND LITERATURE REVIEW

Contagion attracted the attention of economists, politicians and portfolio managers. Several theoretical and empirical works investigates the crisis transmission mechanism. The crisis is considered as the source of outbreak of some crises.

Pericoli and Sbracia (2003) defined contagion as "increasing the probability of a crisis in a country with the advent of a crisis in another country". This definition states that the contagion may occur during financial turbulence when there is an increase in the volatility of asset prices and extends from one market to another market.

For Marais (2003), “contagion occurs when the volatility of asset prices is spreading the crisis countries to other countries.” A simultaneous increase in volatility in different markets could be due to normal interdependence between these markets or structural changes affecting international markets links.

According to Forbes and Rigobon (2002), “contagion occurs when cross-border co-movements in asset prices cannot be explained by fundamentals.” This definition focuses on the phenomenon of contagion, which is identified by a significant increase in co-movements of prices in markets after a crisis in a market or market group.

For Forbes and Rigobon (2002), “the shift-contagion occurs when the transmission channel is growing or, more generally, changes after a shock in a market.”

Contagion is considered a significant increase links between financial markets due to a specific shock to a country or group of countries. These links can be financial or real (economic fundamentals) links or political ties (political relations between countries)

A. Analysis of Unconditional Correlations of Sovereign CDS Spreads in Europe

The objective of this section is to study the dynamics of correlations between sovereign CDS. CDS are very important parameters for investors all over the world. In fact, diversification strategies for risk minimization depend essentially on correlations between those assets. We will test the statistical significance of the increase in the correlation coefficient between this and the quiet period as well as the crisis based on sovereign CDS spreads of countries in the sample. We show the significance of the impact of the Greek crisis to other countries and the spread volatility contagion for the sovereign sector.

1. Data and methodology

The data is extracted from Bloomberg and Reuters. We use time series of sovereign CDS spreads of the countries in the sample. The study covers a period of nearly five years from 01 January 2008 to 31 December 2012, in daily frequency. These values are taken in basis points. The following countries are used: the United Kingdom, France, Germany, Italy, Greece, Spain, Portugal, Belgium, Sweden and Ireland. The study covers a period of nearly five years in daily frequency, i.e., 1,274 observations by markets. A selection of two sub-periods is done: the quiet period that spans from 01/01/2008 to 14/01/2010 (i.e., 487 observations per country) and the crisis period, which runs from 15/01/2010 to 31/12/2012 (or 767 per country). This selection is based on the date of the outbreak of sovereign debt crisis. These values are taken in basis points.

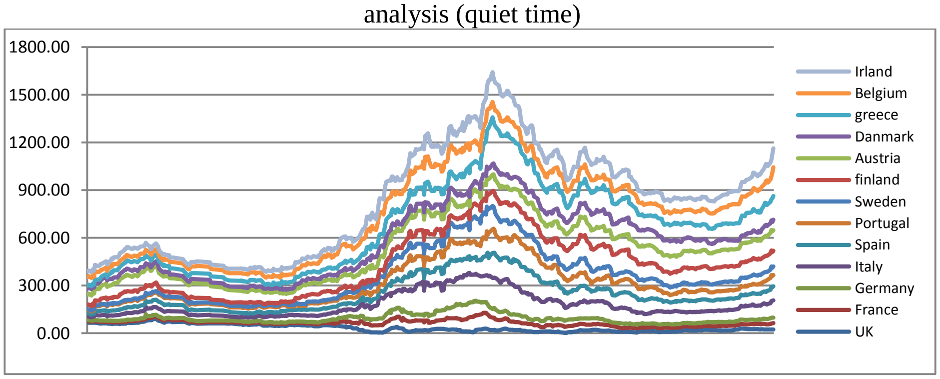
2. Interpretations and results

The correlation coefficient is used to quantify this relationship by the sign of the correlation (positive and negative) and by the strength of this correlation. The interpretation of a correlation coefficient depends on the context and on the objectives.

Following the decomposition of the total time in a quiet period and a crisis period is the date of outbreak of sovereign debt crisis in Greece. It is remarkable at the graphics and the correlation matrix that almost all countries in the sample strongly correlate: the results range from 0.6389 between Ireland-Finland to reach 0.9378 for France-Germany. Denmark-Austria correlation is weak with other countries. The CDS spread in Spain has the most pronounced correlation with all markets. We find that the United Kingdom is highly correlated, but negative sign with the majority of countries.

Figure 1 has witnessed a remarkable evolution of CDS spreads for all countries in the sample for the period 2008-2009. This increase is due to the impact of the subprime crisis and the increased risk of bankruptcy or default on public debt. Following the bailout announced by the IMF to reduce this risk, the trend has resumed at the end of 2009: the spread level before the outbreak of the subprime crisis.

Figure 1
Graph of the evolution of sovereign CDS spread of the European Union country analysis (quiet time)



Statistics provided by authors with Eviews (Version 7.0)

Table 1
Correlation matrix of the sovereign CDS spread of the European Union countries (crisis period)

	Germany	Austria	Belgium	Danmark	Spain	Finland	France
Germany	1.00	0.35	0.77	0.72	0.62	0.04	0.94
Austria	0.35	1.00	0.39	0.52	-0.03	0.51	0.26
Belgium	0.77	0.39	1.00	0.83	0.76	-0.25	0.83
Danmark	0.72	0.52	0.83	1.00	0.72	-0.20	0.75
Spain	0.62	-0.03	0.76	0.72	1.00	-0.55	0.73
Finland	0.04	0.51	-0.25	-0.20	-0.55	1.00	-0.15
France	0.94	0.26	0.83	0.75	0.73	-0.15	1.00
Greece	0.68	-0.10	0.77	0.68	0.85	-0.62	0.80
Irland	0.78	0.43	0.71	0.84	0.60	-0.06	0.78
Italy	0.80	-0.00	0.80	0.68	0.87	-0.36	0.89
Portugal	0.84	0.22	0.83	0.80	0.78	-0.33	0.91
UK	0.34	0.19	0.66	0.58	0.71	-0.51	0.45
Sweden	0.85	0.35	0.57	0.52	0.40	0.27	0.81

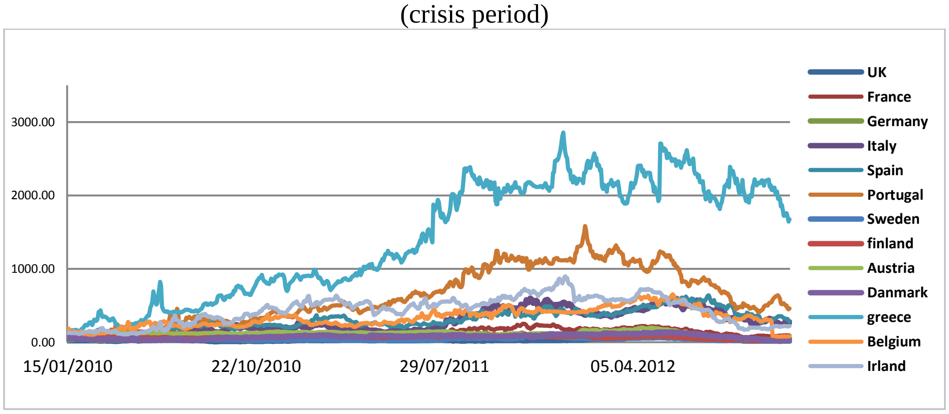
	Greece	Irland	Italy	Portugal	UK	Sweden
Germany	0.68	0.78	0.80	0.84	0.34	0.85
Austria	-0.10	0.43	-0.00	0.22	0.19	0.35
Belgium	0.77	0.71	0.80	0.83	0.66	0.57
Danmark	0.68	0.84	0.68	0.80	0.58	0.52
Spain	0.85	0.60	0.87	0.78	0.71	0.40
Finland	-0.62	-0.06	-0.36	-0.33	-0.51	0.27
France	0.80	0.78	0.89	0.91	0.45	0.81
Greece	1.00	0.62	0.87	0.88	0.59	0.44
Irland	0.62	1.00	0.65	0.80	0.27	0.59
Italy	0.87	0.65	1.00	0.86	0.57	0.68
Portugal	0.88	0.80	0.86	1.00	0.51	0.62
UK	0.59	0.27	0.57	0.51	1.00	0.17
Sweden	0.44	0.59	0.68	0.62	0.17	1.00

Statistics provided by authors with Eviews (Version 7.0)

During the crisis, the graphics of the evolution of sovereign CDS spread in Figure 2 show a breakdown between the countries at the level of the correlation matrix. Indeed, we note that the correlation coefficients between the PIIGS countries with France-Germany are steadier in times of crisis than stable periods and decrease in Finland, Austria and Sweden.

These findings indicate that the sovereign debt crisis in Greece is quickly transmitted to the PIIGS countries, but also to Germany and France. The sovereign debt crisis had no significant impact on the evolution of spread sovereign CDS in some countries as Austria and Sweden, which has a relatively stable correlation with other countries in the sample.

Figure 2
Graph of the evolution of sovereign CDS spread of the European Union countries (crisis period)



Statistics provided by authors with Eviews (Version 7.0)

B. Asymmetric Dynamic Conditional Correlation Model (DCC-GARCH (1.1)) of Sovereign CDS Spreads

To investigate empirically the effect of contagion from sovereign debt crisis in Europe, we review a version of the multivariate GARCH model: the model of dynamic conditional correlation (DCC) and via the one estimated using the program WINRATS software (version 8.2). This model was estimated in two steps. In the first step, we estimate the univariate return series with a GARCH process. Then, in a second step, we used the residuals of various multi-series to estimate the dynamic correlations. This model is often preferred because it has the flexibility of univariate GARCH processes and parsimony of parametric estimation models of dynamic correlations. Thus, it can test the volatility spillovers between countries in the sample. The analysis allows demonstrating the significance of the impact of the Greek crisis to other countries and the spreading volatility contagion for the sovereign sector.

Several studies try to obtain reliable estimates of correlations of assets over 20 years. The study of correlation is useful for the detection of contagion via the transmission phenomena of volatility shocks.

Bollerslev, Engle and Wooldridge (1988) introduced for the first time, the concept of dynamic covariance. They used the GARCH multi varied to calculate the dividend yield VTR functions in the risk premium of the market. Engle and Sheppard (2001) introduced a new class of models varied entitled "Models of conditional correlations." The asymmetric DCC-GARCH model (1.1) is built on the idea of modeling the conditional variances and correlations instead of simple modeling conditional covariance matrix. The conditional covariance matrix is decomposed into conditional standard deviations and correlation matrix: $H_t = D_t R_t D_t$, where $D_t = \text{diagonal}\left(\sqrt{h_{i,t}}\right)$: diagonal matrix of conditional volatility of univariate GARCH models.

The information contained in D_t are generated by the GARCH (p, q) can be formulated as follows:

$$h_{i,t} = w_t + \sum_{p=1}^{p_i} \alpha_{ip}\varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}, \ \forall_i = 1,2 \tag{1}$$

where $R_t = P_{ij,t}$, which is the coefficient matrix of conditional correlations varies over time. A is the square residues delayed; and β is the conditional variance delayed, w:asymmetric term. The parameters (α, β, w) of the DCC model are estimated by the method of maximum likelihood.

Engle (2002) adopts a structure of GARCH in modeling the dynamics of conditional correlations. Indeed, a DCC process of order (M, N) is described as follows:

$$R_t = \left(Q_t^*\right)^{-1} Q_t \left(Q_t^*\right)^{-1} \tag{2}$$

$$Q_t = \left(1 - \sum_{m=1}^{M} a_m - \sum_{n=1}^{N} b_\pi\right)\overline{Q} + \sum_{m=1}^{M} a_m \left(\delta_{t-m}\delta_{t-m}^{'}\right) + \sum_{n=1}^{N} b_n Q_{t-n} \tag{3}$$

with $\delta_t = \left\{\varepsilon_{it} / \sqrt{h_{i,t}}\right\}$, which is the vector that contains the standardized residuals. $\overline{Q} = E\left(\delta_t, \delta_t^{'}\right)$ is the matrix of marginal variance-covariance standard residues univariate models for each series of asset returns. $\left(a_m, b_n\right)$ is the parameters that are supposed to intercept, respectively, the effects of shocks and dynamic correlations delayed on the contemporary level of the latter. Q_t^* is the diagonal matrix containing the square root of the elements of the main diagonal de Q_t.

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sqrt{q_{tt}} \end{bmatrix} \tag{4}$$

The conditional correlation t is based on all information available at t-1. Since it is based on the standardized residuals of the univariate model, the conditional correlation matrix is nothing but the matrix of conditional variance-covariance of the error terms.

The conditional correlation is written as follows:

$$p_{12,t} = \frac{E_{t-1}(r_{1,t}, r_{2,t})}{\sqrt{E_{t-1}(r_{1,t})^2 E_{t-1}(r_{2,t})^2}} \quad (5)$$

Engle (2002) showed that the log-likelihood function can be estimated as follows:

$$L = -\frac{1}{2}\sum_{t=1}^{T}\left(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t^{'} R_t^{-1}\varepsilon_t\right) \quad (6)$$

Note that the data will be used in our study are time series of sovereign CDS spread of the countries considered in the sample. These spreads are used to measure the overall evolution of market returns.

The distributions of the growth of sovereign CDS are calculated based on the time series of sovereign CDS spreads using the following formula:

$$r_t = (\log(p_t) - \log(p_{t-1})) * 100 \quad (7)$$

Due to the complexity of the multivariate GARCH DCC model, our study is limited to the study of contagion of 10 most dynamic markets in terms of changes in sovereign CDS spread.

1. Results and interpretations

The following Table 2 shows the estimated parameters of the multivariate DCC-GARCH model for the quiet period and the crisis period.

After estimating the DCC-GARCH model, we obtain the model parameters α, β, and ω for all countries in the two periods: the quiet period and the crisis period. Table 2 shows the persistence of short-term (α) that remains strong and statistically significant in most equations of the conditional variance. The parameter α is generally very close to 0 and much smaller than the parameter β. In addition, the β coefficient is close to 1 in all countries, except for the case of Sweden and Germany. This indicates a strong presence of the phenomenon of long-term persistence. Nevertheless, the sum of the two parameters (α + β) is very close to unity. This demonstrates the importance of the persistence of the conditional variance of the series studied.

For example, in the case of Greece, the α parameter is four times smaller than the β parameter. This means that the conditional volatility of Greece is strongly influenced by the conditional volatility in the previous period and is less influenced by the new information. The spread of sovereign CDS depends on the state capacity to repay its debts to third parties. Therefore, forecasts of future developments spreads are based on information available today. The arrival of new market information leads investors to revise the values of CDS, which vary its spread. This means that the conditional volatility of spreads is influenced by new information arrival into the markets.

Table 2
Statistics of GARCH (1.1) multi varied (quiet time)

	U.K	FRANCE	Germany	Italy	Spain
W	3.11*	15.17*	21.59*	0.45*	3.34*
	(3.84)	(6.12)	(9.65)	(2.58)	(3.67)
X	0.59*	0.51*	1.72*	0.19*	0.30*
	(6.94)	(4.75)	(7.02)	(6.85)	(4.54)
B	0.58*	0.25*	0.00*	0.83*	0.61*
	(16.42)	(3.48)	(4.46)	(55.78)	(8.62)
Multivariate DCC equation	$h_{i,t} = w_i + \sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}\ ,\ \forall_i = 1,2$				
θ_1	0.02*				
	(2.70)				
θ_2	0.74*				
	(6.77)				

	PORTUGAL	SUEDE	GREECE	BELGIUM	IRLAND
w	1.67*	22.62*	2.25*	0.71*	1.95*
	(4.35)	(7.91)	(3.77)	(3.06)	(2.62)
x	0.30*	0.29*	0.20*	0.17*	0.14*
	(7.02)	(3.40)	(6.07)	(5.92)	(4.36)
β	0.72*	0.10*	0.77*	0.81*	0.78*
	(28.48)	(1.02)	(27.10)	(29.83)	(14.37)
Multivariate DCC equation	$h_{i,t} = w_i + \sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}\ ,\ \forall_i = 1,2$				

Statistics provided by authors with WINRATS (Version 8.2)
*: Statistical significance at the 1% level.

This is confirmed by the persistence phenomena in the evolution of correlation between the spread of sovereign CDS. The parameter measuring the degree of inertia θ_2 is close to 1: the more persistent effects of shocks in the evolution of correlations (i.e., when the correlation coefficient reaches a given under the effect of shock level, there is still some time). This coefficient is 0.744. This corroborates the results on the existence of phenomena marked persistence of volatility, which is an indicator of the same nature as the covariance (or correlation). It is not surprising that the phenomenon of persistence of stylized facts considered in the analysis of variance of the stock markets, also check for correlations. The θ_1 parameter posted a 0.024 level, considered low, so low weight significance of recent shocks correlations.

In the following analysis, we focus on the evolution of correlations adjusted period of stability, and study the projected future trend. The estimated GARCH DCC (1 .1) allows considering the spread of the sovereign debt crisis among European countries. The Figure is available upon request, it illustrate the conditional correlation of returns of the markets studied, and an overview of the expected 100 observations for the next trend. Since the composition of the sample is large, the graph is limited by a group of dynamic figure of the correlation of each country. The correlation coefficients vary over time:

positive and negative changes in all markets. The results of GARCH DCC (1.1) indicate that during the period 2008-2009, the subprime crisis has had a clearly significant impact on the conditional correlations between European countries. We can deduce that the shock affecting Europe has a significant influence on the spread of sovereign CDS. There would be compensated (or corrections) the effects of positive and negative shocks over the long term.

For the crisis period, the parameters of the conditional variance of the ten markets are relatively close. The persistence of short-term (α) remains very strong in that quiet period and statistically significant in most equations of the conditional variance. The positive β coefficient close to 1 in all cases ranges from 0.623 to 0.92 in Greece-suede. This indicates a strong presence of the phenomenon of long-term persistence. The sum of the two parameters (α + β) is very close to unity. This demonstrates the importance of the persistence of the conditional variance of the series studied.

Table 3

Statistics of multivariate GARCH (1.1) (crisis time)

	U.K	FRANCE	Germany	Italy	Spain
w	2.82*	0.29*	1.72*	1.63*	0.88*
	(2.80)	(1.49)	(0.61)	(1.32)	(0.39)
x	0.24*	0.09*	0.15*	0.19*	0.14*
	(3.74)	(4.37)	(1.29)	(1.12)	(0.85)
β	0.65*	0.90*	0.74*	0.75*	0.83*
	(10.95)	(43.98)	(2.90)	(5.13)	(3.69)
Multivariate DCC equation	$h_{i,t} = w_i + \sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}, \ \forall_i = 1,2$				
θ_1	0.01*				
	(5.64)				
θ_2	0.98*				
	(147.49)				
	PORTUGAL	Sweden	GREECE	Belgium	Irish
w	1.21*	0.20*	1.93*	-0.07*	1.05*
	(0.90)	(1.65)	(0.86)	(-0.34)	(1.51)
x	0.15*	0.05*	0.36*	-0.01*	0.32*
	(1.70)	(2.25)	(5.30)	(-1.24)	(6.56)
β	0.79*	0.94*	0.62*	1.01*	0.68*
	(5.29)	(36.17)	(3.63)	(34.23)	(9.94)
Multivariate DCC equation	$h_{i,t} = w_i + \sum_{p=1}^{p_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}, \ \forall_i = 1,2$				

Statistics provided by authors with WINRATS (Version 8.2).

* significance at the 1% level.

For the case of Portugal, the α parameter is three times smaller than the β parameter. This means that the conditional volatility of Portugal is strongly influenced by the conditional volatility of the previous period, and, is less influenced by the new information. If these results with that of the quiet period are compared, we see that the α parameter was 2 times smaller than the β parameter for the same country. Hence, the effect of the sovereign debt crisis highlights the influence of the conditional volatility with the period prior to that period of stability: this means that the crisis of sovereign CDS spreads are much more influenced by the new information arrival.

The presence of persistence phenomena in the evolution of correlation between the spread of sovereign CDS is confirmed. Indeed, over the parameter measuring the degree of inertia θ_2 worth 0.988 here. This corroborates the results on the existence of phenomena marked persistence of volatility, which is an indicator of the same nature as the covariance (or correlation). It is not surprising that the phenomenon of persistence of stylized facts considered in the analysis of variance of the stock markets, also check for correlations. As a result of record, θ_1 is 0.0087, considered low significance of the weight of recent shocks on correlations.

In what follows we will be interested in the evolution of correlations adjusted period of stability, and a study on the projected future trend and that of 100 observations. The figure is available upon request, which illustrates the conditional correlation of returns of the markets studied in crisis and an overview of the expected 100 observations for the next trend. The figure shows that the correlation coefficients vary over time: positive and negative changes. The results of GARCH DCC (1.1) react much more similarly to various shocks affecting the CDS markets in periods of stability. The sovereign debt crisis in Greece had a clearly significant impact on conditional correlations between European countries. We can infer that shocks in Europe have a significant influence on the spread of sovereign CDS. There would be compensations (or corrections) for the effects of positive and negative shocks on long period.

C. Impact of Sovereign Debt Crisis in the European Financial System

The sovereign debt crisis in the euro zone began in early 2010 by the Greek debt crisis. It started with the declaration that the budget deficit of Greece in 2009 will be more than 12% of its GDP. This is far from the prescribed figure by the European Union (EU), 3% ceiling. At this point in time, Greek debt problem triggered. After the downgrade of its sovereign credit rating, Greece officially begins to suffer from the crisis of sovereign debt. Three other European countries, namely Portugal, Ireland and Spain have a deficit level far exceeding the 3% prescribed in the “Convention on the stability and growth” as defined by EU.

Despite the financial bailout of the Greek State initiated by other countries in the euro area and the IMF, rating agencies degrade the sovereign debt of this country and Ireland's turn to in crisis following the necessary rescue its banks due to excessive private debt.

The debt of Greece, Spain and Portugal is no longer an issue for one country, but affects Europe and become a World problem. At the Forum of Davos 2010 on the global economy, participants indicated that the next crisis will be that of sovereign debt. Debt problem become a major concern worldwide. For the debt problem in Europe, it is difficult to transform short-term sovereign debt crisis, but it will weigh heavily on the financial market, the forward market approach and economic recovery.

In 2011, José Manuel Barroso, President of the European Commission, announced the possibility of a threat of a “systemic crisis”. Stock markets plunged twice in spring 2010 and summer 2011, the four international rescue plans (May 2010 and July 2011 for Greece, in November 2010 for Ireland, in May 2011 for Portugal) have not really stemmed the spiral of crisis. Financial institutions directly exposed to sovereign issuers in the euro area have faced a deterioration of both their access to financing and cost.

When the market value of sovereign debt and bank debt in the euro zone fell, becoming more volatile, the funding costs increased. Brokers’ levels securities market have been affected because of their tendency to favor leverage and wholesale funding. Some may have significant exposure to derivatives on sovereign issuers, which usually do not require collateral.

To study the spread of sovereign debt crisis in European financial markets, our study is based on the vector auto-regression model developed by Johannsen (1991) for several European indices. This model is one of the most successful, flexible and easy to use templates for the analysis of multivariate time series. The VAR model has proved particularly useful for describing the dynamic behavior of economic and financial time series and forecasting. The model often provides superior to those of univariate time series forecasts.

This model has several advantages such as the consideration of the origin of shock, impact its amplitude and duration necessary to amortization of share. This model is based on modeling of stationary series. It allows variables to depend on past values of other variables, and does not limit the dependence only historical and error term.

Consider the following VAR model:

$$Y(t) = C + \sum_{s=1}^{m} A(s)Y(t-s) + e(t) \tag{8}$$

where Y (t) is a Kx1 vector of rates of return in the stock market column. C is a column vector (Kx1) constant. A(s) is a matrix of coefficients (KxK). M is the length of delay. And e(t) represents a vector (1xK) residues.

$$E(e(t)) = 0\,,\ \ E(e(t)e'(t-s)) = 0\,,\ \ \forall s \neq 0$$
$$E(e(t)e'(t)) = \alpha \tag{10}$$

with $\alpha = \{\sigma_{ij}, i, j, = 1,2,\ldots K\}$ = positive matrix size (K * K)

Note that Eun and Shim (1989) requires the determination of the length of the delay (m-value), or the length is determined through the use of the following information criteria: Akaike (AIC), Schwartz (SC) and Hannan-Quinn (HQC). So the value of m is chosen which allows the minimization of these criteria:

$$AIC = \log\left|\sum\ \right| + \frac{2}{T}K^2 m \tag{11}$$

$$SC = \log\left|\Sigma\right| + \frac{\log T}{T} K^2 m \tag{12}$$

$$HC = \log\left|\Sigma\right| + \frac{2\log T}{T} K^2 m \tag{13}$$

where Σ=variance of residuals, K=number of parameters, T=sample size, and m=length of delay.

This study concerns the transmission of the sovereign debt crisis in Europe to the financial sector for a sample of countries in the European Union. The data used to analyze the transmission of the crisis in Europe consists of time series of two rate indices and new market indices of the sample countries. The study covers a period of nearly five years from 01 January 2008 to 31 December 2012, in daily frequency, i.e., 1,276 observations indices. A selection of two sub-periods is a quiet period, from 01/01/2008 to 14/01/2010 and a crisis period, from 15/01/2010 to 31/12 / 2012. (This selection is based on the date of the outbreak of the sovereign debt crisis). These values are taken in basis points and extracted from the base of Bloomberg, Reuters and European investor data.

1. Descriptive statistics of variables

A variety of statistical tests performed on the iTraxx Europe and iTraxx SovX and indices markets of the sample are summarized in the following Tables 4, 5, 6, and 7.

Table 4

Descriptive statistics indices (quiet time)

	PSI_20 POR	OMX FINL	ITRAXX EUROPE	ITRAX SOV	IBEX ESP	FTSE ITALIE
Mean	8206.95	2012.68	115.53	67.66	10968.31	24481.37
Median	8153.75	1924.40	103.06	56.10	11373.30	22752.00
Max	13026.66	3010.11	216.37	165.98	15101.90	38447.00
Min	5740.17	1189.09	49.63	24.82	6808.10	12639.00
Std Dev.	1712.02	500.92	37.03	29.50	1912.21	6185.08
Skew	0.67	0.35	0.68	1.30	-0.10	0.42
Kurtsosis	2.51	1.80	2.38	3.80	2.01	2.01
JarqueBera	43.82	41.89	48.81	159.55	22.02	36.91
Prob	0.00	0.00	0.00	0.00	0.00	0.00
Obs	521	521	521	521	521	521

	FTSE Roy	DAX_30 ALL	CAC_40 FRANCE	BEL20 BEL	ATHE GRECE
Mean	4970.48	5614.00	3851.68	2618.36	2767.31
Median	5088.47	5637.21	3767.22	2469.54	2433.24
Max	6479.40	8045.97	5598.93	4122.82	5207.44
Min	3512.09	3677.07	2520.22	1564.31	1469.41
Std Dev.	738.80	980.55	733.99	731.62	927.60
Skew	0.05	0.12	0.33	0.57	0.68
Kurtsosis	1.80	2.03	1.98	1.94	2.29
JarqueBera	31.49	21.57	32.21	52.63	50.51
Prob	0.00	0.00	0.00	0.00	0.00
Obs	521	521	521	521	521

Statistics provided by Eviews (Version 7.0)

Table 5

Descriptive statistics indices (crisis time)

	PSI_20 POR	OMX FINL	ITRAXX EUROPE	ITRAX SOV	IBEX ESP	FTSE ITALIE
Mean	6501.61	2201.89	126.37	208.98	9167.20	18388.60
Median	6721.49	2177.71	118.25	186.50	9276.00	19126.59
Max	8340.46	2710.77	208.25	383.00	1533.10	23946.44
Min	4393.38	1745.25	72.62	62.00	5950.40	12357.70
Std Dev.	1169.00	242.59	31.91	88.09	1389.37	3152.18
Skew	-0.11	0.37	0.57	0.22	-0.31	-0.06
Kurtsosis	1.45	2.18	2.36	1.81	1.96	1.53
JarqueBera	77.16	38.48	53.70	50.16	46.31	68.73
Prob	0.00	0.00	0.00	0.00	0.00	0.00
Obs	753	753	753	753	753	753

	FTSE Roy	DAX_30 ALL	CAC_40 FRANCE	BEL_20 BEL	ATHE GRECE
Mean	5629.87	6535.08	3555.99	2411.10	1172.94
Median	5696.70	6515.94	3557.51	2432.30	1212.97
Max	6091.33	7618.62	4160.78	2773.19	2166.77
Min	4805.75	5063.59	2754.82	1918.51	475.89
Std Dev.	283.23	597.24	336.95	208.26	448.22
Skew	-0.54	-0.15	-0.18	-0.24	0.24
Kurtsosis	2.31	1.91	1.93	1.96	1.76
JarqueBera	51.44	40.41	40.01	41.12	55.55
Prob	0.00	0.00	0.00	0.00	0.00
Obs	753	753	753	753	753

Statistics provided by Eviews (Version 7.0)

Table 6

Correlation matrix indices (quiet time)

	ITraxx Europe	ITraxx SovX	CAC 40	DAX 30	FTSE 100
ITraxx Europe	1.00	0.83	-0.69	-0.76	-0.76
ITraxx SovX we	0.83	1.00	-0.74	-0.77	-0.73
CAC 40	-0.69	-0.74	1.00	0.98	0.96
DAX 30	-0.76	-0.77	0.98	1.00	0.97
FTSE 100	-0.76	-0.73	0.96	0.97	1.00
IBEX	-0.81	-0.80	0.94	0.96	0.97
BEL 20	-0.63	-0.67	0.97	0.95	0.94
FTSE MIB	-0.60	-0.71	0.97	0.95	0.91
PSI 20	-0.68	-0.65	0.90	0.89	0.91
OMX HELSINKI	-0.64	-0.72	0.98	0.96	0.94
ATHENS	-0.60	-0.68	0.94	0.92	0.89

	IBEX	BEL 20	FTSE MIB	PSI 20	OMX 25	ATHE
ITraxx Europe	-0.80	-0.63	-0.60	-0.68	-0.64	-0.60
ITraxx SovX we	-0.90	-0.67	-0.71	-0.65	-0.72	-0.68
CAC 40	0.94	0.97	0.97	0.90	0.98	0.94
DAX 30	0.96	0.95	0.95	0.89	0.96	0.92
FTSE 100	0.97	0.94	0.91	0.91	0.94	0.89
IBEX	1.00	0.92	0.89	0.92	0.91	0.88

BEL 20	0.92	1.00	0.96	0.94	0.97	0.97
FTSE MIB	0.89	0.97	1.00	0.87	0.99	0.95
PSI 20	0.92	0.94	0.87	1.00	0.88	0.93
OMX HELSINKI	0.91	0.97	0.99	0.88	1.00	0.94
ATHENS	0.88	0.97	0.95	0.93	0.94	1.00

Table 7

Correlation matrix indices (crisis)

	ITraxx Europe	ITraxx SovX	CAC 40	DAX 30	FTSE 100
ITraxx Europe	1.00	0.79	-0.89	-0.30	-0.32
ITraxx SovX we	0.79	1.00	-0.67	-0.12	0.01
CAC 40	-0.89	-0.67	1.00	0.44	0.51
DAX 30	-0.30	-0.11	0.44	1.00	0.81
FTSE 100	-0.32	0.01	0.51	0.81	1.00
IBEX	-0.75	-0.61	0.77	-0.07	0.03
BEL 20	-0.89	-0.75	0.91	0.37	0.36
FTSE MIB	-0.86	-0.73	0.88	0.12	0.14
PSI 20	-0.78	-0.67	0.80	-0.03	0.03
OMX HELSINKI	-0.60	-0.45	0.66	0.34	0.43
ATHENS	-0.84	-0.80	0.78	-0.11	-0.08

	IBEX	BEL 20	FTSE MIB	PSI 20	OMX 25	ATHE
ITraxx Europe	-0.75	-0.89	-0.86	-0.78	-0.61	-0.84
ITraxx SovX we	-0.61	-0.75	-0.73	-0.67	-0.45	-0.80
CAC 40	0.77	0.91	0.88	0.80	0.66	0.78
DAX 30	-0.07	0.37	0.12	-0.03	0.34	-0.11
FTSE 100	0.03	0.36	0.14	0.03	0.43	-0.08
IBEX	1.00	0.75	0.89	0.94	0.64	0.90
BEL 20	0.75	1.00	0.85	0.81	0.68	0.79
FTSE MIB	0.89	0.85	1.00	0.92	0.58	0.92
PSI 20	0.94	0.81	0.92	1.00	0.65	0.93
OMX HELSINKI	0.64	0.68	0.58	0.65	1.00	0.52
ATHENS	0.90	0.79	0.92	0.93	0.52	1.00

Most studied index is a left oblique distribution with distribution platikurtique except, in the case of the index of Spain, represents an oblique distribution right with platikurtique distribution and the iTraxx SovX index that represents a forward distribution left with a leptokurtic distribution for the quiet period (01/01/2008 to 14/01/2010).

The descriptive statistics reveal that during the crisis period from 15/01/2010 until 31/12/2012, most indices represent a right oblique distribution with distribution platikurtique, except for the case of the iTraxx Europe index, iTraxx SovX and Greece represent a left oblique distribution with platikurtique distribution.

The analysis of correlation between indices for the stable period shows a strong positive correlation between the sign market indices in Europe ranging from 0.88 between the market index of Portugal and Finland to reach 0.9761 between index Finland and France. We observe a strong correlation between CDS indices SOV iTraxx Europe and iTraxx 0.8291. When comparing CDS indices and market indices, the correlation is strong but negative. The correlation between the indices in the crisis period, (15/01/2010 to 31/12/2012), reveals a high average correlation between positive sign market indices in Europe, but lower than in stable period, between the same markets. We notice a strong correlation between CDS indices SOV iTraxx Europe and iTraxx 0.7864. Another finding in the comparison between CDS indices and market indices since the correlation is strong but negative sign.

III. STUDY STATIONARITY: DICKEY AND FULLER

A series is said to be stationary if it is finite and constant in time average, linear connections between the past values, present and future of this variable, are independent of the time factor and its variance is finally fixed in time. For this study, we use the stationary Dickey Fuller Augmented (ADF), which is based on the estimate by OLS the following three models:

$$\Delta Zt = pZ_{t-1} + \sum_{j=1}^{p} \varphi_j \Delta Z_{t-j} + \nu_t \tag{14}$$

$$\Delta Zt = \alpha + pZ_{t-1} + \sum_{j=1}^{p} \varphi_j \Delta Z_{t-j} + \nu_t \tag{15}$$

$$\Delta Zt = \alpha + \beta_t + pZ_{t-1} + \sum_{j=1}^{p} \varphi_j \Delta Z_{t-j} + \nu_t \tag{16}$$

The principle of ADF test is primarily to determine the number of delay p necessary to whiten the residuals. In the second step, it suffices to apply the sequential strategy Dickey Fuller simpler models.

The results for the two periods are summarized in the following Tables 8, 9, 10, and 11. In order to perform co-integration tests on the market indices we start by the stationarity. We use for this, Dickey Fuller increased (ADF). The results show that the level indices are non-stationary. In fact, the values of the ADF statistics, level, are all above their critical values for the quiet period and the crisis period. However, passing the first difference, all these values are below the different thresholds of 1%, 5% and 10%. All series have become stationary after differentiated once. Therefore they are incorporated of order 1, I (1).

Table 8

ADF test level (quiet time)

Variables	t statistic	Value critique 1%	Value critique 5%	Value critique 10%	Stationarity
GREECE	-2.75	-3.44	-2.87	-2.57	No
Belgium	-2.13	-3.44	-2.87	-2.57	No
France	-2.33	-3.44	-2.87	-2.57	No
Germany	-2.45	-3.44	-2.87	-2.57	No
UK	-2.03	-3.44	-2.87	-2.57	No
Italy	-2.25	-3.44	-2.87	-2.57	No
Spain	-2.19	-3.44	-2.87	-2.57	No
itraxx sov	-1.95	-3.44	-2.87	-2.57	No
itraxx Europe	-1.92	-3.44	-2.87	-2.57	No
Finland	-1.97	-3.44	-2.87	-2.57	No
Portugal	-2.97	-3.44	-2.87	-2.57	No

Table 9
ADF test level (crisis time)

Variables	t statistic	Value critique 1%	Value critique 5%	Value critique 10%	Stationarity
GREECE	-1.51	-3.44	-2.87	-2.57	No
Belgium	-2.23	-3.44	-2.87	-2.57	No
France	-2.39	-3.44	-2.87	-2.57	No
Germany	-1.81	-3.44	-2.87	-2.57	No
UK	-2.97	-3.44	-2.87	-2.57	No
Italy	-1.92	-3.44	-2.87	-2.57	No
Spain	-1.95	-3.44	-2.87	-2.57	No
itraxx sov	-1.62	-3.44	-2.87	-2.57	No
itraxx Europe	-2.28	-3.44	-2.87	-2.57	No
Finland	-1.93	-3.44	-2.87	-2.57	No
Portugal	-1.16	-3.44	-2.87	-2.57	No

Table 10
ADF test in first difference (quiet time)

Variables	t statistic	Value critique 1%	Value critique 5%	Value critique 10%	Stationarity
GRECE	-21.55	-3.44	-2.87	-2.57	No
Belgique	-26.83	-3.44	-2.87	-2.57	No
France	-27.63	-3.44	-2.87	-2.57	No
Allemagne	-23.19	-3.44	-2.87	-2.57	No
Royaume-Uni	-24.96	-3.44	-2.87	-2.57	No
Italie	-26.54	-3.44	-2.87	-2.57	No
Espagne	-25.74	-3.44	-2.87	-2.57	No
itraxx sov	-17.86	-3.44	-2.87	-2.57	No
itraxx Europe	-16.83	-3.44	-2.87	-2.57	No
Finland	-23.33	-3.44	-2.87	-2.57	No
Portugal	-24.48	-3.44	-2.87	-2.57	No

Table 11
ADF test in first difference (crisis time)

Variables	t statistic	Value critique 1%	Value critique 5%	Value critique 10%	Stationarity
GREECE	-25.89	-3.44	-2.87	-2.57	No
Belgium	-29.74	-3.44	-2.87	-2.57	No
France	-27.85	-3.44	-2.87	-2.57	No
Germany	-27.56	-3.44	-2.87	-2.57	No
UK	-26.83	-3.44	-2.87	-2.57	No
Italy	-28.27	-3.44	-2.87	-2.57	No
Spain	-29.85	-3.44	-2.87	-2.57	No
itraxx sov	-25.35	-3.44	-2.87	-2.57	No
itraxx Europe	-26.01	-3.44	-2.87	-2.57	No
Finland	-26.43	-3.44	-2.87	-2.57	No
Portugal	-28.48	-3.44	-2.87	-2.57	No

IV. COINTEGRATION TEST BETWEEN THE STUDY VARIABLES

The analysis of cointegration identifies the true relationship between several variables by searching the existence of a cointegrating vector and eliminating its effect. However, prior to this test, it is pertinent to first determine the optimal number of delay. Simply first we give a number of maximum allowable delay. We will ask p max = 6. Then, we look for the number of delay p^* between 1 and 6 (Dickey Fuller single) and p max that minimizes both AIC and SC information criteria.

Table 12

Choice of the optimal number of delay

	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6
AIC	117.98	117.79	117.60	117.35	117.27	117.20
SC	118.52	118.81	119.12	119.36	119.77	120.19

The Akaike criterion (AIC) leads to a delay optimal choice $p^*=5$, while the Schwartz criterion (SC) leads to $p^*=1$.

It is here in the presence of a diagnostic discrepancy in the use of these information criteria. The purpose of the introduction of the delayed terms is to whiten the residuals, that is to say, to control the autocorrelation of innovations. We seek the minimum structure that achieves this goal. It adopts an optimal choice of delay $p^*=1$.

A. Testing Granger Causality

The application of the ADF test of stationarity of the series of market indices and CDS indices show that all series of order 1 (I (1)) are integrated to a threshold of 5%. So, to analyze the causal relationships for a number of p equal to 1 during the crisis delays. The results are presented in Table 13.

Table 13

Granger causality relationship between the indices in crisis

Granger causality test	PSI_20 POR	OMX FINL	ITRAXX EUROPE	SOVX EUROPE	IBEX ESP	FTSE ITAL	FTSE UK	DAX_30 ALLE	CAC_40 FRANCE	BEL20 BELG	ATHENS GREECE
PSI_20 PORTUGAL		+	+	-	+	+	-	-	+	+	+
OMX FINLAND	+		+	-	-	+	+	+	+	+	+
ITRAXX EUROPE	-	+		+	-	+	-	+	+	+	-
ITRAX_SOV EUROPE	+	-	+		+	+	-	+	+	-	+
IBEX Spain	+	+	+	+		+	+	-	+	+	-
FTSE ITALy	+	+	-	-	-		+	+	+	-	-
FTSE UK	+	+	+	-	-	+		+	+	-	+
DAX_30 Germany	+	+	-	+	+	+	-		+	-	+

CAC_40 FRANCE	+	+	+	+	-	+	+	-		+	+
BEL_20 BELGIQUE	+	+	+	+	-	+	+	-	+		-
ATHENS GREECE	+	-	+	+	+	+	-	+	+	+	

Statistics provided by Eviews (Version 7.0)
The "+" indicates the existence of a significant causal relationship between the variable and the column line. The "-" means that the column variable does not Granger cause under the variable line.

Note that of causation as the probability does not exceed the threshold of significance of 5%. We confirm that there are different relations between Granger markets studied. Most indices are caused by the index of Portugal and Belgium, so these values are used to better predict the market index values. There is a correlation in the sense of Granger between the values of market indices at 5%. If we consider the index of Athens Greece, we find that the null hypothesis that “there is no issue in Granger “is rejected for a number of lags p = 1 for the majority of the indices, except for the case of indices: OMX (FINLAND) and FTSE (UK).

But the main finding, the iTraxx index SovX, because the sense of Granger indices: PSI (Portugal), cac40 (France), FTSE (Italy), Athens (Greece), dax40 (Germany) and IBEX (Spain).

Changes in the index of sovereign CDS present a very significant effect on the evolution of the market indices in Europe and especially, the PIIGS countries, Germany and France.

B. Cointegration Test

The cointegration test is the test of Johansen (1991, 1995), which is based on the number of eigenvectors ordered and the value of the likelihood ratio (LR) calculating the statistical Johansen following:

$$Q_r = -T \sum_{i=r+1}^{n} Ln(1-\gamma i) \quad (17)$$

with T is the number of observations. r=0 .... K-1. γi is the largest eigenvalue. Q_r is “trace statistic” and it tests the following hypotheses:

H0: no cointegrating relationship between the series.
H1: presence of at least one cointegrating relationship between the series

It is based on the critical values at the 5% and 1% that we accept or reject H0. If the LR statistic is greater than the critical data at the 5% and 1% values, we reject H0 and accept H1 and there is at least one cointegrating relationship between the series studied.

The results of the tests are generated based on the comparison of the LR statistic with critical values given in the 5% threshold. While this statistic is higher than the values, there is at least one cointegrating relationship between markets; otherwise no cointegrating relationship exists between these markets. The results of the cointegration tests are summarized in the following tables:

C. Cointegration Test between Indices in A Quiet Period

Inspection of Table 14 shows that during the quiet period, the result of cointegration tests between the market indices in Europe is quite significant. These markets follow a path of evolution close. The results of cointegration tests show that the overall trends in the indices of these markets seem to be parallel to the period.

By cons, no cointegration relationship is recorded between the index of SOV and other market indices in Europe. In other words, these markets do not respond strongly to financial shocks and are far from being affected by the contagion effect during adverse developments in the iTraxx Europe index SOV western (that took place during this period). These markets resist to any increases or decreases that take place on other financial markets.

However, the observation in Table 14 shows the presence of different cointegrating relationships between market indices in Europe. Indeed, it should be noted that except for Germany, all countries share at least one cointegrating relationship with other markets. This multiplicity of cointegrating relationships between the groups in question is a great explanation in the movement of global markets in the European Union.

Table 14
Cointegration test between the indices in quit time:

Johansen test	PSI_20 POR	OMX FIN	ITRAXX EUR	SOVX EUR	IBEX ESP	FTSE ITAL	FTSE UK	DAX_30 GERMAN	CAC_40 FRAN	BEL_20 BEL	ATHENS GREECE
PSI_20 PORTUGAL		2	0	2	2	2	2	2	2	2	2
OMX FINLAND			0	0	1	1	1	2	2	2	2
ITRAXX EUROPE				2	0	2	0	0	0	0	0
ITRAX_SOV EUROPE					0	0	0	0	0	0	0
IBEX Spain						2	2	2	2	0	0
FTSE ITALIy							1	2	2	1	2
FTSE UK								1	1	2	0
DAX_30 Germany									2	1	2
CAC_40 FRANCE										1	2
BEL_20 BELGIUM											2
ATHENS GREECE											

The high mobility of capital, the boosting of financial activities for monetary creation, the creation of new financial products and the ease with which the provision of international credits, explain the multiplicity of cointegrating relationships between these groups.

Inspection of Table 15 shows that during the crisis period of the study, the results of cointegration tests between the market indices in Europe are lower than recorded in a quiet period. These markets follow a path of evolution close. The results of cointegration tests reveal that the overall trend in the indices of these markets seems to be parallel to the period.

There has been a change in the results of cointegration relationship between the index recorded SOV and other market indices in Europe index of Greece, Belgium, France and Portugal. In other words, these markets respond more strongly to financial shocks and can be affected by the contagion effect during adverse developments in the iTraxx Europe index SOV western that took place during this period.

The observation of Table 15 shows the presence of different cointegrating relationships between market indices in Europe. And especially among the PIGS countries (Portugal, Italy, Greece and Spain) and they share at least one cointegrating relationship between them. This multiplicity of cointegrating relationships between the groups in question is a great explanation for the effect of the sovereign debt crisis that hit first Greece and other countries like Italy, Spain, Portugal and Ireland.

Table 15

Cointegration test between the indices in times of crisis:

Johansen test	PSI20 POR	OMX FINL	ITRAXX EUR	SOVX EUR	IBEX ESP	FTSE ITAL	FTSE UK	DAX30 GERMA	CAC40 FRAN	BEL20 BEL	ATHENS GREECE
PSI_20 PORTUGAL											
OMX FINLAND	0										
ITRAXX EUROPE	1	2									
ITRAX_SOV EUROPE	1	0	1								
IBEX SPAIN	1	0	1	0							
FTSE_MIB ITALY	1	1	1	0	1						
FTSE100 UK	0	2	2	0	2	2					
DAX_30 GERMANY	0	0	0	0	0	0	2				
CAC_40 FRANCE	1	2	2	2	0	1	0	2			
BEL_20 BELGIUM	1	1	1	1	1	1	2	0	1		
ATHENS GREECE	1	0	1	1	1	1	0	0	0	1	

The great bond between European Union countries, the boosting of financial activities related to money creation can explain the multiplicity of cointegrating relationships between these different groups.

D. The Impulse Response Functions

Following the implementation of the various cointegration tests on the market indices with SOV iTraxx index, we now come to the heart of the analysis of VAR models. A model which models inherently dynamic relationships between a group of selected variables to characterize a particular economic phenomenon. The pulse analysis will allow determining the influence of a shock related to the evolution of a variable on the other variables of the system. We will test the relative importance of each shock in explaining fluctuations SOV iTraxx index.

The following figures depict the impulse response functions. We look at the effects of the shock of 10 periods (that is to say 10 years). This horizon represents the time required for the variables back to their long-run levels.

The graphs describe the impulse responses of the ITraxx index SOV on different stock market indices in Europe during the crisis of sovereign debt. When the index occurred in Greece, Belgium and Portugal shock, generated results are identical. It is clear that the ITraxx index SOV has no contemporary impact in the first period on these indexes, since the curve departs the origin. But, soon a negative effect beginning of the second period before payback in the sixteenth time to return to its long term.

The case of Germany shows that the impulse response curve departs the origin and effect positive shock occurred on the index. This effect disappears seventh period to return to its long-term.

For Finland, the ITraxx index SOV has no impact on the contemporary OMX 30 index since the impulse response is always zero during the 10 periods. For France and the United Kingdom, we see that the impulse response curve departs the origin, then the negative effect of shock came on the index, this effect continued long-term level.

For Italy and Spain, we see that the impulse response curve departs the origin. Hence, the ITraxx index SOV has no contemporary impact on these indexes. This effect continues until the sixth period, and a positive effect of shock came on the index during the sixth and seventh period, and this effect quickly disappears to return to its long-term level.

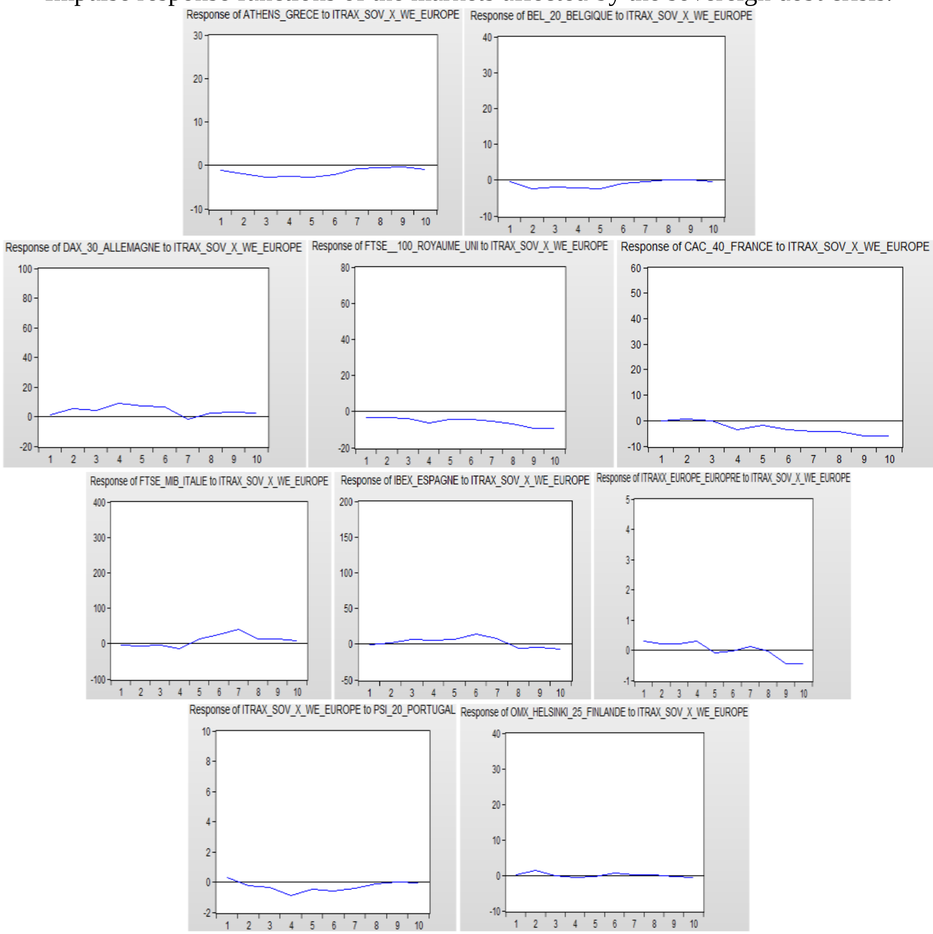
The ITraxx index EUROPE reacts with the amplitude more students from other indices. In fact soon the first period, a positive impact on the index results in a positive effect on ITRAXX SOV dice the first period. This effect disappears in the fifth period. During the seventh period, there has been a fall reflecting a negative reaction from the ITraxx index EUROPE.

V. CONCLUSION

We explore the dynamics of the financial sector near the financial crisis for the sovereign debt crisis in Europe. We focus on the mechanism that was at the origin of its amplification and highlight the transmission of shocks to volatility of the sovereign debt crisis in Europe and in particular in Greece. We check empirically contagion by analyzing the evolution of sovereign CDS spreads of countries peripheral Europe, via the DCC GARCH (1 .1) multi varied.

Figure 3

Impulse response functions of the markets affected by the sovereign debt crisis.



Provided by the author via the Eviews software, version (7.0)

We conduct a second empirical verification of the transmission of shocks to volatility of sovereign debt crisis. We investigate the financial crisis in Europe and the measurement of the magnitude of these shocks transmitted through contagion. We use VAR in conducting the analysis of the results of cointegration tests and impulse functions.

The results emerged from the DCC GARCH model (1.1) allows us to find that the conditional correlation of returns react more similarly to various shocks affecting the CDS markets that recorded in periods of stability. The sovereign debt crisis in Greece clearly had a significant impact on the conditional correlations between the countries of Europe. We can infer that shocks in Europe have a significant influence on the spread of sovereign CDS. There would be compensations (or corrections) effects of both signs positive and negative shocks over the long term.

We analyze the Johansen co-integration test for market indices. The markets respond more strongly to financial shocks and can be affected by the contagion effect during adverse developments in the ITraxx Europe index SOV western that took place during this period.

Finally, due to the decomposition of the forecast error variance that arises from the impulse response function to detect the impact of a shock on ITRAXXSOV index and its effects on other market indices were have found that the sensitivity indices opposite the index CDS is not the same and differs depending on the market in question and that it depends on the transmission channel especially the degree of dependence of the relevant market.

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