

## 1st International Conference on Cliometrics and Complexity

Nonlinear interdependencies or contagions  
phenomena between the main European stock  
market indices? Evidence from a chaos-stochastic  
model

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06/09/2016

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  - 1 contagion reflects the transmission of a collision between two countries that do not have common characteristics
  - 2 contagion capture the vulnerability of a country to the events that occur in other countries.

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VS

CONTAGION EFFECTS

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- links on European Stock Market indices (ESMI) : warnings signs of systemic risk. De Bandt and Hartmann(2000): impacts of contagion effects on systemic risk.



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- Constancio(2012): a contagion is an externality to the 'contaminated' market ⇒ Financial compensation?

## What are the causes of the contagion?

### Theory of non-contingent contagion -fundamentales causes-

- Trade links
- Financial links [↘ FDI...]
- Global shocks

### Theory of contingent contagion -Behaviours of investors-

- Investor psychology
- Endogenous liquidity shock
- Political contagion

Aim: Bring out the nature (interdependence or contagion) of Stock Market Indices in Eurozone countries for economics policies purposes.

# Outline

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- 4 Conclusions: empirical implications and futurs work



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- Constancio (2012), Amisano and Tristani (2011): contagion between European countries after financial crises(2007 & 2012).
- Beirne and Fratzcher(2013): Eurozone countries are characterized by an underestimation of the sovereign risk in pre-crisis and an overestimation in crisis periods.  
 $\Rightarrow$  What about the market risk of Eurozone Stock Market Indices?

Contagions and interdependencies  $\iff$  an important literature and a diversity of methodologies:

King and Wadhani(1990) }  
Baig and Goldfajn(1998) } Linear correlation coefficient

Boyer et al.(1997) }  
Forbes and Rigobon(2001) } Adjusted correlation coefficient

Dungey et al.(2005): structural breaks, autoreg. and heterosc. structures.

Corsetti et al.(2005): comparaison between a corrected correlation coefficient and an index of interdependence.

Caporale et al.(2005): Method based on a conditional correlation which include heteroskedasticity.

Xu(2008): Extreme Value Theory

Kyrtsou and Labys(2006, 2007): Non linear causality test of Granger (bivariate Mackey-Glass (MG) model)

Kyrtsou and Vorlow(2009): Noisy bivariate MG with BEKK-GARCH process.

Our methodology:

We propose an original model for detecting and analysing the nature of the links between ESMI:

**The multivariate Mackey-Glass-DCC-GARCH model:**

$$X_{it} = \alpha_i \frac{X_{i,t-\tau_i}}{1 + X_{i,t-\tau_i}^{c_i}} - \delta_i X_{i,t-1} + \sum_{\substack{j=1 \\ j \neq i}}^n \alpha_j \frac{X_{j,t-\tau_j}}{1 + X_{j,t-\tau_j}^{c_j}} - \delta_j X_{j,t-1} + \epsilon_{i,t}$$

With

$$\epsilon_t = \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \\ \dots \\ \epsilon_{i,t} \\ \dots \\ \epsilon_{n,t} \end{pmatrix}$$

And  $\epsilon_t | \Omega_{t-1} \sim N(0, H_t)$  Where  $\Omega_{t-1}$  the set of informations available in  $t - 1$ .  $H_t$  is defined by :

$$H_t = D_t R_t D_t \quad (1)$$

$$D_t = \text{diag}(h_{1t}^{1/2}, \dots, h_{Nt}^{1/2}) \quad (2)$$

$$R_t = (\text{diag} Q_t)^{-1/2} Q_t (\text{diag} Q_t)^{-1/2} \quad (3)$$

DCC with  $t=1, \dots, n$

$R_t \{$  CCC with  $R_t = \bar{R}$

$\forall t = 1, \dots, n$



Chaos(Mackey-Glass part) + Stochastic(DCC-GARCH part)

A fundamental-based  
relationship

A  
non-fundamental-based  
relationship ie investors  
actions'

Contagion phenomenon:

- in mean : a feedback effect is highly significant in stressed period and low or inexistant in calm period.
- in variance : intensification of conditional correlations in stressed period.

Six Europeans indices: Germany (DAX 30), France (CAC 40), Italy (SP 40), Portugal (PSI 20), Spain (IBEX 35), Greece (ATHEX 20).

### Analysis in 2 periods:

	Period 1 [11/28/2003- 11/27/2007]	Period 2 [11/28/2007- 11/25/2012]
Common characteristics for all indexes	calm period low variance	stressed period leptokurticity, high variance.
Engle and Sheppard (2001)'s test	CCC-GARCH	DCC-TGARCH

## What are the relationships between the eurozone countries?

### Fundamental contagion

- special relationships between French, German and Italian indexes
- calm period: Greek index is strongly impacted by German, French, Italian and Portuguese indexes...
- ... **BUT** on stressed period: Hellenic index is still impacted by French and German indexes and has a significant impact on Italian and Portuguese indexes.  
↔ fundamental vs non-fundamental impacts. [▶ feedback effects](#)
- No fundamental interactions between Portuguese and Spanish indexes.

## Are there contagion phenomena?

## Psychological contagion

	FR	ALL	IT	ES	PORT	GR
FR	1	0,70	0,60	-0,08	0,47	0,43
ALL	0,70	1	0,79	0,03	0,46	0,38
IT	0,60	0,79	1	0,06	0,40	0,38
ES	-0,08	0,03	0,06	1	0,03	0,01
PORT	0,47	0,46	0,40	0,03	1	0,32
GR	0,43	0,38	0,38	0,01	0,32	1

Table: Correlations coefficients (Calm period)

	FR	ALL	IT	ES	PORT	GR
FR	1	0,94	0,89	0,85	0,73	0,03
ALL	0,94	1	0,85	0,80	0,69	0,02
IT	0,89	0,85	1	0,85	0,74	0,02
ES	0,85	0,80	0,85	1	0,73	0,02
PORT	0,73	0,69	0,74	0,73	1	0,00
GR	0,03	0,02	0,02	0,02	0,00	1

Table: Mean of the correlations coefficients (stressed period)

- Original modelling: multivariate approach of fundamental and non-fundamental interdependencies.
  - 1 fundamental relationships are described by a non-linear chaotic model
  - 2 non-fundamental relationships are described by a DCC-GARCH model.
- Empirical results
  - 1 Mecanic contagion:  $CAC \rightarrow IBEX$ ,  $CAC \leftrightarrow DAX$ ,  $DAX \& CAC \rightarrow SP$ ,  $DAX \rightarrow PSI$ .
  - 2 Psychological contagion:  $DAX-CAC$ ,  $SP-CAC$ ,  $IBEX-CAC$ ,  $PSI-CAC$ ,  $SP-DAX$ ,  $IBEX-DAX$ ,  $PSI-DAX$ ,  $IBEX-SP$ ,  $PSI-SP$ ,  $PSI-IBEX$ .

- a highly integrated group (French, German and Italian indexes) with :
  - 1 a leadership: German index
  - 2 'transfert' index: Italian
  - 3 'consensual' index : French
- Results for the Hellenic index are interesting:
  - 1 a fundamental impact of German and French index
  - 2 isolated in stressed period (correlations)

- confined contagions: strong impacts for French, German and Italian indexes.
- need for more integration of the Hellenic index to avoid mechanic impacts on European indices.

Open issues:

- What is happening in a more general framework, ie, with more indices?
- If Brexit occurs, how the relationships will be modified?

**Thank you for your attention.**



Calm period			Stressed period		
$X_{it}$	$X_{jt}$	$(\alpha_j - \delta_j) * 100$	$X_{it}$	$X_{jt}$	$(\alpha_j - \delta_j) * 100$
CAC	DAX	2,82	CAC	DAX	17,4
	SP	15,25		SP	6,7
	PSI	6,07		IBEX	1,5
DAX	CAC	-26	DAX	CAC	-49
	SP	5,6		SP	0,2
SP	DAX	1,35	SP	DAX	9,5
	CAC	-19		CAC	-26
IBEX	DAX	-21		ATHEX	9,6
	SP	4,07		IBEX	12,6
PSI	DAX	4,1		PSI	13,4
	IBEX	15		DAX	2,5
ATHEX	DAX	81	IBEX	IBEX	16,9
	CAC	-28		ATHEX	-29
	SP	23,5		PSI	DAX
	PSI	34,8	IBEX		0,55
			ATHEX	ATHEX	7,1
				DAX	23,2
				CAC	52
				PSI	-16