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

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Motivations

- Financial crisis
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- systemic risk: potential threat to the stability of the global financial system.
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■ Sovereign debt crisis in the Eurozone from spring 2010.
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- Financial contagion: a mechanism through which financial instability spreads to the systemic risk.
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1 contagion reflects the transmission of a collision between two countries that do not have common characteristics.
- Financial crisis
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  - Sovereign debt crisis in the Eurozone from spring 2010.
- Financial contagion: a mechanism through which financial instability spreads to the systemic risk.
  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.
No contagion VS Contagion Effects

Why is it important to dissociate an interdependent relationship of contagion relationship?

**No contagion** VS **contagion effects**

Why is it important to dissociate an interdependent relationship of contagion relationship?


- Interdependencies: Short term policies are inefficient.
  
  Why? It is a long term relationship unchanged whatever the period.
Motivations

No contagion VS Contagion effects

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- Interdependencies: Short term policies are inefficient.
  → Why? It is a long term relationship unchanged whatever the period.

- 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

1 Introduction
Outline

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2 Literature review
Outline

1. Introduction
2. Literature review
3. Empirical results
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3. Empirical results
4. Conclusions: empirical implications and future work

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Contagions or interdependencies? An approach by a chaos-stochastic model
Is there contagion between European countries?

**NO**


**YES**
Is there contagion between European countries?

**NO**

- Potential bias: use of two stressed period.

**YES**

- Beirne and Fratzcher (2013): Eurozone countries are characterized by an underestimation of the sovereign risk in pre-crisis and an overestimation in crisis periods.

⇒ What about the market risk of Eurozone Stock Market Indices?
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  ⇒ What about the market risk of Eurozone Stock Market Indices?
Contagions and interdependencies ↔ an important literature and a diversity of methodologies:

- King and Wadhani (1990)
- Baig and Goldfajn (1998) \( \rightarrow \) Linear correlation coefficient
- Boyer et al. (1997)
- Forbes and Rigobon (2001) \( \rightarrow \) Adjusted correlation coefficient
- Dungey et al. (2005): structural breaks, autoreg. and heterosc. structures.
- Corsetti et al. (2005): comparison 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

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:**

\[
X_{it} = \alpha_i \frac{X_{i,t-\tau_i}}{1 + X_{i,t-\tau_i}^{c_i}} - \delta_i X_{i,t-1} + \sum_{\substack{j=1 \atop j \neq i}}^{n} \alpha_j \frac{X_{j,t-\tau_j}}{1 + X_{j,t-\tau_j}^{c_j}} - \delta_j X_{j,t-1} + \epsilon_{i,t}
\]
With
\[
\begin{pmatrix}
\epsilon_{1,t} \\
\epsilon_{2,t} \\
\vdots \\
\epsilon_{i,t} \\
\vdots \\
\epsilon_{n,t}
\end{pmatrix}
\]
And \( \epsilon_t \mid \Omega_{t-1} \sim N(0, H_t) \) Where \( \Omega_{t-1} \) the set of informations available in \( t - 1 \). \( H_t \) is defined by :

\[ H_t = D_t R_t D_t \]  \hspace{1cm} (1)

\[ D_t = diag(h_{1t}^{1/2}, ..., h_{Nt}^{1/2}) \]  \hspace{1cm} (2)

\[ R_t = (diagQ_t)^{-1/2} Q_t (diagQ_t)^{-1/2} \]  \hspace{1cm} (3)

DCC with \( t=1, ..., n \)

\[ R_t \{ \text{CCC with } R_t = \overline{R} \} \]

\( \forall t = 1, ..., n \)
Methodology

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:

<table>
<thead>
<tr>
<th>Common characteristics for all indexes</th>
<th>Period 1</th>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm period</td>
<td>low variance</td>
<td>stressed period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>leptokurticity, high variance.</td>
</tr>
</tbody>
</table>

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.
  \[ \text{feedback effects} \]
- No fundamental interactions between Portuguese and Spanish indexes.
Psychological contagion

<table>
<thead>
<tr>
<th></th>
<th>FR</th>
<th>ALL</th>
<th>IT</th>
<th>ES</th>
<th>PORT</th>
<th>GR</th>
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<td>0,46</td>
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<td>0,03</td>
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<td>0,01</td>
<td>0,32</td>
<td>1</td>
</tr>
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</table>

**Table:** Correlations coefficients (Calm period)

<table>
<thead>
<tr>
<th></th>
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<th>IT</th>
<th>ES</th>
<th>PORT</th>
<th>GR</th>
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<tbody>
<tr>
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<td>0,80</td>
<td>0,69</td>
<td>0,02</td>
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<tr>
<td>IT</td>
<td>0,89</td>
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<td>0,85</td>
<td>0,74</td>
<td>0,02</td>
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<td>ES</td>
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<td>0,73</td>
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<tr>
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<td>0,02</td>
<td>0,02</td>
<td>0,02</td>
<td>0,00</td>
<td>1</td>
</tr>
</tbody>
</table>

**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.
Results

- 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.
<table>
<thead>
<tr>
<th></th>
<th>Calm period</th>
<th>Stressed period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$X_{it}$</td>
<td>$X_{jt}$</td>
</tr>
<tr>
<td><strong>CAC</strong></td>
<td>DAX</td>
<td>2,82</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>15,25</td>
</tr>
<tr>
<td></td>
<td>PSI</td>
<td>6,07</td>
</tr>
<tr>
<td><strong>DAX</strong></td>
<td>CAC</td>
<td>-26</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>5,6</td>
</tr>
<tr>
<td><strong>SP</strong></td>
<td>DAX</td>
<td>1,35</td>
</tr>
<tr>
<td></td>
<td>CAC</td>
<td>-19</td>
</tr>
<tr>
<td><strong>IBEX</strong></td>
<td>DAX</td>
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<tr>
<td><strong>PSI</strong></td>
<td>DAX</td>
<td>4,1</td>
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<tr>
<td></td>
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<td>15</td>
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<tr>
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<td>DAX</td>
<td>81</td>
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<tr>
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<tr>
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<td>CAC</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>PSI</td>
<td>-16</td>
</tr>
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