Overreaction to the 2015 Greek debt crisis: A study on FTSE, CAC & DAX
ANTOINE BERGER

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Dissertação apresentada à Escola de Economia de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre Profissional em Economia.

Campo do Conhecimento:

International Master in Finance

Orientador Prof. Dr. Pedro Valls
Prof. Dr João Pereira

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ABSTRACT

The Greek crisis happened in a total of three peaks, the last one happening during the Summer 2015. Western European financial sectors as well as financial markets in general in Europe were hardly hit despite the fact that private sectors in Europe widely reduced their exposure to Greece. In this research paper, we aim to test for Overreaction on the FTSE 100, DAX 30, and CAC40. The Overreaction Hypothesis states that overreacting indices display an asymmetric mean and variance. In this optic, we test for ARCH type models on the previously cited markets.

Keywords: Finance, Greece, Debt Crisis, Eurozone, Euro, Equity Markets, Overreaction, Systematic Risk, Europe, Asymmetry
RESUMO

A crise grega aconteceu em um total de três picos, o último a acontecer durante o Verão de 2015. Setores financeiros da Europa Ocidental, bem como os mercados financeiros em geral na Europa quase não foram atingidos apesar do fato de que os setores privados na Europa amplamente reduziram a sua exposição à Grécia. Neste trabalho de pesquisa, pretendemos testar a reação exagerada sobre o FTSE 100, DAX 30, e CAC40. A reação exagerada hipótese afirma que os índices de reagirem excessivamente exibir uma média assimétrica e variância. Nesta óptica, testamos para os modelos tipo de arco nos mercados citados anteriormente.

Palavras-chave: Finanças, Grécia, crise da dívida, da Zona Euro, Euro, a Equity Markets, reação exagerada, risco sistemático, Europa, Assimetria
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II – Introduction

A) The European Monetary Union

The European Monetary Union, or Eurozone regroups countries from the European Union which adopted the Euro as their national currency. Out of 28 current members, 19 use the Euro (€). Bills and coins are in circulation since January 1\textsuperscript{st}, 2002. Few criteria are mandatory in order to join the Eurozone:

- Public deficit inferior than 3% of GDP
- Public debt inferior than 60\% than total GDP
- Controlled inflation
- Independent central bank
- Stable currency for at least 2 years

B) Major Financial indexes

Our research will be based on the main European equity indexes\textsuperscript{1}, which are:

- Footsie 100 (London SE)
- DAX (Frankfort)
- CAC40 (Paris)

\textsuperscript{1} The IBEX will not be used, as Spain was also hardly hit by the 2008 crisis, making the country incomparable
C) The Eurozone Crisis

The first wave 2009 - 2010

In 2010, one year after the subprime crisis, a rescue plan is being approved by the European institutions in order to bailout Greece, in a catastrophic situation. The plan, also provided by the IMF, contained more than 110 billion Euros in unilateral loans.

Three days after (May, 10th, 2010), the European Financial Stability Facility is created with a capital of 750 billion Euros in order to help other countries in difficulty (Ireland, Spain, Portugal). The deficit goals concerning Greece are not met and the country receives more help. The Hellenic nation is heavily criticized on its lack of transparency.

Along Greece, Ireland is living a very serious financial crisis and its main banks are almost bankrupt. The government lent money to the banks, increasing the public deficit to 32% of total GDP. Ireland is helped by the EFSF with a total of 80-90 billion euros loans.

Spain was also largely hit but needed less financial help than the others. The Iberian country applied the austerity plans properly. Italy also applied drastic measures.

The second wave, 2012

Greece is very late on schedule and faces important internal troubles (violent demonstrations, strikes). The countries to whom debt is still rates AAA; Germany, Finland, Netherlands; are questioning the Greek presence in the Eurozone.

IMF and other institutions insist on a debt restructuration. Finally, due to the fear of a contagion, a new bailout plan is endorsed against the promise of more austerity and reforms.
In mid-2015, the 2012 bailout plan expires. The Greek people elected SYRIZA a government very hostile to European reforms. Rumors of “Grexit” and default pull the European financial markets down while the private financial exposure to Greece was reduced to almost zero.

After a hard and tense month for Greece, for the European Financial Institutions and the financial markets, a new bailout loan is made through the EFSF (86 billion euros on 3 years) against the promise of new reforms.

D) Overreaction: a market dysfunction?

Definition of overreaction: “A market hypothesis stating that investors and traders react disproportionately to new information about a given security/market. This will cause the security's/market’s price to change dramatically, so that the price will not fully reflect the true value immediately following the event. Typically, the price swing from overreaction is not long lasting, as the stock price will tend to return back to its true value over time.”

Source – Investopedia.com

Few analysts stated, in 2015, that the European financial markets overreacted to the third peak of the Greek situation, given that the private economic exposure\(^2\) was reduced. Could we call this phenomenon a market dysfunction since the systematic risk was theoretically closer of zero than one?

\(^2\) Economic, financial, and operational exposure of the private sector (ex. banks, multinational companies)
A) Evolution of the European exposure to Greece

Public sector –

The exposure labelled “1st program” concerns the bilateral loans used to bailout Greece the first time. The total amount reached 77,3 billion Euros. The IMF completed with an additional loan of $30 billion.

The exposure from “Guarantees on EFSF loan funding” represent the exposure through the Guarantees given by each country on each EFSF loans.

The “indirect exposure through TARGET 2” represents the potential losses of a default of Greece on its loans given by the ECB.

The label “Holding of Greek Debt” is the second most direct form of exposure to Greece after the bilateral loans.
As a matter of facts, the **direct exposure** to Greece has largely decreased since the first peak. However, the **indirect exposure** has increased through different means: EFSF, liabilities to the ECB… The consequences of a Greek partial or complete default would then be harder to measure for each and every country.

*Private sector* –

In 2010, the banks’ exposure to the Greek represented a huge systematic risk for the whole financial world in Europe. A Greek default would have provoked the loss of more than a *250 billion euros to the European banks only*.³

The first wave provoked a downward reaction on the financial markets all over the world.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC 40 (France)</td>
<td>-8,33%</td>
</tr>
<tr>
<td>DAX (Germany)</td>
<td>-3,06%</td>
</tr>
<tr>
<td>FTSE (London)</td>
<td>-7,42%</td>
</tr>
<tr>
<td>MIB (Milan)</td>
<td>-15,48%</td>
</tr>
</tbody>
</table>

*Indices performance during the 1st debt crisis wave – Yahoo Finance*

Since this first peak and the fear of a contagion over Europe, the private sector largely reduced its exposure to the Greek debt market. A good example of this reduction is the follow up of the German and French banks over the Hellenic country:

³ Source – Thompson Reuters, BIS, and BlackRock Institute.
The public exposure of the German and French banks has been reduced to $181 and $102 millions.

“The exposition of European banks to the private sector of Greece excluding banks is also very limited, even if it recently increased for German banks, for which it amounts to $ 7.885 billion. The exposure of German banks to Greek banks amounts to $ 5.702 billion. Their other potential exposure to Greece amounts to $ 2.912 billion in the form of derivatives, guarantees extended and credit commitments. The exposure of the French banks to the private sector of Greece excluding banks is limited to $ 1,646 billion. Their exposure to Greek banks is limited to $ 471 million. Their other potential exposure to Greece amounts to $ 1.747 billion.” – Eric Dor, IESEG School of Management, January 2015

B) Impact of a sovereign default probability on the financial sector

Cabrera, Dwyer and Samartin-Saenz (2016) built an event-study based research in order to measure the relationship between Sovereign finances events and stock markets reaction.

As a matter of facts, the banks’ sector is more likely to react significantly to government’s finance news – independently of the bank’s size.

Two hypothesis are tested:

• “H1: Events affecting governments’ fiscal positions are positively correlated with banks’
abnormal stock returns”

• “H₂: Events affecting governments’ fiscal position have a larger effect on larger banks’ stock returns, if larger banks are regarded as too big to save.”

57 events are tested and concern a financial aid approving, request, Sovereign downgrades, forecast revisions and suspension of eligibility.

The main conclusion of this paper resides in the fact that, when the government ability to bail out banks deteriorates (through a worsening of the public finances situation), banks react negatively.

“For the Eurozone sovereign-debt crisis, the evidence indicates that No Bank is Too Small to Save. We find a clear statistical association between banks’ stock returns and announcements concerning governments’ finances. We find bits of evidence supporting the propositions that larger banks are Too Big to Fail and Too Big to Save.” – Matias Cabrera, Gerald Dwyer and Margarita Samartin-Saenz

Papafilis, Psillaki, and Margaritis (2015) examine the relationship between sovereign and bank credit risk after the increase of the Private Sector Involvement (PSI, 2011) during the Greek crisis. The objective is to identify the change in causality on the CDS market for 8 Eurozone countries. The figure page 12 below indicates that the average spreads on the Credit Default Swaps observed and overall jump after the announcement of the Private Sector Involvement (October 2011).

“It becomes imperative, the need for the undertaking of initiatives, by political and economic leaders of the Eurozone, to aim to reduce the interdependence between sovereign and bank credit risk. This fact will contribute, not only, in strengthening the stability of the financial system, but, in improving the financial conditions of the European countries which are facing serious economic problems.” - Michalis-Panayiotis Papafilis, Maria Psillaki, and Dimitris Margaritis, 2015
The study concludes that, after the implementation of the PSI by the European Institutions, the correlation between sovereign and bank credit risk has largely decreased for the studied sample.

C) Impact of bailouts and other interventions on the stock markets, financial and “real sectors” – Evidence of the Athens Stock Exchange

According to Kosmidou, Kousenidis and Negakis (2014), the intervention of the financial institutions during the Greek sovereign crisis shifted the systematic risk in all sectors.
Their research first studies the short term impact of the news of an intervention and then analyses the long term impact of each new announcement. The event study covers all sorts of firms’ sectors: stock of banks, financial sector, industrial firms and commercial firms.

The focus is made on the 2009-2012 period, filled by significant events (three bailout plans, implementation of the Greek restructuring plan, political instability).

The tested hypothesis are as the following:

1. The announcement of news related to the Greek sovereign crisis had a more significant impact on the stocks of banks than on those of the other firms.

2. The announcement of each category of news had a significant impact on the wealth of the shareholders of firms in the banking, financial, and real economy sectors.

This research was the first to study the impact of interventions of the European Union and IMF combined on a problematic situation within the EU. Both hypothesis are verified in the following citation:

“The results of the regression analysis indicate that the actions of the troika have played an important role in affecting the systematic risk of firms in the banking and financial sectors of the Greek capital market. In particular, we show that the troika actions have been associated with positive average shifts in the risk of the firms, in these sectors. This finding indicates that news announcements concerning the intended policy actions of the troika partners are unlikely to reverse the negative wealth effects and reduce the systematic risk of Greek banking and financial firms.”

Kyriaki V. Kosmidou, Dimitrios V. Kousenidis and Christos I. Negakis
According to their results, actions of the local authorities only have a significant impact on the banking sector. As a matter of facts, the financial markets anticipate a governmental action on the banks (liquidity or other guarantees).

Overall, the findings suggest that the interventions of the troika and the Greek government did not succeed in preventing the financial crisis to turn into a “real world” crisis.

D) Spillovers and contagion risk of the Greek debt crisis on the Eurozone financial sector

Bhanot, Burns, Hunter and Williams (2013) examine the impact of the Greek sovereign debt crisis over the financial sector stocks in Portugal, Spain and Netherlands. A spillover here is defined as: “an event where increases in Greek yield spreads lead to negative abnormal returns on an index of financial firms in another country.” The sample period is between January 2005 to June 2011 – the first crisis peak being studied.

Significant evidence of spillovers is found, especially on downgrading announcement dates or broadcasts from important financial institutions.

“Our analysis also sheds light on the different means by which new information about potential default of the Greek debt is incorporated in the prices of financial firms in the Eurozone countries.”

Karan Bhanot, Natasha Burns, Delroy Hunter, Michael Williams
There is a shed of proof that these spillovers on foreign stock markets are communicated through an increase in spreads on the domestic bonds market.

**E) Previous research on overreaction**

Through GARCH models estimations

De Bondt and Thaler (1985) have been among the first academic researchers to study Overreaction on stock markets. According to psychology studies, people tend to overreact to unexpected and dramatic news events: do financial markets duplicate this behavior and to which extent? Their findings display that investors follow poor Bayesian decisions.

Consistent with the Overreaction Hypothesis, they found that portfolio of prior “losers” are found to outperform prior “winners”, leading to an outperformance of contrarian strategies.

Their research implies that negative shocks increase the variance and revert faster while positive shocks decrease the variance and take longer to revert. An increase in volatility after negative returns is a sign of overreaction.

Since De Bondt and Thaler, the Overreaction Hypothesis has been extensively examined from an empirical point of view taking both a long-term and a short-term perspective.

Glosten, Jagannathan and Runkle, D (1993) first used the GJR model in order to capture the asymmetry observed in the American market, from 1951 to 1989.

Kulp-Tag (2007) used an Exponential-Garch in order to test this market phenomenon on Nordic stock markets. Their purpose was to observe the asymmetric mean-reverting behavior of both mean and variance of the Swedish, Norwegian and Danish markets, from January 1996 to December 2004. Studies on asymmetry (also known as leverage effect) aim to investigate the effects of
negative or positive returns on volatility. Asymmetry on markets would imply that the contrarian strategy is effective.

“The EGARCH is extended so that the conditional mean is a function of the conditional variance. The model (ARCH-M) was first presented by Engle et al. (1987), and includes the conditional Variance as a function in the conditional mean. This gives the EGARCH-M model for the variance. With an exponential GARCH in mean model, (EGARCH-M), the problem with time-varying volatility effects affecting the asymmetric pattern can be reduced.” Sofie Kulp-Tag

As they estimate the model, the Generalized Error Distribution is used, its advantage being that fact that it allows for thick tails, characteristics of financial data. Her empirical finding states that autocorrelation is smaller after negative returns than positive returns. A large asymmetric pattern has been found in the conditional variance, negative returns having a large effect on volatility. However, a fast correction (mean reversion process) is observed, leading to the conclusion that negative overreaction is a short term phenomenon.

Alberg, Shalit and Yosef (2008) established an empirical analysis of the mean returns and conditional variance on the Tel-Aviv Stock Exchange (TASE), from October 1992 to May 2005. The performance prediction is processed using a comparison among GARCH models and GJR / APARCH models. Their empirical findings state that EGARCH, APARCH and GJR models give better estimates than traditional GARCH models, with a t-student distribution. They conclude that the EGARCH model with a t-student distribution captures best the dynamic behavior of their sample: it reflects well the serial-correlation and asymmetric volatility found in the sample.
“If investors’ over or underreaction is real, then the price correction process should occur primarily over a very short-term since it is difficult to justify that any arbitrage opportunities arising from these deviations persists over a long period of time…” Hudson, Atanasova (2008)

Through regressions

Kassimatis, Galariotis (2007) examine short term reactions to extreme shocks in the British equity market from December 1988 to January 2004. Their study aims to test that the contrarian strategy is profitable since investors overreact to good and bad news. Their methodology consists in computing the Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) after shocks in the equity markets. This leads to the computation of the Average Cumulative Abnormal Returns for each index and each type of stocks. Their findings state that there are more negative than positive shocks, as well as the fact that big capitalization react much stronger to the shocks and in an efficient way.

“As regards the reaction to extreme negative news the results are also to some extent consistent with behavioral models that predict initial underreaction to information and a subsequent overreaction” K. Kassimatis, E. Galariotis

However, underreaction cannot be explained by calendar effects (January, May), bid-ask spread biases or by a unique global financial crisis. By using the Fama and French approach, they conclude that small & medium capitalization underreact to extreme shocks.

Otchere, Chan (2010) studied the short run overreaction present in the Hong Kong market, using data from March 1996 to June 1998. They use different benchmarks in order to compute abnormal returns: the mean adjusted model, the market model and the CAPM. The mean adjusted & market
model are usually efficient in detecting abnormal returns whilst the CAPM captures the effects of interest rates fluctuations (important factor for rational investing). Before the Asian financial crisis, there is evidence of overreaction on the 3rd following the initial negative return. However, the magnitude of this phenomenon is not high enough to represent important overreaction and is interpreted only as a late reaction of the market. During the Asian crisis, they observe important Abnormal Returns but there is weak evidence of overreaction. As a conclusion, the evidence of overreaction is more important in the pre-crisis period than the post-crisis period: the crisis shocks brought more efficiency into the market (decrease of noise trading). Size effect, bid-ask bounce, calendar effect do not explain this phenomenon. They also conclude that a contrarian strategy can be effective, capturing well the abnormal returns when a market is overreacting to new information.
IV – Hypothesis

The previous literature review showed a few important points:

1) Prior to the third Euro-crisis, private and public claims to Greece have been largely reduced, especially by the bank sectors throughout the European Union.

2) Previous research established a relationship between the Sovereign credit risk and financial sectors. Stock markets go through abnormal returns during a Sovereign debt crisis.

3) Bailouts and other interventions do not have the fully desired effect on financial systematic risk in the domestic market.

4) There is evidence of spillovers and a contagion risk on the European financial sector when a Eurozone country goes through a debt crisis.

5) Overreaction has been widely studied and can be observed through asymmetric econometrics model such as EGARCH, GJR, APARCH. However, overreaction after negative returns is usually observed on the short term. Empirical findings also state that the models previously quoted are good forecasting tools.

6) The phenomenon can also be studied through computation of abnormal returns and through a comparison of subsamples. But previous literature following this methodology can be contradictory.

What would be the reason of a possible overreaction? Were the European financial markets afraid of the “Grexit” itself, or its consequences for countries in recovery such as Portugal, Spain, Ireland?
V – Empirical study

A) Data

As specified in the introduction, our study focuses on the main European financial indexes, as follows;


DAX 30 [Deutscher Aktienindex] – Index composed of the top 30 capitalizations quoted in the Frankfurt Stock Exchange. Prices are taken from the Xetra trading system.

CAC 40 [Cotation Assistée en Continu] – Main French equity index, composed by the 40 biggest companies quoted in the Paris Stock Exchange. The CAC is now part of Euronext.

The data was downloaded through a Bloomberg terminal.

B) Samples and Sub-Samples

The data was downloaded from January 2\textsuperscript{nd}, 2013 (avoidance of possible bias due to 2\textsuperscript{nd} Greek wave in 2012) to January, 2\textsuperscript{nd}, 2016. In order to obtain proper estimation and results, we define the following subsamples:

- The Pre-Event Period starts from January 2\textsuperscript{nd} 2013 to June 29\textsuperscript{th} 2015, eve of the Greek partial default.

- The Event Window starts from January June 30\textsuperscript{th} 2015, day of the Greek partial default on the IMF loan to August 14\textsuperscript{th}, day of the agreement approval by the Greek parliament.

- The Post-Event Period goes from August 15\textsuperscript{th} to the end of the sample (January 2\textsuperscript{nd} 2016).
C) Methodology

First of all, **it is important to give a definition of overreaction, helping the reader to understand the methodology processed in this research.** The Overreaction Hypothesis suggests that after negative returns, financial market revert much faster than positive returns do. We can observe as well an increase in volatility. The Overreaction Hypothesis is an advocate of asymmetry in the conditional mean and variance. To test for asymmetry, we need a specific structure in the conditional mean of the process that allows for asymmetry. As a result, a model accounting for asymmetrical structure in the conditional mean & variance should be used for financial data, explaining the following methodology. Moreover, if an index/stock overacts to new information, it will shift away from its fair value resulting in a future price reversal which could be forecastable. The following models will be estimated for each subsamples, through OxMetrics:

• GARCH with a normal, t-student, Generalized Error Distribution

• IGARCH with a normal, t-student, Generalized Error Distribution

• EGARCH with a normal, t-student, Generalized Error Distribution

• GJR model with a normal, t-student, Generalized Error Distribution

The goodness of fit should be higher for either EGARCH or GJR model during the Event-window to start proving overreaction. To measure the goodness of fit, special attention will be paid to the Schwarz and Akaike criteria.

The GARCH models (Generalised Autoregressive Conditionally Heteroscedastic) allows the conditional variance to depend on the square of past returns. They are widely used for financial data due to their randomly varying volatility. As a matter of fact, GARCH models usually show thick tails, known property of financial time series.
The conditional variance for GARCH(s,m) is given by:

\[ \sigma_t^2 = \omega + \sum_{i=1}^{m} \alpha_i \sigma_{t-i}^2 + \sum_{j=1}^{s} \beta_j \sigma_{t-j}^2 = \omega + \alpha(L) \sigma_t^2 + \beta(L) \sigma_t^2 \]

Where \( \alpha(L) \) and \( \beta(L) \) are polynomials in the lag operator \( L \). One advantage of the GARCH model is that the non-negativity conditions are stronger, with \( \omega > 0, \alpha_i \geq 0, \beta_j \geq 0 \) for \( i=1,\ldots,m \) and \( j=1,\ldots,s \).

The Integrated GARCH (IGARCH) possesses a property called “persistent variance”. The current information is then capital to estimate the conditional variance over all horizons of time. The necessary condition for an IGARCH is: \( \alpha(1) + \beta(1) = 1^5 \). How to measure persistence? We need to define how long can shocks to conditional variance can persist.

If the returns on a given sample follow an IGARCH, then its unconditional variance is infinite. Then, the square returns would not meet the definition of the covariance stationary process.

The principle property of the presented GARCH models is the symmetry in volatility while negative news occur on the markets. As seen in the previous parts of this work (literature review), negative shocks within the markets create an increase in the volatility, known as the “leverage effect”.

Nelson (1990) brought the exponential GARCH (EGARCH), with the logarithm of the conditional variance given by:

\[ \ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[ \frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] \]

One of the main advantages of this model is the fact that the parameters are unrestricted. \( \gamma \) is negative, implying that the volatility increases when returns are negative.

---

4 « Aula_volatileidade_univariada_MCFE_continuacao » Pedro Valls, class notes (FGV/EESP & CEQEF)
5 « Lecture notes on GARCH models » Eduardo Rossi, lecture notes (University of Pavia, 2014)
The GJR, or Threshold Garch (TGARCH) introduces a dummy variable to the GARCH(1,1) model. The GJR has been introduced by Glosten, Jagannathan & Runkle (1993) and consists in the following equation:

\[ \sigma_t^2 = \omega + \sum_{i=1}^{q} (\alpha_i a_{t-i}^2 + \gamma_i S_{t-i}^- a_{t-i}^2) + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \]

Where \( S_{t-i}^- = \begin{cases} 1 & \text{if } a_{t-i} < 0 \\ 0 & \text{if } a_{t-i} \geq 0 \end{cases} \), inducing that the volatility increases with negative returns. The GJR model would fit the sample if negative shocks contribute more to volatility than positive shocks. As the EGARCH, the GJR model includes the leverage effect.

Each model will be estimated for normal, t-student and generalized error distribution. The normal distribution, of mean= 0 and variance= 1 is a very common probability distribution used in many fields, as Finance.

The T-Student distribution is suitable when studying a small sample size and if the standard deviation is unknown. This distribution plays an important role in statistic studies, notoriously through the t-test, indicating the significance of the difference between two means. In comparison to the normal distribution, the t-student has heavier tails. On financial data, it would mean that extreme returns have more probability to occur.
The GED distribution, or Generalized Error Distribution is a symmetrical unimodal distribution within the exponential family. This univariate probability distribution is often used to describe financial data⁶. The GED represents the generalized form of the normal distribution, but possesses a natural multivariate form, as a parametric kurtosis and represents possesses special cases proper to the normal distribution and the double exponential distributions (La Place).

While estimating the models, three information criteria will be used to determine the goodness of fit. The Akaike information criterion (AIC) is founded on the information theory, by disclosing the amount of information lost in the model estimation. However, AIC is not an assessment about the quality of the model itself. The Schwarz criterion (or Bayesian Information Criterion). It is similar to the Akaike information criterion and partly based on the maximum likelihood function. While we estimate de models, one would prefer the lowest information criterion. The Hannan-Quinn information criterion (HQC) is an alternative to the Akaike information criterion, with a less common use.

D) Returns overview

As we aim to test overreaction over negative returns on the chose indexes, we must observe negative returns during the event window. You will find enclosed below a table with a summary of the returns on each period.

<table>
<thead>
<tr>
<th>Indexes</th>
<th>CAC40</th>
<th>FTSE</th>
<th>DAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returns 58 days pre-event</td>
<td>0.94%</td>
<td>-0.63%</td>
<td>-2.30%</td>
</tr>
<tr>
<td>Returns event window</td>
<td>-12.10%</td>
<td>-14.00%</td>
<td>-14.92%</td>
</tr>
<tr>
<td>Returns 58 days post-event</td>
<td>6.39%</td>
<td>4.83%</td>
<td>-1.33%</td>
</tr>
</tbody>
</table>

*Table – Returns on the different periods for CAC40, FTSE, DAX*

In order for the returns observed during the event to be comparable with pre-event and post event-period, we computed the returns 58 days before and 58 days after event window. During the event window, from June 4th 2015, day of the Greek’s demand of postponement on an IMF loan to August 24th (10 days after of the agreement approval by the Greek parliament), the studied indexes posted heavy losses. The CAC40 lost 12.10%, FTSE 14% and the DAX 14.92%.

However, the performances following the event window showed adjustment for the main French and British market except for the DAX which kept underperforming.

E) Volatility study

As to study the volatility, we decided to compute the standard deviation of log returns on all three indexes. For determining the pre-event windows and post-event windows, we followed the same methodology as explained in the returns. You will find below the excel outputs summary:
Table – Standard Deviation outputs on different periods for CAC40, FTSE, DAX

<table>
<thead>
<tr>
<th>Indexes</th>
<th>CAC40</th>
<th>FTSE</th>
<th>DAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. std 58 days pre-event</td>
<td>4,69%</td>
<td>3,17%</td>
<td>6,50%</td>
</tr>
<tr>
<td>Av. std event window</td>
<td>7,53%</td>
<td>4,98%</td>
<td>7,30%</td>
</tr>
<tr>
<td>Av. std 58 days post-event</td>
<td>7,16%</td>
<td>7,45%</td>
<td>8,57%</td>
</tr>
<tr>
<td>Average std total sample</td>
<td>5,16%</td>
<td>3,84%</td>
<td>5,20%</td>
</tr>
</tbody>
</table>

As expected, the monthly standard deviation increased from the chosen pre-event window to the event window. However, this increase is not considered dramatic (+2,83%, 1,81%, 0,80% for CAC, FTSE & DAX respectively) but still observable. As we could expect the volatility to decrease following the events, we observed different trends during the post-event period.

- The monthly volatility on the French market remained stable: -0,37%
- The monthly volatility on the British market kept increasing by 2,47%
- The monthly volatility on the DAX kept increasing as well by 1,27%

Our intuition behind this phenomenon would be that, a couple of days after the end of the Greek crisis, markets were worried about the Chinese equity krach which did not bring necessarily negative returns but more volatility.

F) Models estimation

The models were estimated through OxMetrics (G@RCH). You will find the output summary below. Every estimation was conducted on the dlog of prices.
All models were first formulated and estimated with an order of (1,1). It appears that the GJR model with a Student Distribution fits most to our pre-event sample on the French CAC40, with a Schwarz of -6,3599, an Akaike of -6,4021 and a Hannan-Quinn of -6,3857.

Concerning the Event window, the best model is an IGARCH with a normal distribution. The information criteria are the following: Schwarz of -5,6938, Akaike of -5,7841 and Hannan-Quinn of -5,8298.

As for the post-event period, the goodness of fit is best for the GJR model with a normal distribution. The Schwarz is equal to -5,4534, the Akaike to -5,5861. However, the Hannan-Quinn indicates a GED distribution with a value of -5,5663.

We now estimated the best model order for our subsamples; up to 4 lags in order to avoid over-fitting.
Concerning the pre-event period, the Schwarz and Hannan-Quinn criteria indicate an order of (1,1) while the Akaike points at an order of (3,2) with values of -6,3599; -6,3857; -6,4086 respectively.

As for the event window, the Schwarz criterion indicates an order of (1,1) while Akaike and Hannan-Quinn point at an order of (4,2).
Table – CAC40 Estimation of the model orders for the post-event window

The information criteria are unanimous on an order of (1,1) for the post-event period on the French market.
As for the pre-event period, the information criteria are unanimous and indicate a GJR model with a GED distribution. The Schwarz is equal to -6.3315, the Akaike to -6.3739 and the Hannan-Quinn to -6.4575. During the event period, the goodness of fit is best for the IGARCH with a normal distribution. The Schwarz is equal to -5.6625; the Akaike to -5.7986 and the Hannan-Quinn to -5.7528. During the post event window, all 3 information criteria indicate a GJR model with a Normal distribution. The Schwarz is equal to -5.3108; the Akaike to -5.4452 and the Hannan-Quinn to -5.3909.
Concerning the pre-event period, the Schwarz indicates an order of (1,1) while the Akaike opts for a (4,4) order and the Hannan-Quinn for a (4,3) order.

Table – DAX Estimation of the model order for the event window

The information criteria are unanimous on an order of (3,2) for the post-event period on the German market.

Concerning the pre-event period, the Schwarz indicates an order of (1,1) while the Akaike opts for a (1,3) order and the Hannan-Quinn for a (4,4) order.

Table – DAX Estimation of the model order for the post-event window
As for the pre-event period, the information criteria are unanimous and indicate a GJR model with a GED distribution. The Schwarz is equal to -7,0334, the Akaike to -7,0754 and the Hannan-Quinn to -7,0591. During the event period, the goodness of fit is best for the IGARCH with a normal distribution. The Schwarz is equal to -6,5439; the Akaike to -6,6799 and the Hannan-Quinn to -6,6342. During the post event window, both Schwarz and Akaike indicate a GJR model with a normal distribution. The respective values are -5,8922 and -6,0266. The Hannan-Quinn criteria opts for a GED distribution (Value: -6,0338).

Table – FTSE 100 Models formulations & estimations of order (1,1)
The information criteria are unanimous on an order of (1,1) for the post-event period on the British market.

**Table – FTSE Estimation of the model order for the event window**

Concerning the event window, both Schwarz and Hannan-Quinn indicate an order of (2,2) while the Akaike shows an order of (3,2).

**Table – FTSE Estimation of the model order for the post-event window**
The information criteria are unanimous on an order of (1,1) for the post-event period on the British market.

G) Interpretation of the results

We first identify an increase in volatility and significant negative returns during the event period, non-exhaustive signs of overreaction in Financial Markets.

After estimating the proposed statistic models on our subsamples, it appears that the data follows the same path (as shown in the scheme below).

![Diagram showing GJR, IGARCH, and GJR models for pre-event, event, and post-event periods.]

Concerning the pre-event period and the best fit of a GJR model, our findings are consistent with DeBondt and Thaler (1985). Markets naturally overreact to new information, leading to significant price drifts. Moreover, our results converge with the research presented in our literature study: in a normal market environment, the conditional mean and variance tend to be asymmetrical (Dima Alberg, Haim Shalit, and Rami Yosef, 2008). Moreover, the distributions fitting the best the pre-event sample data are Generalized Error Distribution (FTSE & DAX) and Student Distribution (CAC). This founding is coherent with previous research and was expected: one of the main characteristic of financial data is its fat tails.
Concerning the event period, the best fit is an IGARCH model with normal distribution (CAC and FTSE) and IGARCH with student distribution (DAX). This result is surprising. We recall that the Integrated GARCH (IGARCH) possesses a property called “persistent variance”. The current information is then capital to estimate the conditional variance over all horizons of time. We need to define how long can shocks to conditional variance can persist. If the returns on a given sample follow an IGARCH, its unconditional variance is infinite, the square returns would not meet the definition of the covariance stationary process.

As for the post event period, the best fit is a GJR model with a normal distribution for all three markets. The fact that the best model is a GJR for both pre-event and post-event implies a come back to stationary world. The normal distribution is the best fit for the post-event subsample, mainly because the fat tails included in the GJR as well as more than one parameters take care of the fat-tails representative of financial data.

By studying the relationship among those findings, we have the following interpretation: since we are expecting overreaction, the information included in the conditional mean before and after is stationary. However, it is not when the event is integrated. During the pre-event period and post-event period, we expect overreaction and the probabilities distribution does not shift through time. However, it does shift during the event period. Non stationary data, as a rule cannot be modeled and hardly forecasted.
H) Possible sample biases

While trying to interpret the results of this study, it is important to assess any possible bias that could compromise the estimations’ results. We recall that:

- The **Event Window** starts from January June 30\(^{th}\) 2015, day of the Greek partial default on the IMF loan to August 14\(^{th}\), day of the agreement approval by the Greek parliament.
- The **Post-Event Period** goes from August 15\(^{th}\) to the end of the sample (January 2\(^{nd}\) 2016).

Then, the first possible bias we identify would be our small subsample for the Event and Post-Event estimations.

Moreover, the Chinese liquidity crisis could be as well a potential bias for our event and post-event period. The Chinese stocks market crash started on the 24\(^{th}\) of August 2015, at the edge of the Greek crisis ending, which could have impacted our estimations.
VI – Conclusion

This paper aims at testing any French, British and German overreaction on their main equity indices during the last Greek debt crisis of 2015. Through the literature review, we study the fact that the public and private sectors in the studied countries reduced significantly their exposure to Greek public and private debt.

Our sample data starts from January 2\textsuperscript{nd}, 2013 to January, 2\textsuperscript{nd}, 2016. In order to obtain proper estimation and results, we define the following subsamples: The Pre-Event Period starts from January 2\textsuperscript{nd} 2013 to June 29\textsuperscript{th} 2015, eve of the Greek partial default. The Event Window starts from June 30\textsuperscript{th} 2015, day of the Greek partial default on the IMF loan to August 14\textsuperscript{th}, day of the agreement approval by the Greek parliament. The Post-Event Period goes from August 15\textsuperscript{th} to the end of the sample (January 2\textsuperscript{nd} 2016).

In order to test for overreaction, we first studied both returns and volatility: we do observe significant negative returns during the event period as well as an increase in volatility, non exhaustive signs of overreaction.

The Overreaction Hypothesis suggests that the conditional mean and variance are asymmetric: negative shocks in returns will therefore bring more volatility. We decided to estimate 4 different models (GARCH, EGARCH, IGARCH, GJR) with 3 different distributions (Normal, Student, GED) on our subsamples. Our best fit for pre-event period and post-event period is a GJR model, allowing for overreaction. As for the event period, our best fit is a IGARCH model. We obtain consistent results with previous research on the subject for both pre-event periods and post-event periods: financial data is usually overreacting to negative news. However, it appears that we are
leaving the stationary world for the event period – the probabilities distribution shifts over time – making the returns unforecastable and hardly modelable.

Testing for overreaction in the short term and with a subsample division is a very challenging prospect – nonetheless not very reliable through statistic models estimations. Another way for future research on this subject would be to estimate regressions and compute abnormal returns following each and every event of the crisis.


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