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Q1 # Does the Euro crisis change the cross-correlation pattern between bank shares and national indexes?

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HIGHLIGHTS

- We study the relationship between bank shares and the respective national index.
- We analyze 39 banks in 13 Eurozone countries and 24 banks in 8 non-Eurozone countries.
- In the Eurozone, 19 banks show increasing correlation, mainly in critical markets.
- In countries outside the Eurozone, we found 14 banks with an increasing correlation.
- Results could indicate some risk of economic instability in the future.

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ABSTRACT

The objective of this paper is to analyze if the Euro crisis, which started in 2009, changes the cross-correlation pattern of bank shares with the national stock indexes in both in Eurozone and non-Eurozone countries. We study all banks listed in the main stock indexes of European Union countries, applying the detrended cross-correlation coefficient. An increase in the correlation indicates that the banking sector now has a greater influence in the national index, while a decrease in the correlation means the opposite. Our results show that 19 of the 39 banks analyzed in the Eurozone increased their correlation with national indexes, whilst in the non-Eurozone countries this happened with 14 of the 24 studied banks. While some authors argue that the crisis may have been aggravated by the weight of banks in the economy, Eurozone policy makers should pay attention to this feature.

1. Introduction

On 20th October 2009, the Greek Prime Minister disclosed that the country's budget deficit was expected to reach approximately 12.5% of GDP, greatly exceeding the threshold of 3% of GDP set in the Stability and Growth Pact signed by Eurozone member states. This episode caused rating agencies to downgrade the Greek credit rating which had a direct influence on the banks' ratings. Moreover, the Greek crisis had a spiral effect on other Eurozone banks, with several bankruptcies and recapitalizations (mostly in Greece, Ireland, Spain and Portugal). High levels of public and private debt, banks' exposure to debt and the great weight of banks in some economies are some of the reasons for this major banking crisis which also had severe consequences in European economies (see, for example, Ref. [1] or [2], among others).

In this paper, we will analyze the European Union banks. Dividing our sample into before the crisis and after the beginning of the crisis (with that date as the benchmark), we will use detrended cross-correlation analysis (DCCA) and its correlation

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coefficient to analyze if the Euro crisis changed the cross-correlation pattern of bank shares with national indexes. We perform the same analysis for Eurozone and non-Eurozone banks, in order to compare if the Eurocrisis had a similar effect on these banks.

DCCA [3] is an original methodology from physics that have been used widely in other research areas, namely in economics and finance. In fact, the particular interest of physics researchers in studying problems in economics with statistical physics methodologies, allowed the appearance of Econophysics, as an interdisciplinary research field. Although numerous studies apply this kind of methodologies, as far as we know no studies analyze the bank stock market of the European Union as a whole.

Regarding the financial aspect, the importance of studying the behavior of stock markets is related not only with possible trade strategies and portfolio constructions but in this particular case, could also be used by the decision makers, to decide financial policies. In fact, an increased correlation between bank shares and the respective national index is the result of a stronger linkage between national indexes and the banking sector in general. If banks are not secure, due to their possible exposure to risks, economies could suffer from contagion.

Therefore, this paper is organized as follows: in Section 2 we present the methodology and data used in our analysis, Section 3 describes the results, first for the Eurozone banks and then for other banks; and Section 4 concludes.

2. Methodology and data

2.1. Methodology

In this paper, we use detrended cross-correlation analysis (DCCA), a methodology to study long-range cross-correlation between time series.[1] Created by Podobnik and Stanley [3], it can be described by the following steps: considering the data given by x_k and y_k with $k = 1, \ldots, t$ equidistant observations, the first step of DCCA is obtained by integrating both series, calculating new series given by: $x(t) = \sum_{k=1}^{t} x_k$ and $y(t) = \sum_{k=1}^{t} y_k$. After the integration of those series (with N samples), they are divided into boxes of equal length, n. Afterwards, we divide them into $N - n$ overlapping boxes and in each box the local trend ($\tilde{x}_k$ and $\tilde{y}_k$) is defined, with ordinary least squares. Then, the detrended series is calculated, obtaining the difference between original values and the trend. Next, we calculate the covariance of the residuals in each box given by $f_{DCCA}^2 = \frac{1}{n-1} \sum_{k=i}^{i+n} \left(x_k - \tilde{x}_k\right) \left(y_k - \tilde{y}_k\right)$. Finally, the detrended covariance is calculated summing all $N-n$ boxes of size n, given by $F_{DCCA}^2(n) = \frac{1}{N-n} \sum_{i=1}^{N-n} f_{DCCA}^2$. This process is repeated for different length boxes in order to find the relationship between the DCCA fluctuation function and n, to find the long-range cross correlation $F_{DCCA}(n)$ given by the power law $F_{DCCA}(n) \sim n^{\lambda}$. The λ exponent could be interpreted as follows: if λ is greater than 0.5 means persistent long-range cross-correlations while values lower than 0.5 mean anti-persistent cross-correlation.[2]

Although DCCA gives information about cross correlation between series, it does not quantify that relation. In order to make that quantification, Zebende [7] created the correlation coefficient given by $\rho_{DCCA} = \frac{F_{DCCA}^2}{F_{DFA\{xi\}}F_{DFA\{yi\}}}$. This correlation coefficient is calculated using results from DCCA between x and y and from detrended fluctuation analysis (DFA) for each series. It has the general properties of one correlation coefficient, namely $-1 \le \rho_{DCCA} \le 1$. A value of $\rho_{DCCA} = 0$ means that there is no cross-correlation between series, while a positive or negative value means, respectively, evidence of cross-correlation or anti cross-correlation between series. This correlation is debated on Zebende et al. [8], and its efficiency is shown in Ref. [9]. The significance of that coefficient could be tested, with the procedures indicated by Podobnik et al. [10].

It is also important to refer that if a researcher is aware of some hidden influence that commonly affects both of the series that he wants to study, it is preferable to use the detrended partial cross-correlation analysis [11].

We can also find some studies applying DCCA and its correlation coefficient to stock markets: those by Ferreira and Dionísio [12], Silva et al. [13] or Rak et al. [14] are just some of the examples. Once again, we cannot find studies applied to the Eurozone banks, although it is possible to find some analysis comparing non-financial and financial firms (see Ref. [15], analyzing US firms).

2.2. Data

The object of this study is to analyze whether the Eurocrisis had any influence on changing the pattern of cross-correlation between banks' shares and the correspondent country's index. Considering that we will center on the Eurocrisis, we collected information from the beginning of the European common currency (January 1999). Our total sample is divided into two different groups: the period before the crisis (from January 1999 to 19th October 2009) and the period after the crisis (from 20th October 2009 to 11th March 2016). The first subsample contains 2816 observations and the second 1669.

[1] Other methods could be studied to analyze long-range cross-correlation between time series, such as the time-lag random matrix theory, used in Ref. [4] or [5].

[2] DCCA was not originally created to study the behavior of financial time series. See, for example, the work of Filho et al. [6], which analyzes the crime time series.

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