



# Sovereign debt crisis in the European Union: A minimum spanning tree approach

João Dias\*

*ISEG-Technical University of Lisbon and UECE, Rua do Quelhas, 6, 1200-781 Lisbon, Portugal*

## ARTICLE INFO

### Article history:

Received 24 March 2011

Received in revised form 30 September 2011

Available online 17 November 2011

### Keywords:

Minimum spanning tree

Sovereign debt

Government bonds

Crisis

## ABSTRACT

In the wake of the financial crisis, sovereign debt crisis has emerged and is severely affecting some countries in the European Union, threatening the viability of the euro and even the EU itself. This paper applies recent developments in econophysics, in particular the minimum spanning tree approach and the associate hierarchical tree, to analyze the asynchronization between the four most affected countries and other resilient countries in the euro area. For this purpose, daily government bond yield rates are used, covering the period from April 2007 to October 2010, thus including yield rates before, during and after the financial crises. The results show an increasing separation of the two groups of euro countries with the deepening of the government bond crisis.

© 2011 Elsevier B.V. All rights reserved.

## 1. Introduction

In the aftermath of the recent financial and economic crisis, many European Union (EU) member states, as well as countries in other regions, have significantly raised their budget deficits and public debts. One such example is the case of Greece, which recorded a government debt and budget deficit representing 126.8% and 15.4% of Gross Domestic Product (GDP) respectively in 2009. This unsustainable situation created difficulties in accessing international financial markets and a new crisis emerged, this time related to government bonds.

After Greece, Ireland became the next country to draw on financial assistance from the EU and the International Monetary Fund (IMF), with Portugal following some months later. Spain also has been impacted by high government bond yield rates although its budget and debt problems are not of the same magnitude as those of the other three countries. Nevertheless, strong pressure has loomed over the euro area, given that other countries, such as Italy or Belgium, have also accumulated large public financial imbalances. There is now an increasingly widespread fear that the Euro might be in jeopardy, with even the European Union itself called into question as a project for economic and political integration in Europe, should this crisis not be contained.

In this paper, sovereign debt crisis in the European Union is analyzed with tools developed and largely applied in the field of econophysics. The euro area is of particular concern and, thus, the main focus of the paper lies in the network topology of the eurozone members. The minimum spanning tree (MST) provides the main analytical approach and the dynamics of daily government bond yields are investigated using rolling windows of three months, from April 2007 through October 2010. Our methodology is similar to that used in a recently published paper in this journal [1], related to comovements in government bond markets over 1993–2008. Like in this latter paper, we also base our analysis on minimum spanning trees, hierarchical trees and use rolling windows. However, our subject is different, since we are interested in the analysis of the current sovereign debt crisis in the EU. Although we use 10-year government bond yield rates as well, the country

\* Tel.: +351 213925852; fax: +351 213971196.

E-mail address: [jdias@iseg.utl.pt](mailto:jdias@iseg.utl.pt).

**Table 1**  
Country groups, abbreviations and group symbol.

Abbrev.	Country	Euro	Group	Symbol
AT	Austria	1999	E5, E7	□
BE	Belgium	1999	E7	□
CZ	Czech Republic	–	NE6	○
DK	Denmark	–	NE6	○
FI	Finland	1999	E5, E7	□
FR	France	1999	E3, E5, E7	□
DE	Germany	1999	E3, E5, E7	□
GR	Greece	2001	G4	■
HU	Hungary	–	NE6	○
IE	Ireland	1999	G4	■
IT	Italy	1999	E7	□
NL	Netherlands	1999	E3, E5, E7	□
PL	Poland	–	NE6	○
PT	Portugal	1999	G4	■
SK	Slovakia	2009	–	◡
SI	Slovenia	2007	–	◡
ES	Spain	1999	G4	■
SE	Sweden	–	NE6	○
UK	United Kingdom	–	NE6	○

composition (only EU countries), period under analysis (last four years) and even frequency of data (daily values) are quite distinct. Besides, we use a larger set of measures in the rolling windows.

In addition to this Introduction, the paper is structured as follows. Section 2 briefly describes the data used. Section 3 explains the methodology adopted and Section 4 presents the results obtained. Finally, Section 5 draws the main conclusions.

## 2. Data characterization

We analyze daily yield rates on 10-year government bonds for nineteen EU countries. Thirteen of them belong to the euro area: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Slovakia, Slovenia and Spain. However, Slovakia and Slovenia only recently became members of the eurozone. The six non-Euro countries are the Czech Republic, Denmark, Hungary, Poland, Sweden and the United Kingdom. Table 1 lists all the countries and groups in the sample, their abbreviations and the year they adopted the euro.

The data for all countries corresponds to the Thomson Reuters Government Bond Indices and are end-of-day 10-year government bond yields as calculated by Datastream. All data are valued in local currencies and were obtained from this last database.

The sample covers the last four years, from the beginning of April 2007 to the end of October 2010, with a total of 933 observations. This corresponds to distinct phases in the current economic and financial crisis, although we do not pretend here to provide any rigorous characterization of it. Accordingly, the sample is split into three periods. The first (*P1*) includes the observations from April 2007 up to the end of August 2008 and largely corresponds to pre-crisis data, even though the last months already show significant declines in stock markets all over the world. Period two (*P2*) covers the most critical financial crash from September 2008 up to December 2009. Finally, the last period (*P3*), from January to October of 2010, shows some economic and financial recovery in many countries but exposes deep budget problems in others and gives rise to a new crisis, this time related to government bonds.

Fig. 1 illustrates this periodization with the evolution of the S&P 500 index (S&P500) and 10-year government bond yield rates for Greece (Greece\_Y10). In the first period, in spite of a substantial reduction in the stock market index, no clear trend is observed in the case of bond yield rates, whose values ranged from 4.21 to 5.31. During the second period, the crash also generated some concerns with government bonds and yield rates jumped to a maximum of 6.18. However, the recovery in stock markets was accompanied by some pressure relieve on government bond yield rates during most of the second half of 2009. These rates exploded in the third period, from a minimum of 5.55 to a maximum of 12.27 and this peak was followed by some decline in the S&P500.

On average, yield rates have been decreasing from the first to the last period. Fig. 2 shows the evolution of the average and standard deviation computed over the 19 countries. Average values were reduced by around ten percent between the first

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات