Analysis of the European Government Bonds and Debt after the European Financial Crisis

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Abstract
Purpose – The objective of this paper is to determine the effects of the European debt crisis on the European government bonds.
Design/methodology/approach – In this paper, we present the European government bond; we explain the European debt crisis; and we examine the evolution of the European debt.
Findings – Our results suggest that the increase of the European debt contributed to the increase of the risk and the default of the European debt and to the depreciation of the economies of the European countries.
Originality/value – We calculate the value of the European debt risks in normal cases and in the case of crisis with normal distribution.
Keywords: European debt crisis, government bond market, Eurozone
Paper type: Research paper

JEL Classification codes: G18, G38, H63

The financial crisis of 2008 generated a recession in many European countries. It has had implications on the banking system, on the real economy, and on the economic dynamics. To prevent this situation, the European countries have increased their debt, which has led to deterioration in their budget balances. The European bond yields began to increase rapidly, especially in countries with a weakened macroeconomic situation and a vulnerable banking sector.

There are several motivations for this study. Firstly, we present the European government bonds - we present the factors and the microstructure of the European corporate bond market. Secondly, we explain the European financial crisis. We intend to present the European debt crisis and we examine its implications on the financial markets and the authorities' reactions regarding policies. Finally, we develop an empirical analysis to explain the volatility of the European debt during the crisis period. In this paper, we use the European debt density to analyze its effectiveness and severity for the last 10 years before the crisis (1999–2008) and to make a comparison between two periods: five years before the crisis (2004–2008) and five years after the crisis (2009–2013).

The paper is organized as follows: The first section presents the European government bonds, followed by a presentation of the European financial crisis in the second section. The

next section discusses the empirical analysis and summarizes the results, and the final section presents the conclusions.

Presentation of the European Government Bonds

The government debt in many developed countries is comparable to the sizes of their economies. It is issued by a government to cover budget deficits and to refinance debts. It's a main indicator of the economic behavior and is calculated as the difference between spending and the Gross Domestic Product (GDP) of a country. The conventional solution to reduce the debt is the budget surplus. Also, governments can create money to monetize their debts but this practice can result in hyperinflation.

Governments usually borrow by issuing government bonds, bills, and securities. Occasionally, some countries borrow directly from an organization (International Monetary Fund [IMF] and the World Bank) or international financial institutions. As the government draws the majority of its income from the population, government debt is considered as an indirect debt of the taxpayers. Government debt can be categorized as an internal debt (owed to lenders within the country) and external debt (owed to foreign lenders). Also, governments bonds in foreign currencies are referred to as "sovereign bonds".

Issues of government bonds take place on the primary market in which investors receive a periodic interest payment during the fixed term of the government bond. After the maturity date, the government must repay the value of the debt. In addition, government bonds are traded on the secondary market. Companies and other enterprises also issue bonds in order to raise financial assets, but government bonds are considered by investors as safe investments. International credit rating agencies will provide ratings for the bonds, but market participants will make up their own opinions.

There are three risks of government bonds: credit risk (when a government defaults on its domestic currency debt, such as Russia in 1998), currency risk (when the value of the currency of government bonds declines when compared to the holder's reference currency), and inflation risk (when the value of the government bonds declines over time and the risk emerges when the inflation rate is higher than expected).

The bond market plays a very important role in the financial systems. It brings lenders and borrowers together. It allows lenders to invest in relatively low risk assets and borrowers to obtain funds in relatively liquid markets. Bond markets are important in determining the prices of other assets and bank interest rates usually follow the market-determined interest rates on bonds. Faini (2004) estimated a positive impact of the government debt on the ex-post real interest rates in 10 European countries.

An important bond market should operate well, this means both efficiency and liquidity. Efficient bond prices, incorporating all available information, will be a better signal to investors. Liquid bond markets bring transactions costs down for investors. Bagliano, Brandolini, and Dalmazzo (2000) found that small trades will be able to obtain better execution quality on limit-order markets and that large traders will seek to trade with dealers.

According to the Dutch State Treasury Agency, the global government bond market amounted to EUR 26.3 trillion at the end of February 2010. The United States of America has the largest share of the market, followed by the European Union (EU). The European governments delegate the issuance of their government bonds to institutions known as Debt

Management Offices (DMOs). In Europe, bonds amount is approximately two-thirds of the total amount of outstanding securities and the bond market is dominated by government bonds and bonds issued by financial intermediaries. However, the distribution of the total debt differs significantly between Europe and the United States. According to Figure 1, we note that the share of government bonds is important in the European financial market. Once government bonds are issued, they become available for trading by investors. This is known as the secondary market.

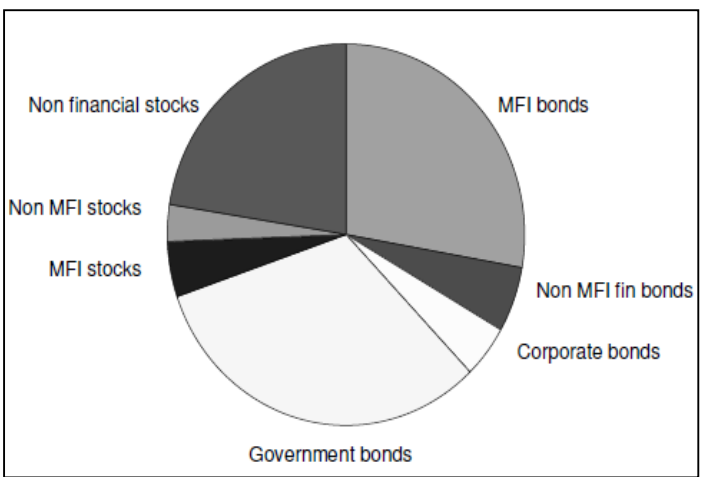

Figure 1. Outstanding amount of stocks and bonds in 2005 in Eurozone.

Investors want to be able to take positions in a well-founded way in a market which they can trust. Liquidity, efficient price formation, and ratings are contributory factors. Investors in the government bond market are looking for relatively safe investments. Downgrades will, therefore, lead to relatively high volumes of sales, but this situation will lead to further price declines and can threaten the stability of the system. These procyclical effects were observed in various markets, including the Greek market, in the form of reductions in credit ratings for these bonds, which led investors to liquidate their positions. This created downward pressure on prices in the market.

It is difficult to supervise the trading in government bonds. Government bond trading is dominated by large players executing large transactions. Large investors have access to pre-trade information, but only the large dealers have access to a significant part of the post-trade information. For that, investors need transparency. Flood, Huisman, and Mahieu (1999) found positive benefits of post-trade transparency.

On the other hand, transparency could reduce the supply of liquidity. If an investor tries to resell a part of his purchase, his competitors may be tempted to react opportunistically and they will raise the prices. According to Naik, Neuberger, and Viswanathan (1999), less transparent competitive dealership markets may benefit participants of any type when there is significant competition for order flow. Also, Pagano and Roell (1996) did not clearly separate transparency between pre-trade and post-trade, but they found that uninformed investors benefit from pre-trade transparency. Another argument against transparency is that it could reduce information acquisition and revelation in the market place. Because transparency reduces the rents earned by informed traders, it reduces the incentives to acquire information.

The transparency of the secondary markets for corporate bonds is currently heavily debated on both sides of the Atlantic.

According to Eurostat, the economy of the EU generated a GDP of over EUR 12.894 trillion in 2012, which made it the largest economy in the world. The European Monetary Union (EMU) represents a supranational construction, which used to have beneficial effects on the financial stance of each of its members. The microstructure of the European corporate bond market is characterized by:

- The differences among bonds are less marked because when an investor desires to trade a certain category of bonds, it will not only ask for a quote, but it will also enquire about which bond is for trade at the moment.
- It is difficult and costly to short sell bonds. This further reduces the liquidity of the bond market.
- The characteristics of the bonds' payoffs (redemption date and relative safety) concern generally two types of investors: pension funds and insurance companies.
- The bond market is much less concentrated than the stock market. Each issuer has several bonds outstanding. In the bond market, large operators will have an interest only in a subset of securities. Hence, in the bond market it will be much more difficult to identify counterparty than in the stock market.

The European corporate bond market is an over-the-counter market, revolving around dealers and brokers. Brokers in the European corporate bond market are not explicitly rewarded by commissions. In their trades, they receive the bid-ask spread between the price paid by the buyer and the price received by the seller. Because of their permanent presence on the market, dealers and brokers are in a good position to cope with the informational problems arising in the bond market. They have good private information about which bonds are relatively easier to trade and about who is interested in trading.

Traditionally, interaction in the bond market has taken place by telephone. Investors could call dealers on the phone and negotiate over the price. Also, they have the option to call another dealer or they could call a broker who could simultaneously call several dealers. However, this technology limits the number of dealers that the investors can contact. Now, electronic communication complements the telephone. Investors, dealers, and brokers communicate through Bloomberg screens and messaging systems. Also, investors can purchase access to real-time information from Bloomberg. Recently, electronic trading platforms have been developed. They can be put in place by a single dealer or by several dealers, to offer its/their customer pricing information. One of the most successful platforms in the European corporate bond market is MarketAxess, which relies on 20 dealers and 360 clients and facilitates trading in approximately 5,000 bonds in Europe. Thus, electronic communication and trading platforms have enhanced transparency and efficiency in the markets. Over time, the investors may expect further growth of electronic trading systems with beneficial effects on competition and transparency.

The European bond market is decentralized, but it's regulated by the International Capital Market Association (ICMA). Also, the Financial Services Authority (FSA) plays a key role in the regulation of the European bond market. Other regulators concerned with this market include the London Stock Exchange and the *Autorité des Marchés Financiers* (AMF) in France. All the London-based members of ICMA (the majority of dealers in the European

corporate bond market) and all members of the Council of Reporting Dealers have to report their trades to this self-regulatory organization through the "TRAX" system.

Currently, there is no systematic post-trade transparency in the European corporate bond market. For large investors, there is a significant amount of pre-trade transparency because institutions can obtain competing firm quotes from dealers through electronic trading platforms or brokers. In addition, information on quotes is disseminated via Bloomberg messaging. In contrast, for retail investors and small institutions, there might be little transparency in the bond market, be it pre- or post-trade.

An important example of electronic quote dissemination in the bond market is offered by the International Index Company (IIC), which computes and disseminates iBoxx indices. iBoxx indices are computed for hundreds of Euro-denominated bonds and hundreds of Sterling bonds. Ten dealers (ABN Amro, Barclays Capital, BNP Paribas, Deutsche Bank, Dresdner Kleinwort Wasserstein, HSBC, JP Morgan, Morgan Stanley, Royal Bank of Scotland, and UBS Investment Bank) transmit an indicative bid and ask quotes to the "Deutsche Börse" every minute for every bond in the iBoxx universe. Once IIC receives these data, it conducts quality controls. Then, average ask prices and bid prices are computed for each bond. IIC sells the data in real-time through vendors, such as, Bloomberg, Telerate, Telekurs, Reuters, etc. In addition, daily closing prices can be freely observed on the IIC website.

Analysis of the European Financial Crisis

The crisis is an unusual situation characterized by its instability and requires the adoption of specific governance to return to normal mode. The most famous notion of crisis is the financial crisis which affects the financial markets and slows down the global economy. Kindleberger (1978) and Gorton (1988) noted that crises tend to occur near the peak of a business cycle, and suggested that changes in the expected profitability of firms lead to either a contraction in lending or a banking/financial crisis or both. Also, many financial crises were associated with banking panics, stock market crashes, and currency crises. Sprague (1910) claimed that the financial market could normally withstand such a financial market shock without much issue.

The term financial crisis is applied when some financial assets suddenly lose a large part of their value. Many financial crises were associated with banking panics and many recessions include stock market crashes, currency crises, and sovereign defaults. Financial crises directly result in a loss of wealth, but do not necessarily result in changes in the real economy. We can define three types of financial crises: banking crisis, international financial crisis (forced to devalue currency), and wider economic crisis (recession with negative GDP growth). Friewald, Jankowitsch, and Subrahmanyam (2012) showed that liquidity effects are more pronounced during periods of financial crises, especially for bonds with high credit risk.

The debt crisis is a situation where a country cannot service its debts, often leading to calls to other countries for assistance in the form of a bailout. According to Reinhart and Rogoff (2009), sovereign debt crises have been recurrent events over the past two centuries. Also, sovereign debt crises have been increasingly linked to the banking sector. Reinhart and Rogoff (2011) concluded that the banking crises typically precede or coincide with sovereign debt crises.

The debt crisis deals with countries and their ability to repay borrowed funds. Therefore, it deals with national economies, international loans, and national budgeting. The most basic definition that all agree on is that a debt crisis is when a national government cannot pay the debt it owes and seeks, as a result, some form of assistance. Tomz and Wright (2007) documented 250 sovereign defaults by 106 countries between 1820 and 2004. According to Beers and Chambers (2006), the amount of sovereign debt in default peaked at more than USD 335 billion in 1990. This debt was issued by 55 countries.

Also, the debt crisis can affect the economy because debts have to be paid back in the creditors' currencies in time. This may have exacerbated the harmful environmental practices that prevail in many countries, as governments and entrepreneurs mine their natural resources in order to generate hard cash. According to Cruces and Trebesch (2013), most sovereign default episodes are followed by a settlement between creditors and the debtor government. The settlement may take the form of a debt exchange or debt restructuring, and the new stream of payments promised by the government generally involves some combination of lower principal, lower interest payments, and longer maturities.

The financial crisis of 2008 is considered, by many economists, the worst financial crisis since the Great Depression. It resulted in the threat of total collapse of the United States' housing market and large financial institutions and in the downturn in stock markets around the world. The United States' housing market has turned especially when the sales and construction of new homes dropped steeply in 2007. This decline was related to the boom in the mortgage markets from the increase of subprime lending, which contributed to the increase of home ownership rates, the overall demand for housing, and the housing prices. Housing prices peaked in early 2006, started to decline in 2006 and 2007, and reached new lows in 2012. Fortowsky and LaCour-Little (2002) considered that many factors, including borrower credit history and prepayment risk, can substantially affect the pricing of loans. According to Gerardi, Shapiro, and Willen (2007), the house price experience of individual households had a large effect on delinquency status.

In fact, the subprime lending creates the opportunity for homeowners – who not qualify for a mortgage in the past – to create wealth. According to Calem, Gillen, and Wachter (2004), subprime lending was most prevalent in neighborhoods with high concentrations of minorities and weaker economic conditions. Nevertheless, Pennington-Cross (2005) showed that nonprime loans were less sensitive to interest rate changes and, as a result, subprime borrowers had a harder time taking advantage of available cheaper financing.

Besides, the subprime lending has introduced a substantial amount of risk-based pricing into the mortgage market. Pennington-Cross (2005) found that credit-constrained borrowers with substantial wealth were most likely to finance the purchase of a home by using a subprime mortgage. It allowed the increase of the numbers of homeowners who did not understand the conditions. Bostic, Engel, Pennington-Cross, and Wachter (2008) showed that some lenders may have had difficulty to understand and comply with the new information in the first year when it was required. Besides that, many homeowners took a second mortgage secured by the price appreciation. Also, Bucks and Pence (2008) showed that households often did not understand the terms of more complex mortgage contracts and, therefore, did not understand how much their payment could increase when taking on a mortgage.

The financial crisis of 2008 can be attributed to a number of factors: high-risk mortgage loans, bad monetary and housing policies, the inability of homeowners to make

their mortgage payments, and especially weak financial risk management. It led to the failure of key businesses, declines in consumer wealth, a downturn in economic activity, a lack of homeowner refinancing of mortgages, a rising refinancing costs, homeowners' declining home equity, homeowners' deteriorating financial conditions, declines in consumer wealth estimated in trillions of dollars and a downturn in economic activity. It contributed to emerge the European debt crisis.

The European debt crisis turned into a massive public debt relative to tax revenues and the failure or refusal of the government of a sovereign state to pay back its total debt. The Eurozone crisis resulted from a combination of complex factors, including the easy credit conditions during the 2002–2008 period that encouraged high-risk lending and borrowing practices, fiscal policy choices related to government revenues and expenses, government program to bail out the banking systems, and international trade imbalances.

The Eurozone crisis is a financial crisis that has been affecting the countries of the Eurozone since early 2009, when a group of 10 central and some European banks asked for a bailout. The crisis made it difficult or impossible for some countries in the Eurozone to repay or refinance their government debt without the assistance of third parties, such as, the European Central Bank (ECB) or IMF.

The crisis introduced adverse economic effects directly or indirectly for the EU countries. Also, it had a major political impact on the ruling governments in eight out of the 17 Eurozone countries and led to power shifts in Greece, Ireland, Italy, Portugal, Spain, Slovenia, Slovakia, and the Netherlands. According to Figure 2, we notice the decrease of the long-term interest rate of the European government bonds before the introduction of Euro and those rates were similar after the introduction of Euro notes and coins. Nevertheless, we notice the increase of those rates at the beginning of the 2008 financial crisis and this situation got worse with the beginning of European debt crisis.

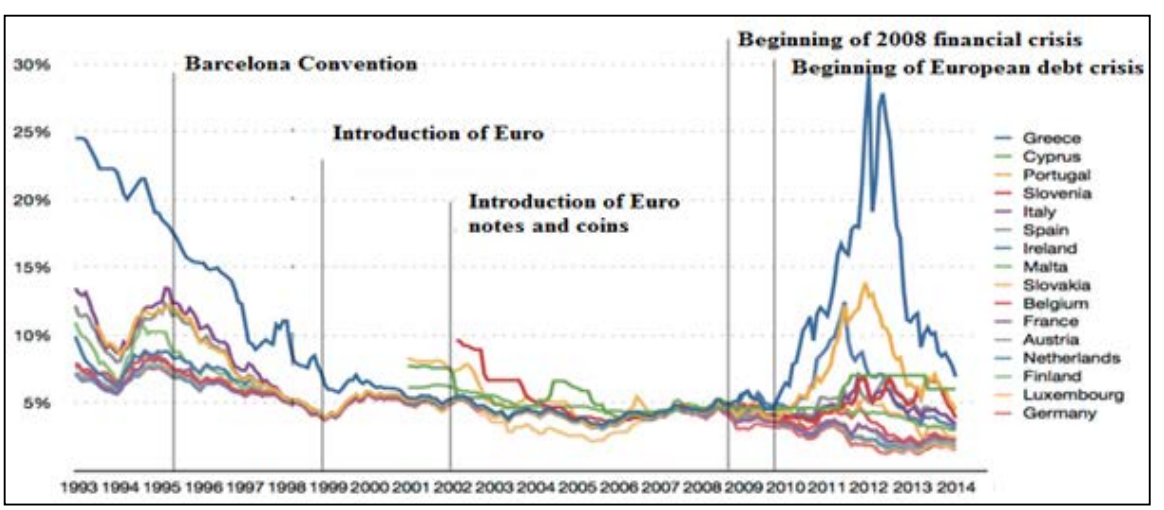

Figure 2. Evolution of the long-term interest rates of the government bonds in the Eurozone countries.

Beber, Brandt, and Kavajecz (2009) analyzed ten Eurozone sovereign markets and showed that most of the spread differences were accounted for by the differences in credit quality, although liquidity played a role for the bonds of higher-rated countries. Also, Bai, Julliard, and Yuan (2012) studied the Eurozone sovereign bond markets and concluded that

bond spread variations prior to the recent global financial crisis were mostly due to liquidity concerns but, since late 2009, they had been more attributable to credit risk concerns, exacerbated by contagion effects.

The European debt crisis escalated with the onset of the global financial crisis in 2008, but its origins are to be traced long before that. When they created the single currency, the European countries had taken care to put in place rules aimed at limiting the public deficits and public debt to prevent any risk of budgetary crises. On top of these general principles, there were certain numerical criteria to be respected in order to be able to join the single currency: a budget deficit of less than 3% of the GDP and a gross debt not exceeding 60% of the GDP. Unfortunately, not only were these rules not respected, but the monetary integration led to an unexpected divergence in the borrowing behavior of the various European countries. Towards the end of 2006, the gross public debt of the Eurozone countries was close to 75% of their GDP. Within the zone, the ratios varied widely from Ireland at one extreme with only around 30% to Greece and Italy at the other with 120%.

In addition, another debt level was imposed by the European Commission (EC), which compares the debt with the budget revenue. On this basis, the gross public debt of the Eurozone countries is at the equivalent of less than two years' tax revenue. If the debt is now measured on a net basis, the Eurozone figure falls to only around one year's tax revenue.

In the spring of 2011, the crisis entered a new phase. The budgetary restrictions introduced in Greece, as part of the program negotiated, led to a severe contraction in the activity and the country's economic and social disorganization was manifested. In mid-2012, it became clear that Greece could not return to the markets for financing. For that, it needed additional public financing and the private sector should have contributed to the financing of the government debt.

The implications of a financial crisis can be numerous and they can refer, especially, to the financial sector and the real economy. Cogman and Dobbs (2008) confirmed that the impact of previous crises on the real economy has not always been the same. The direction of the impact was due to the actions pursued by governments for recapitalizing banks, introducing stimulus measures and restoring investors' confidence in the economy. Also, according to Reinhart and Rogoff (2008), countries usually need two years in order to start recovering from past recessions after major banking crises.

One important aspect of the European debt crisis is that it has not impacted all European countries. In fact, there is a big divergence between the core countries (Germany and France) and the peripheral countries (Greece, Ireland, Portugal, and Spain): While the core countries have been enjoying an economic recovery since 2010, the peripheral countries are still struggling with recession.

Also, the recent crisis brought changes in the government debt issuance practices in the Eurozone countries. Before the crisis, these practices had converged to a common standard, which involved the placement of long-term and fixed rate debt denominated in the national currency via competitive auctions. De Broeck and Guscina (2011) explained that, after mid-2008, the standard could not be followed anymore because of the increase in the sovereign funding needs and the risk premia. They established a research on a sample of 3,000 debt issuances by governments in the Eurozone and Denmark during the period of 2007–2009 and they found that the new standard for issuing government debt was defined by shorter maturities, foreign currency denomination, and floating rates.

Therefore, the impact of the crisis forced governments to assume additional risks. This negative effect was especially pronounced in countries with high deficit and high debt. De Broeck and Guscina (2011) concluded that the mentioned change in the standard for government debt issuance allowed governments to deal with the reduced risk appetite of investors and to limit the impact of high deficits and debt on interest payments, but at the same time exposed them to significantly higher risks of refinancing and repricing, and sometimes to exchange rate risk as well.

Another implication of the crisis was that the use of complex financial instruments has been more and more questioned. Nelson, Belkin, and Mix (2010) reminded that during the crisis, the Greek governments used derivatives to conceal the true level of Greece's debt. For example, they traded currency swaps through which they were receiving upfront payments that – under the EU's accounting rules – could not be recorded as loans.

In addition, this crisis led to an increase of the general government deficit from 2.4% in 2008 to 6.9% in 2009 in the EU despite the decrease in 2011 and 2012. Also, the currency EUR/USD decreased from 1.75 on June 2008 to 1.38 on April 2014 despite the two period of increase in 2009 and 2011. Also, the rating agencies (especially Fitch, Moody's, and Standard & Poor's) decreased the note of several European countries debt which reflected the massif increase of the European debt. Bond ratings are important because of their role in informing investors and they affect the interest rate that companies and government agencies pay on their issued bonds. According to Figure 3, we notice the decrease of rating of several European countries debt in 2010 and 2011, following the European debt crisis. In January 2012, Standard & Poor's downgraded France and Austria from AAA rating, lowered Spain, Italy and, five other Eurozone members, and maintained the top credit rating for Finland, Germany, Luxembourg, and the Netherlands.

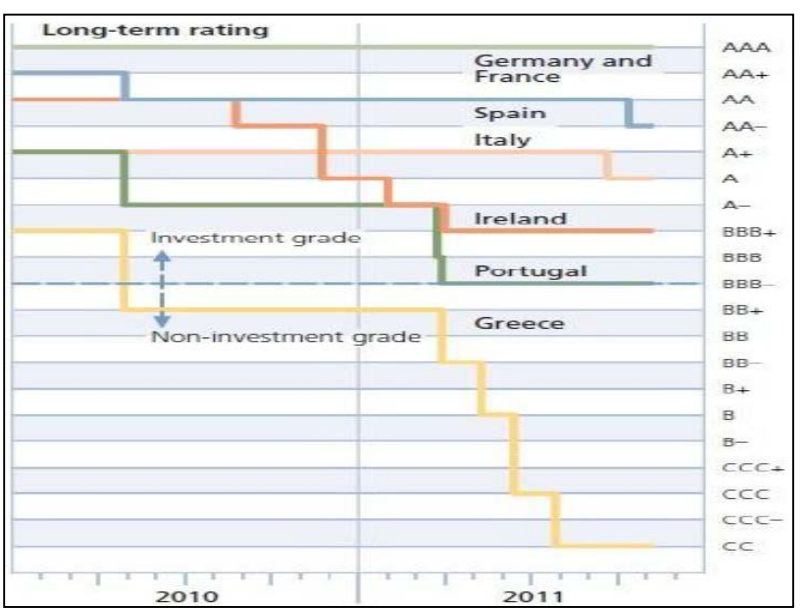

Figure 3. Long-term rating of major Eurozone countries with Standard & Poor's.

As such, the crisis is likely to continue to weigh on markets and can have possible negative implications on the global growth. However, while the crisis is affecting the markets, the global outlook is not as bleak as the weakness in the markets suggests. For investors, the best long-term strategy is to invest in skilled investment managers that can see through the

market noise to find strong investment opportunities irrespective of the European debt concerns.

The authorities' reactions to crisis policies are identified on three measures. The first measure is the EU emergency measures, which are composed of two programs. The first program is the European Financial Stability Facility (EFSF) which was created in 2010 by the EU. It's a legal instrument aiming to preserve the financial stability in Europe by providing financial assistance to the Eurozone states in difficulty. The EFSF can issue bonds or other debt instruments on the market with the support of the German Debt Management Office to raise the funds needed to provide loans to the Eurozone countries in financial troubles and recapitalize banks or buy sovereign debt.

According to the EFSF (2011), the program has been fully operational since August 2010 and its purpose is to finance loans for the Eurozone member states that are experiencing difficulty in obtaining financing at sustainable rates. The EFSF issued EUR 5 billion of five-year bonds at its inaugural benchmark issue on the 25th January 2011 and attracted an order book of EUR 44.5 billion. This amount is a record for any government bond in Europe. According to the Financial Times (2011), the EFSF issued its first bond on the 24th of January 2011 and met spectacular demand on this occasion, bankers not being able to recall such a large order book for any bond, government, or corporate. Emissions of bonds are backed by guarantees given by the Eurozone member states in proportion to their share in the paid-up capital of the ECB.

Also, correlated with the EFSF, the EC required the EU member countries to publish their debt information in a standardized methodology, including debts that were previously hidden to satisfy minimum requirements on a national and European level.

The second program is the European Financial Stabilization Mechanism (EFSM), which was created in 2011 by the EU. It's an emergency funding program reliant upon funds raised on the financial markets and guaranteed by the EC using the budget of the EU as collateral. It runs under the supervision of the Commission and aims at preserving financial stability in Europe by providing financial assistance to the EU member states in economic difficulty. The commission fund, backed by all 27 EU members, has the authority to rise up to EUR 60 billion.

The second measure was adopted by the ECB to reduce volatility in the financial markets and improve liquidity. In May 2010, it took the following actions:

- It began the Open Market Operations (OPM) by buying government and private debt securities, reaching EUR 219.5 billion in February 2012, though it simultaneously absorbed the same amount of liquidity to prevent a rise in inflation.
- It reactivated the dollar swaps lines with the support of the Federal Reserve of America.
- It accepted, as collateral, all outstanding and new debt instruments issued or guaranteed by any European government.

With the aim of stimulating the recovery in the Eurozone economy by lowering interest rates for businesses, the ECB cut its bank rates in multiple steps during the period of 2012–2013, reaching the historic low of only 0.25% in November 2013. The lowered borrowing rates caused the fall of the Euro relative to other currencies, which was hoped to boost exports from the Eurozone and further aid the recovery. According to Figure 4, we

notice the decrease of the interest rate on the Main Refinancing Operation in 2009 following the 2008 financial crisis and in 2012 following the European debt crisis. Those decreases led to the decrease of the overnight interest rate (EONIA).

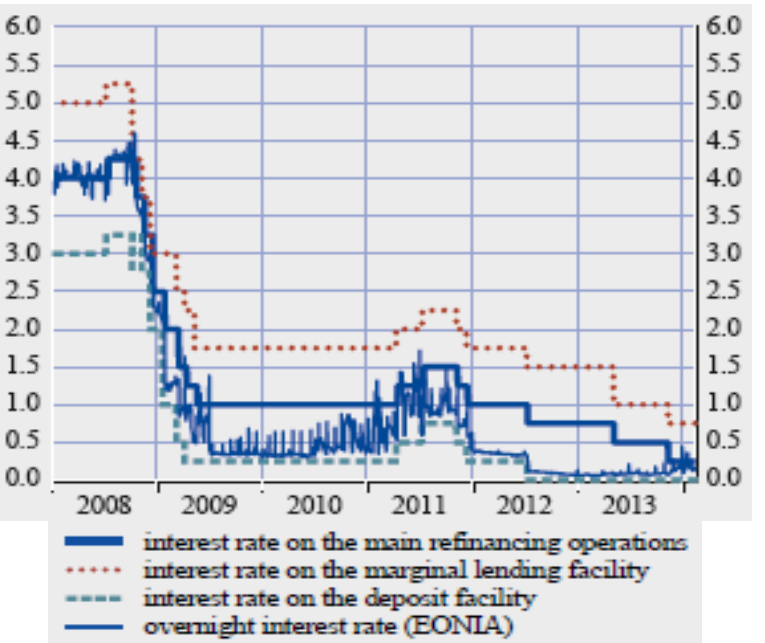

Figure 4. ECB interest rates.

In 2010, the ECB launched a program of purchases of public debt securities in which it purchased EUR 50 billion worth of Greek, Irish, and Portuguese securities. In 2011, the ECB started the biggest infusion of credit into the European banking system. Under its Long Term Refinancing Operations (LTROs), it loaned EUR 489 billion to 523 banks for an exceptionally long period of three years at a rate of 1%. The biggest amount of EUR 325 billion was tapped by banks in Greece, Ireland, Italy, and Spain.

Hence, the ECB tried to make sure that banks had enough cash to pay off EUR 200 billion of their own maturing debts in the first three months of 2012 and at the same time to keep operating and loaning to businesses. Also, it hoped that banks would use some of the money to buy government bonds to ease effectively the debt crisis. In February 2012, the ECB held a second auction, LTRO2, providing 800 Eurozone banks with further EUR 529.5 billion in cheap loans. In June 2012, the ECB lending largely replaced the inter-bank lending. Spain had EUR 365 billion and Italy had EUR 281 billion of borrowings from the ECB. Germany had EUR 275 billion on deposit.

In addition, in 2012, the ECB announced a new program, the Outright Monetary Transactions (OMT), to offer additional financial support in the form of some yield-lowering bond purchases for all the Eurozone countries involved in a sovereign state bailout program from EFSF/ESM. A Eurozone country can benefit from the program if it is found to suffer from stressed bond yields at excessive levels and the country must comply with all the terms in the signed Memorandum of Understanding (MoU) agreement. Countries receiving a precautionary program, rather than a sovereign bailout, can qualify for OMT support if they suffer from stressed interest rates on its government bonds.

In order to promote price stability in the medium term, the ECB announced some measures to improve the operation of the bond markets, increase liquidity, and reduce volatility. These measures consist of purchasing a debt paper in the secondary market to increase the trade in government bonds. In order to ensure the program and not cause inflation, the ECB will neutralize its effects on the money supply.

The third measure is the European Stability Mechanism (ESM). It's a permanent rescue funding program to succeed the temporary EFSF and EFSM in July 2012. ESM became operational in 2013 when the EFSF expired. ESM loans will enjoy the preferred creditor status and they will be junior only to IMF loans. According to the EFSF (2011), the aim of ESM will be to support countries of the Eurozone which may find themselves in financial distress.

According to some economists, there are other solutions to the European debt crisis:

- A debt restructuring, this means cutting a portion of the total debt of the country to improve liquidity.
- Exit from the EMU of the debt-stricken countries. It's in effect illegal, but is considered by some as a better alternative than the debt restructuring.

Empirical Analysis

The 2008 financial crisis was the largest crisis in the post-world war period. Its implications in Europe have been so numerous especially on the banking system and the financial markets, which pushed many European countries to increase their debt to minimize its effects and stimulate the economy. However, this strategy has increased the risk of those debts. In this paper, we investigate the evolution of the European debt and its effects during the European debt crisis.

Data Description and Methodology

Our study examines the impact of the European debt crisis. For this, we used data of the European debt from the Eurostat website and made an analysis of the *effectiveness*— which means to compare the probability of the data with the threshold of confidence of 95% and between the periods – and the *severity* – which means to compare the risk (density tail) between the periods – of the European debt at the threshold of confidence of 95%.

We calculated the European debt probability and the function of the European debt density with the normal distribution in two parts: in the first part, we calculate for the last 10 years before the crisis (1999–2008). In the second part, we calculate for two periods: five years before the crisis (2004–2008) and five years after the crisis (2009–2013).

The choice of the normal distribution relates to its characteristics. The normal distribution is one of the distributions of probability, which is the most suitable for modeling natural phenomena from several random events. The normal distribution is a function that tells the probability that an observation in some context will fall between any two real numbers. This distribution is used in many analyses, such as the Value at Risk (VaR). According to Hull, Godlewski, and Merli (2007), Microsoft indicated in its annual reports that

the company calculates the VaR with a time horizon of 20 days and a threshold of confidence of 97.5%. Also, in the 1980s, some traders used the log-normal distribution in their strategies.

The normal distribution has been integrated into many computing software. In this study, we use Microsoft Office Excel to calculate the probability of the threshold of confidence of 95% and the Matlab software to calculate the density under the normal distribution to analyze the risk and effectiveness of the European debt.

The methodology is based on two parts. In the first part, we calculate two values with Microsoft Office Excel : the probability of the European debt with normal distribution (for that we must calculate the mean and the standard deviation of data) and the value of the threshold of confidence of 95%. We calculate these values with the statistics table of the normal distribution. In the second part of the methodology, we calculate the density function of the series with the normal distribution with the Matlab software. The probability density of the normal distribution is as follows:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \mathrm{e}^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

where:

- The parameter x is the value of data,
- The parameter μ is the mean of the distribution,
- The parameter σ is the standard deviation.

In this empirical analysis, we analyze the debt of governments which it's different from financial products. Also, we are interested in the growth rates for the three periods following the increase of the European debt throughout the period of 1999–2013. Hence, an increase of the growth rate leads to increased risk, which leads to a decrease of density of the normal distribution.

Data Analysis

We calculated some statistics of the data for the three periods: 10 years before the crisis (1999–2008), five years before the crisis (2004–2008), and five years after the crisis (2009–2013). Then, we calculated the probability of value with normal distribution and the value of the threshold of confidence of 95%.

Table 1 shows the calculation of mean, median, standard deviation, maximum, minimum, growth rate, Skewness, and Kurtosis for the three periods. We note an increase of the minimum and the mean following the improvement of the European debt. Also, we note the increase of standard deviation reflecting the increased risk of the European debt despite the decrease in the second period (2004–2008). The growth rate of the European debt decreased in the second period (2004–2008) and increased in the third period (2009–2013). In addition, we note that the Kurtosis coefficient is low (less than three) which indicates a low probability of occurrence of extreme points. Finally, the coefficient of Skewness is different from zero, which illustrates the presence of asymmetry.

Table 1
Statistics of Data for the Three Periods

	10 years before the crisis (1999–2008)	5 years before crisis (2004–2008)	5 years after crisis (2009–2013)
Mean	6,534.8	7,175.4	10,363.8
Median	6,439.1	7,212.9	10,439.2
Max	7,769.7	7,769.7	11,776.3
Min	5,644.8	6,613.5	8,767.5
Growth rate	37,643 %	17,482 %	34,317 %
Standard deviation	752.3081	429.1036	1,145.632
Skewness	0.270794	0.090938	-0.211045
Kurtosis	1.68153	2.091666	1.946103

In addition, Table 2 shows the calculation of the European debt probability for the 10 years before the crisis (94.96% below 95%) and for the two periods: five years before crisis (91.69% below 95%) and especially five years after the crisis (89.12% below 95%).

Table 2
Calculation of the European Debt Probability for the Three Periods

	10 years before the crisis (1999–2008)	5 years before crisis (2004–2008)	5 years after crisis (2009–2013)
Value at the end of the period in millions of Euros	7,769.7	7,769.7	11,776.3
Probability of value with normal distribution	0.949651278	0.91695649	0.891208201
The probability in percentage	94.96%	91.69%	89.12%
Value of the threshold of confidence of 95% in millions of Euros	7,772.236656	7,881.25261	12,248.15668

The first part of our analysis studies the computing of the European debt density for 10 years before the crisis (1999–2008). Figure 5 shows that the European debt probability for the last 10 years before the crisis (94.96%) was below the threshold of confidence of 95% (red line).

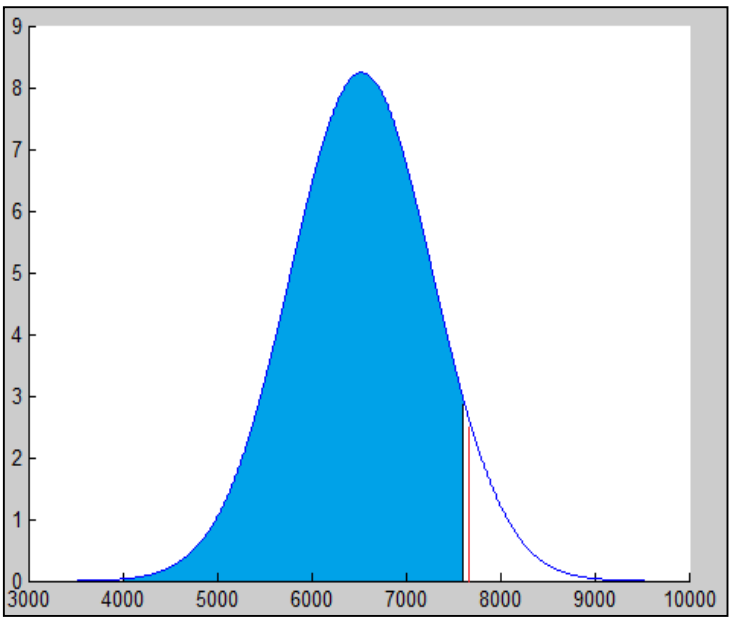

Figure 5. The European debt density of the last 10 years before the crisis.

In the second part of our analysis, we developed an empirical technique that can be used to distinguish between the two periods: five years before the crisis (2004–2008) and the five years after the crisis (2009–2013). Figure 6 shows that the density of the European debt of the five years after the crisis (2009–2013) is below the level of the five years before the crisis (2004–2008), which amounts to the increase of the growth rate and the risk of European debt (density tail), and there has been a decrease in the percentage of its severity (blue area) from 91.69% to 89.12%. Also, for the five years before and after the crisis, the European debt probability is below the threshold of confidence of 95% (red line).

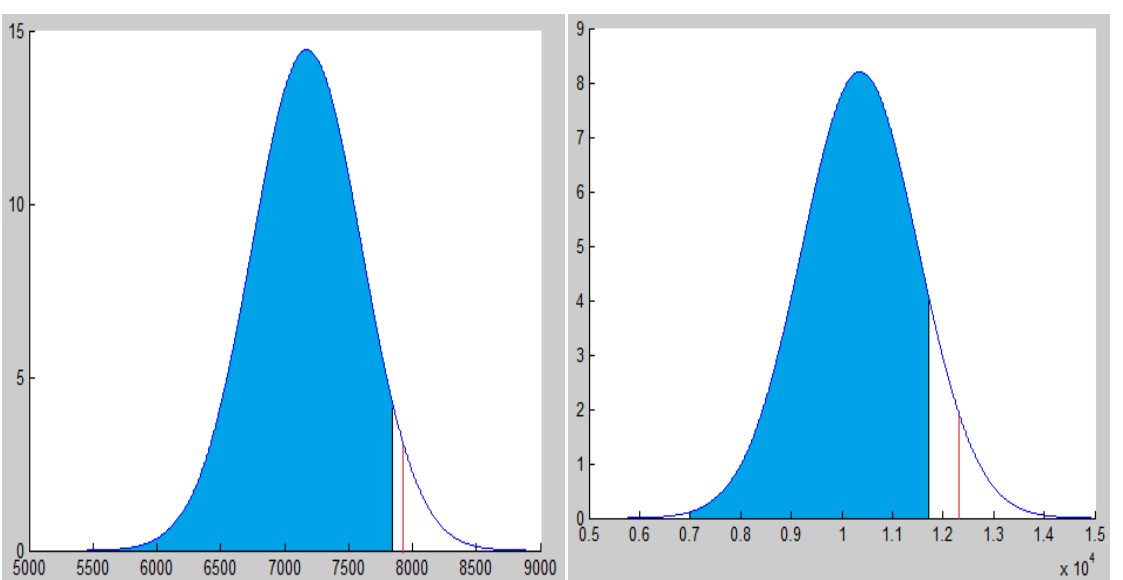

Figure 6. The European debt density of the five years before the crisis and the five years after the crisis.

The results can be summarized as follows:

For the last 10 years before the crisis (1999–2008):

- The European debt probability (94.96%) was below the threshold of confidence of 95% despite the increase of the European debt.

For the five years before the crisis (2004–2008) and the five years after crisis (2009–2013):

- The density of the European debt of the five years after the crisis is below the level of the five years before the crisis. This amounts to the increase of the growth rate and risk of the European debt.
- There has been a decrease in the percentage of its severity from 91.69% to 89.12%, meaning that the default of the European debt has increased.
- The European debt probability, for both periods, is below the threshold of confidence of 95% despite the massive increase of the European debt.

The goal of this section is to determine and calculate the value of the European debt risks in normal cases and in the case of a crisis. Before the European debt crisis, we noticed the long-term interest rates of the government bonds in the Eurozone were similar and the increase of European debt was normal. But, we notice the decrease of effectiveness of the European debt for the five years before the crisis (2004–2008) relative to the last 10 years before the crisis (1999–2008) from 94.96% to 91.69% and the increase of density from 8 to 14, which shows the decreased risk of the European debt following the decrease of growth rate and standard deviation.

Since 2009, we notice that the long-term interest rates of the government bonds in the Eurozone have been different among the countries, especially for Greece, and there has been a massive increase of the European debt. The depreciation of the economy of the European countries led to the increase of the European debt risk. Also, this crisis led to a decrease of effectiveness of the European debt for the five years after the crisis (2009–2013) relative the last 10 years before the crisis (1999–2008) from 94.96% to 89.12%, which shows the effect of the European debt crisis. Nevertheless, we notice that the density keeps the same level (8) between the two periods following the increased standard deviation despite the fact that the growth rate was at the same level.

Our results suggest that the European debt has increased massively after the 2008 financial crisis, which relates to the depreciation of the economy of the European countries. This situation has led to an increase of the risk and the default of the European debt.

The contribution of this paper is to determinate the results of the assistance of ECB and governments to escape from the effects of the European debt crisis. In fact, the measures adopted by the European authorities were efficient despite the massive increase of the European debt.

Perhaps, if the growth rate of the European debt during the period of 2009–2013 had been lower, the European governments had minimized the expansionist budget and had found other sources to finance their economies, the European debt crisis would have been smaller.

The European debt crisis has affected the EU, led to the premature end of a number of European national governments, and influenced the outcome of many elections. For that, the EU countries must find economic reforms and recovery proposals in the short term and propose long-term solutions.

Conclusion

In this paper, we explained the European government bonds and the microstructure of the European corporate bond market. Also, we examined the European debt crisis, its implications on the financial markets, and the policy reactions of the authorities. This paper modeled and provided an empirical evidence for the risk of the European debt and its fragility by computing its probability.

The Eurozone crises have led to a number of policy initiatives by the European fiscal authorities to improve the fiscal discipline within the Eurozone. At the same time, the ECB has used a series of non-standard policy measures to put pressure on the financial system. But, it's becoming increasingly apparent that there's no short-term solution to the European debt crisis. For that, some economists suggest the ramification of the European banking system, a consistent growth strategy, and specific solutions to the government debt crises to solve the crisis in Europe.

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