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Sovereign bond spreads and credit default swap premia: cointegration and causality

Abstract

This article presents an analysis of the possible relationship existing between the spreads of sovereign bonds and the premia of credit default swaps (CDS), in order to determine if they are useful tools for measuring the sovereign risk either separately or taking into account the joint evolution of their values. Data on several countries representative of various regions of the world, developed and emerging economies, have been used. The empirical methodology used in the paper is related to the stationarity of the series, the degree of cointegration and tests of causality. In general, a relationship of cointegration between the two measures is found for some of the countries analyzed. When we study the causality, according to Granger, for these variables, the CDS premium is found to be the cause of the risk spreads in the majority of cases. In the light of the data and their corresponding interpretation, we can conclude that dealings in the CDS market contain clear and fairly useful information on the sovereign risk of a country, and that CDS dealings have become a leading rather than a lagging market with respect to the determination of the prices of public debt bonds.

Keywords: sovereign debt, spread, credit default swap, cointegration, causality.
JEL Classification: H63, G24, E49, F37.

Introduction

Our objective in this study has been to estimate the relationships of equilibrium that may exist between the spreads of sovereign bonds and the premia of credit default swaps or CDS. In particular, the questions to be answered are: Do these two parameters converge in spite of the numerous frictions that arise in the market? and Which is the better measure of sovereign risk?

The determining factors of the differential of sovereign bonds are:

1. Liquidity premium: the liquidity of a bond depends, to a large extent, on the circumstances of the market, and this changes over the course of time; the greater the liquidity of a bond, the lower will be its return and the higher its price. In situations of economic uncertainty, investors tend to focus their portfolios towards safer and more liquid assets; the effect of this is to reduce the liquidity of those assets considered higher risk (sovereign bonds of countries in difficulties), thus increasing their profitability. Thus they become, in turn, even more unsafe.
2. Credit risk premium: compensation demanded by investors given the perceived possibility of default of the issuer. The differentials of public debt can be approximated to the premia of the CDS.

Therefore, the principal objective of this study is to analyze the degree of relationship that exists between the spreads of the public debt and the premia of the CDS, in order to determine if they are useful tools for measuring the sovereign risk either separately or taking into account the joint evolution of their values. Data on several countries representative of various regions of the world have been used. In particular, in Europe, France and the United Kingdom have been included as relatively strong countries, and Spain and Italy as economies more seriously affected by the crisis; Japan is included as an Asiatic country; and from the Latin American region, Argentina, Brazil and Chile are included. Indirectly the USA and Germany have also been considered, by taking their bonds as benchmark risk-free assets, in the calculation of the differential.

This study is organized as follows. Section 1 presents literature review. Section 2 and 3 present analysis of correlation, empirical methodology and results (stationarity of the series, degree of cointegration, tests of causality) and the final section concludes.

1. Literature review

There have been many econometric studies conducted to determine statistically the relationships of equilibrium between the spreads of sovereign bonds and the premia of credit default swaps or CDS, considering whether or not the frictions in the market prevent their convergence.

Hull, Predescu and White (2004) examined firstly the relationship between the differential of credit default swaps and the yield of bonds; and secondly performed a series of tests to analyze how the announcement of the Moody's rating affected the changes in the CDS premia.

Blanco, Brennan and Marsh (2005) studied the relationship between the CDS and the risk premia at the corporate level, and determined that the prices of the CDS are substantially higher than the credit differentials if the study period is long.

Alexopoulou, Andersson and Georgescu (2009) analyzed the price of credit risk in CDS and in

This study has been financed by the Project of Excellence P09-SEJ-4467, 2009, of the Consejería de Innovación, Ciencia y Empresa of the Junta de Andalucía.

corporate bonds, taking the European markets as reference; they reached the conclusion that a relationship existed between these two markets in the long term.

Attinasi, Checherita and Nickel (2009) focused their study on the determinants of the increase of the risk premium in Europe from the start of the crisis in 2007. They put special emphasis on the fiscal changes and on the new government measures for the reduction of fiscal deficits.

Fontana and Scheicher (2010), studied the relation between CDS premia and spreads of sovereign bonds for ten countries of the Euro Area.

Broto, Pérez-Quirós and Sebestyén (2011) analyzed the same relation between CDS and bonds for ten countries including some of the Euro Area and the United States, the United Kingdom and Japan.

Arce, Mayordomo and Peña (2011) continued the previously-cited investigations, and studied whether the markets for bonds and CDS reflect the same information, in the Euro Area.

Also, for a good approach to the sector sovereign CDS is very interesting the Global Financial Stability Report (2013) of the International Monetary Fund.

In general it can be said that, with the increasing turbulence in the sovereign debt markets, and as the risk spreads and CDS premia rise rapidly, interest in studies of this subject will also increase. We are, however, still in the early stages in respect of the published scientific literature on these matters, and we may suppose that this literature will be developed much further with time.

2. Analysis of correlation

Before starting the empirical study, a graphical analysis will be made of the variables with a view to finding a possible correlation between the two. The countries to be considered are: Spain, France, Italy, the United Kingdom, Japan, Argentina, Brazil and Chile. A sample is taken of countries with different economic situations and located in different geographic settings, with the object of reaching more general conclusions.

The CDS premia are obtained from the daily data, from January 2004 to August 2012, using the Thomson Reuters Datastream database. The maturity term of these contracts is 10 years and, although the market for 5 year CDS is more active and therefore more liquid and efficient, this term is taken in order to match the spreads. The data obtained are not continuous: there are some periods for which there is no information. This discontinuity is a consequence of the lack of transparency of this market which is not organized or OTC (Over the Counter).

For the calculation of the spread in absolute terms the premium of the CDS of the German or the US Treasury bond (according to the case) is added to the spread of the bond in question, with the object of approximating the price of a notional risk-free asset, in accordance with the following formula:

Spread of the bond of country A = (The interest rate of the 10-year bond of country A minus the interest rate of the German/US 10-year bond) plus the 10-year German/US CDS premium.

The rationale for adding the German or the US CDS premium to the spread relies in the intent of obtaining an absolute measure of the risk of the bond rather than a relative one. In this way we are approximating the calculus towards the concept of a comparison of the spread of the bond against a truly risk-free asset.

For the calculation of the spread in Argentina, Brazil and Chile, the return of the EMBI Global Diversified[1] is used as a substitute for the interest rate of the bond.

Other authors use different alternatives when calculating the bond spreads and the CDS premia. At this respect, Arce et al. (2011) employ the differential between the 5-year bond yields and that of the German bond of the same maturity. Accordingly they estimate the premia of the 5-year CDS.

Fontana and Scheicher (2010) use the spread between the 10-year bond yields and the 10-year swap rate because the swap curve is a good measure of the risk-free rates in opinion of many market participants. As for the CDS they utilize the 10 year horizon but with the contracts in dollars.

Broto et al. (2011) make use, when calculating the spreads, of the 10-year bonds and the German bond of the same maturity. As for the CDS they employ the 10-year contracts but also nominated in dollars.

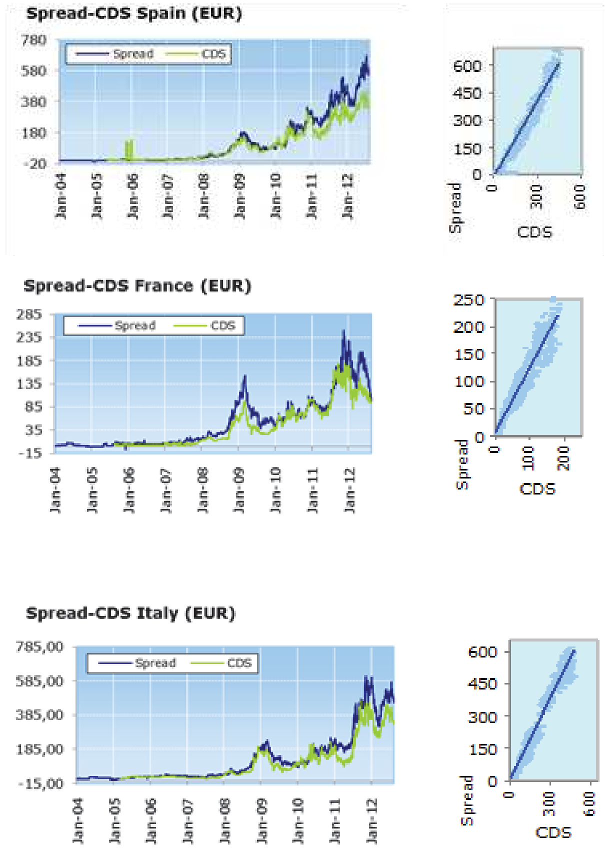
The use of CDS nominated in dollars is a common practice in the Eurozone because, in case of a sovereign default, a depreciation of the euro could be possible. Accordingly we have used also CDS contracts nominated in dollars for all the countries studied.

The different ways of calculating the bond spreads and the CDS premia make difficult a comparison among the results of the studies about the risk of sovereign bonds.

From now on we analyze the different countries mentioned in the introduction of this paper.

[1] The Emerging Market Bond Index or EMBI is an index of the yield of a portfolio of bonds of public debt for emerging countries with very diverse issues, and always in dollars. The Global Diversified is one variant of the EMBI. The indices are calculated by J.P. Morgan.

2.1. The cases of Spain, France and Italy. Figure 1 shows the evolution of the CDS premia and the spreads of the 10-year bonds of public debt of Spain, France and Italy. The degree of positive correlation existing between these two markets can be deduced from these graphs; that is, the two variables grow in the same direction. The spread reaches values higher than the premia of the CDS in almost all the period, although there are certain intervals (January 2010-September 2010) when the price of the CDS recovers[1]; this coincided with an episode of tensions in the financial conditions of the countries considered, leading the regulatory authorities to suspect the existence of speculative practices, and even manipulation, in the markets for sovereign CDS. The preceding situation, in turn, gave rise to more unfavorable conditions of financing for these countries, which put them in a more vulnerable fiscal situation. This suggests that the CDS may play a de-stabilizing role. The difference between the CDS premia and the bond spread reached a higher level in Spain and Italy. Consequently, it would be logical to think that these countries are more sensitive to the effect of contagion and to possible speculative activity. At the beginning of 2011, the spreads began to rise above the CDS premia; at the end of our period of study (August 2012) the difference between the two parameters reached 150 basis points (b.p.) in the case of Spain. Thus, the contagion effect of the pessimism prevailing in the markets caused investor confidence in the Spanish sovereign debt to fall.



Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.
Note: * For the calculation of the spread, the premium of the CDS of the German State bond has been added to the spread of this bond, with the object of approximating the price of a risk-free asset, in accordance with the following formula: Spread of the bond of country A = (Interest of the bond of the country A – Interest of the German bond) + CDS of Germany.

Fig. 1. Differentials of the public debt (*) of Spain, France and Italy over the German bond and CDS on Public Debt (b.p.)

Table 1. Coefficients of determination spread-CDS: Spain, France and Italy (spread as a dependent variable)

Coefficient of determination	R^2	Slope
Spain (EUR)	0.969	1.398
France (EUR)	0.923	1.183
Italy (EUR)	0.970	1.292

Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.

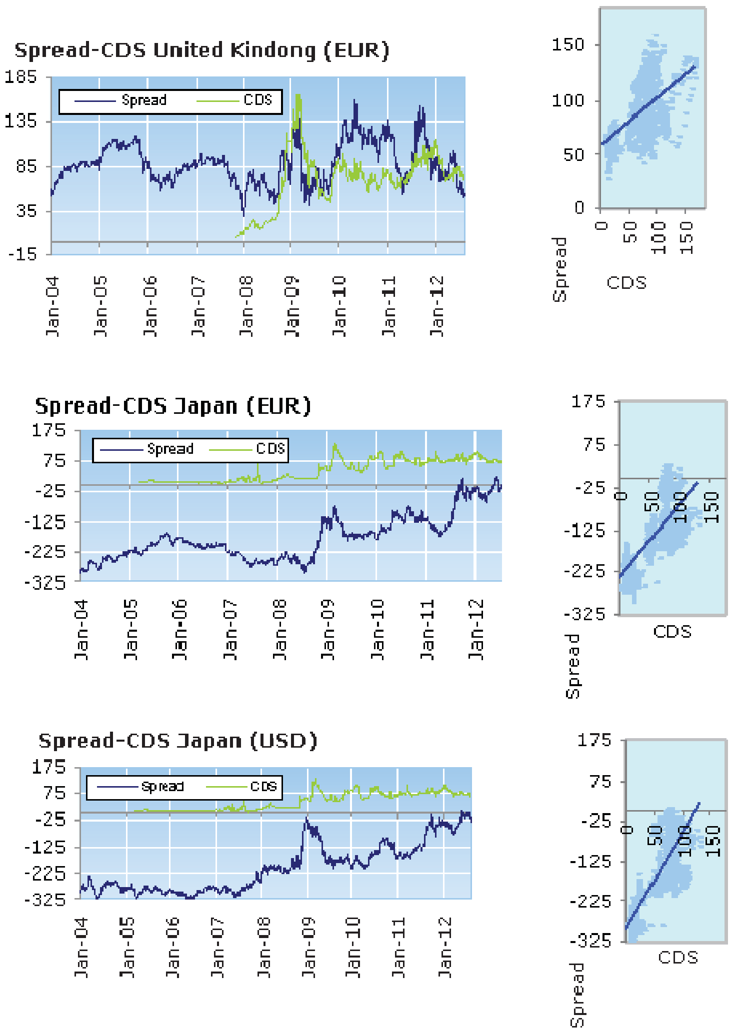
[1] When we calculate the basis, as the difference between the premium of the CDS and the spread of the bond, if this is positive after adding the German or US CDS to the spread, the basis will decrease. If it is negative, the basis will increase.

As can be observed in Figure 1, both instruments of measurement of credit risk move in the same direction and, up to the year 2008, remained at very low levels and with a base close to zero; after this date, coinciding with the start of the financial crisis, both values began to increase, causing the cost of financing the debt of these countries (Spain, France and Italy) to increase.

In the scatter diagrams it can be observed how the slope of the trend line shows that the spreads of the bonds remain above the CDS premia. Spain is the country where there is most difference between these two variables, followed by Italy and then France.

The coefficient of determination (R^2), according to Table 1, is fairly high in the three countries, above 90%; this is a sign of a high degree of association between the concepts studied. Both variables move in the same direction and a variation in the premium of the CDS predicts, in a high percentage of cases, the variation of the spread in the bonds. The existence of correlation does not imply causality nor cointegration. These are aspects that will be analyzed in the next part.

2.2. The cases of the United Kingdom and Japan. The findings are different when the behavior of the markets in the United Kingdom and Japan are analyzed (Figure 2). It can be deduced that a low degree of correlation exists between these two variables. For the case of the UK, there are two basic reasons for this weak association: the differences in the yield curves of the pound and the euro; and the lack of information on the CDS premia quoted up to December 2007. The German bond is taken as reference, although the currency in which most of the UK public debt is issued is the pound sterling. This observation can also be deduced from the coefficient of determination, R^2 = 0.263 (Table 2).



Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.
Note: * For the calculation of the spread, the premium of the CDS of the German or US State bond (as applicable) has been added to the spread of this bond, with the object of approximating the price of a risk-free asset, in accordance with the following formula: Spread of the bond of country A = (Interest of the bond of the country A – Interest of the German/US bond) + CDS of Germany/USA.

Fig. 2. Differentials of public debt (*) and CDS on debt public (b.p.) of the United Kingdom and Japan

The conclusions reached for Japan are similar to those for the United Kingdom; the majority of Japanese issues of debt are in the yen although, to follow the same approach as in the previous case, the return on its sovereign bonds is compared with the German and the US debt. In Japan a great difference is observed between the spread and the CDS premium; the return on the Japanese public debt is less than that of Germany and the USA; in other words, the spreads are negative.

It is also interesting to analyze the degree of correlation between the Japanese market and those of Germany and the USA; although the values are rather different, it can be observed that they are relatively correlated (see Table 2). Morover, the market in Japan seems more correlated with the market in the USA than with the German one as could be expected.

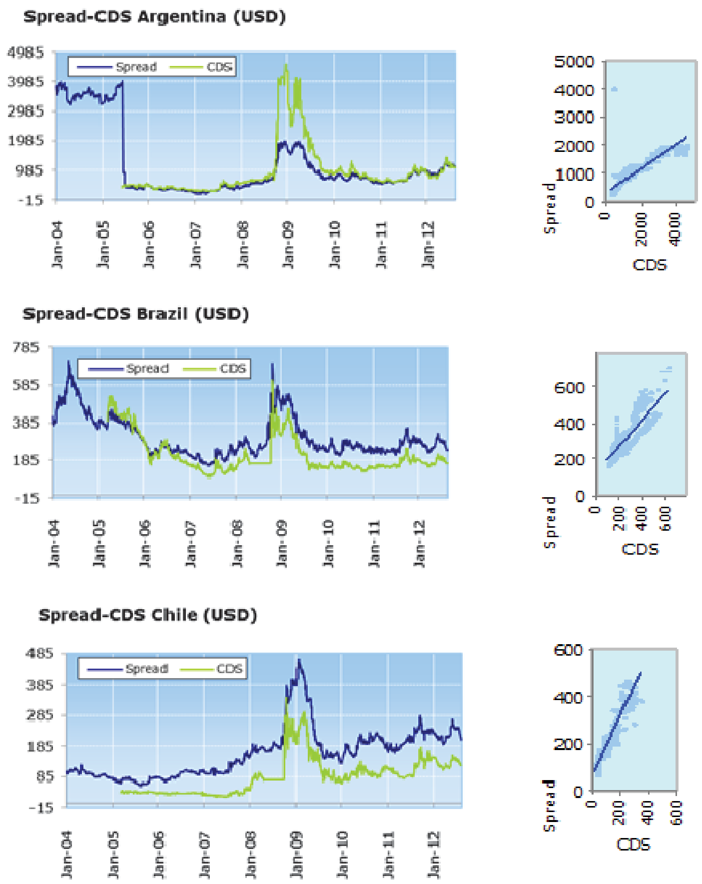
Table 2. Coefficients of determination spread-CDS: the United Kingdom and Japan (spread as a dependent variable)

Coefficient of determination	R^2	Slope
United Kingdom (EUR)	0.263	0.447
Japan (EUR)	0.596	1.737
Japan (USD)	0.725	2.407

Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.

In general, it can be said that when comparing bonds not nominated in the same currency the results have a lower power of explanation because the yield curves are different. Nonetheless, before the euro was usual in Europe to compare the yields of the bonds against the German bund as a benchmark; for example, in Spain, we calculated the differential of the Spanish bond in pesetas against the German bund in marks.

2.3. The cases of Argentina, Brazil and Chile. Moving to Latin America, the correlation between the CDS and the risk premium for Argentina, Brazil and Chile is fairly high (Figure 3), with very similar evolutions. In Argentina the CDS premia remain at the same level as the debt differentials, except in 2009 when they evolve at a higher level. In both Brazil and Chile this closeness in their association can also be observed although, throughout the entire period of evolution, the bases are negative (the CDS premium is less than the risk premium of the bonds). This could be the consequence of the sellers of protection taking more risky positions, or of the low demand for bonds, which would make their spread to raise.



Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.
Note: * For the calculation of the spread, the premium of the CDS of the US bond has been added to the spread of this bond, with the object of approximating the price of a risk-free asset, in accordance with the following formula: Spread of the bond of country A = (Return on the EMBI of the country A – Interest of the US bond) + US CDS.

Fig. 3. Differentials of public debt (*) and CDS on debt public (b.p.) of Argentina, Brazil and Chile

Table 3. Coefficients of determination spread-CDS: Argentina, Brazil and Chile (spread as a dependent variable)

Coefficient of determination	R^2	Slope
Argentina	0.637	0.429
Brazil	0.735	0.737
Chile	0.883	1.297

Source: Thomson Reuters Datastream. Data from January 2004 to August 2012.

The coefficient of determination of these countries also indicates that the association between the variables is high and that, as the CDS premia increase, there is an increase of the spreads of the bonds, in a high percentage of cases (Table 3); however, this does not mean that the rise of one causes the rise of the other.

Of all the countries evaluated, the one that presents the greatest degree of correlation between the variables analyzed is Italy, followed very closely by Spain.

The spreads or differentials of the bonds with respect to the risk-free assets and the CDS premia are variables that indicate the risk of default of the same debt of reference; therefore, it would be logical to think that a close correlation must exist between them. From the empirical models proposed on this subject, it can be deduced that these indicators are closely linked, especially when their behavior is analyzed over an extended time horizon[1]. It should not be forgotten that, in an environment without frictions, the two measurements should tend to coincide, although the dynamics of the markets demonstrate that such a situation is very far from reality[2]. As already stated, designating the difference as the base, if the CDS premium is greater than the spread, the base is considered positive and, in the contrary case, negative.

In fact, the basis should tend to zero but the frictions in the market and the difficulty of making arbitrages drive its value away from the point of equilibrium.

If the basis is positive, that is premium CDS greater than bond spread it is possible to arbitrate selling CDS protection and short-selling the bond. This is the case of most sovereigns in the market but to implement such arbitrage is rather difficult. If the basis is negative, that is premium CDS lesser than bond spread, it is feasible to arbitrate buying CDS protection and the bond. This is the case for most corporate bonds since the crisis and the arbitrage is relatively easier to implement (Fontana and Scheicher, 2010).

[1] Duffie and Darrell (1999), Hull and White (2004), Blanco et al. (2005), Zhu (2006) and Alexopoulou et al. (2009).

[2] Mayordomo et al. (2009) studied the persistent deviations between the CDS premia and the bond spreads between 2005 and 2009.

3. Empirical methodology and results

From the correlation models of the preceding part, it can be deduced, as already stated, that the CDS premia and the bond spreads are closely related, but this does not mean that a relationship of dependence exists between them. The trend over the longer term, in the same direction, may lead one to think that the variables are significantly associated with each other in a regression, leading to erroneous conclusions.

To demonstrate the possible real relationship between the spread and the CDS premia, the analysis of cointegration and the causality tests of Granger[3] are used. The object is to determine whether, in the long term, the series of data move together in a similar way and whether the differences between them are stable; i.e. whether there exists a cause-effect relationship between these financial variables.

This empirical study has been carried out in two stages:

In the first stage, the existence of relationships of dependence between the values of the two variables under study has been checked; for this, cointegration analysis is used. This stage is divided in two tasks:

- Checking if the price series are fixed (i.e. stationary series) or if they have unit roots (i.e. non-stationary series)[4]. The Augmented Dickey-Fuller (ADF) test (1979) is used[5].
- Determining the range of cointegration proposed by Johansen (1991).

In the second stage, Granger's measures of causality are analyzed. The problem with this test is that the correlation does not necessarily imply causality in the sense in which this is usually understood. The test of causality of Granger uses an enlarged concept of correlations to find causalities. Therefore, despite obtaining a positive result from Granger's test, it must never be concluded that, if X causes Y, then the variable Y is necessarily the effect of variable X.

On the basis of the foregoing argument, and with the object of demonstrating the relationships existing between the variables analyzed, the following steps constitute the methodology adopted:

- Analysis of the stationarity of the series.
- Determination of the degree of cointegration.
- Causality tests.

[3] This part of the analysis is based on the study of Chan-Lau and Sook (2004) and on that of Schuster (2005).

[4] A series has unit roots when it departs from its initial value without following a specific trend; otherwise, the series is designated fixed.

[5] The difference between the Augmented Dickey-Fuller (ADF) test and that of Philips-Person, is that in the latter it is assumed that the error is not correlated. In the ADF test the error is considered as white noise, that is, the error is correlated.

3.1. Stationarity of the series. Before making a deeper analysis, the characteristics of the time series on which the empirical study is based should be considered.

A time series can be said to follow a non-deterministic, random or stochastic trend when, on the basis of knowledge of the past values, it is not possible to predict with total certainty the next value of the variable; the effect of this evolution is that the series may remain above or below the mean for long periods of time. The mean, the variance and the autocorrelation of these values depend on time. A time series that follows this trend is known as non-stationary, and it presents unit roots in its autoregressive part.

The deterministic tendency is a temporal cadence, linear or not, that by its characteristics can be estimated with more or less accuracy. A time series that presents these characteristics is designated stationary and its distribution is constant over the course of time.

Before commencing the empirical analysis, the series of observations must be converted into stationary series, that is, into series in which the mean, the variance and the autocorrelations do not depend on time. Once the series have been "stabilized", the next step is to evaluate their possible regularities, in order to identify a mathematical model. For this reason it is necessary to test for the presence of unit roots in the various time series, to determine their non-stationarity.

Why is the stationarity of the series important?

- When this condition is not met, certain problems can arise, in that two completely independent variables can appear as significantly associated with each other in a regression by nothing more than both showing the same trend and both increasing (or decreasing) at similar rates over the course of time, leading to unreal conclusions in the analysis. This is known as the problem of spurious regression.
- The conversion of the series into the stationary type also allows us to draw conclusions on the effects that any short-term economic change has on the long-term behavior of macro-economic or financial series.

To evaluate if the series studied are characterized by a unit root the Augmented Dickey-Fuller (ADF) test is used. The null hypothesis is assumed, that a series presents a unit root[1] in the autoregressive part of the model in question, is not stationary, has a mean equal to zero and its trend is not deterministic.

Table 4 shows the results of the ADF test. On applying the test to the statistical series of spreads the conclusion reached is that the absolute value of the *t*-statistic is less than that of the critical-*t* of the table of MacKinnon or of DF, also in absolute value; this means that the series present unit roots, or what is the same thing, the series are non-stationary (the null hypothesis, H_0, is accepted). An exception is only observed for the United Kingdom; it is demonstrated that the series is stationary in the case of this country. It is logical to expect that the results for this country would be different because the spread is calculated in function of the interest of the German bond (in euros), while the debt issues are in pounds.

The decision criteria:

- *H_0: The time series is not stationary and presents a unit root.*
- *H_1: The time series is stationary and does not present a unit root.*

Decision rules:

- *Reject H_0 when |t-est| > |Mackinnon-t at 1%, 5% and 10%|.*
- *Accept H_0 when |t-est| < |Mackinnon-t at 1%, 5% and 10%|.*

Table 4. Augmented Dickey-Fuller test to identify unit roots in the spreads

Augmented Dickey-Fuller test (SPREAD)					
	t-statistic or tau (ADF)	Critical-*t* of Mackinnon (*t*)			Durbin-Watson
		1%	5%	10%	
Spain	0.539671	-3.4365	-2.8634	-2.5678	1.992
France	0.342924	-3.4365	-2.8634	-2.5678	1.994
Italy	1.957324	-3.4365	-2.8634	-2.5678	1.997
United Kingdom (EUR)	-3.808140	-3.4365	-2.8634	-2.5678	1.999
Japan (USD)	-0.686460	-3.4365	-2.8634	-2.5678	2.001
Japan (EUR)	-0.733053	-3.4365	-2.8634	-2.5678	2.001
Argentina	-2.169547	-3.4365	-2.8634	-2.5678	1.999
Brazil	-2.006178	-3.4365	-2.8634	-2.5678	2.001
Chile	-1.606619	-3.4365	-2.8634	-2.5678	2.072

Source: Thomson Reuters Datastream. Data January 2004-December 2011.

[1] In econometrics, a series that presents a unit root is known as a *random walk*.

Another conclusion obtained from this Table (4) is the absence of autocorrelation between the residuals. Thus, the Durbin-Watson statistic is maintained very close to 2.

Table 5 shows the results of the ADF test for the CDS. On applying this test to the statistical series of CDS premia the conclusion reached is that the absolute value of the *t*-statistic is less than that of the critical-*t* of the table of MacKinnon or of DF, also in absolute value. This means that the series present unit roots and that they are non-stationary (the null hypothesis, H_0, is accepted).

Another conclusion from this table is the absence of autocorrelation in the residuals, since the Durbin-Watson statistic is close to 2 in all the countries studied.

In summary, the series of the bond spreads and those of the CDS premia are both non-stationary and they follow a random walk pattern.

Table 5. Augmented Dickey-Fuller test to identify unit roots in CDS

Augmented Dickey-Fuller test (CDS)					
	t-statistic or tau (ADF)	Critical-*t* of Mackinnon (*t*)			Durbin-Watson
		1%	5%	10%	
Spain	-1.161481	-3.4371	-2.8637	-2.5679	2.002
Germany	-0.979824	-3.4372	-2.8637	-2.5680	2.003
France	-0.197633	-3.4372	-2.8638	-2.5680	2.000
Italy	-0.383431	-3.4370	-2.8636	-2.5679	1.998
United Kingdom	-1.897727	-3.4392	-2.8647	-2.5684	2.003
Japan	-1.466855	-3.4370	-2.8636	-2.5679	1.999
USA	-1.648060	-3.4378	-2.8640	-2.5681	2.001
Argentina	-2.073695	-3.4371	-2.8637	-2.5679	1.997
Brazil	-2.819868	-3.4370	-2.8636	-2.5679	1.994
Chile	-2.016875	-3.4370	-2.8636	-2.5679	1.969

Source: Thomson Reuters Datastream. Data January 2004-December 2011.

3.2. Determination of the degree of cointegration. In econometric terms, it is said that two or more series are cointegrated if over the long term they move together, jointly, and the differences between them are stable, even though each series individually may be non-stationary and may follow a stochastic or non-deterministic trend.

In statistical terms, two or more time series that may not be stationary, of order *I*(1), are cointegrated if a linear combination of those series exists that is stationary, or of order *I*(0). The vector of coefficients that this new series creates is the cointegrating vector. Put another way, when the two series are combined linearly, values are obtained that fall above and below the mean, and with constant variance.

Once the non-stationarity of the series has been determined (Tables 4 and 5), the next step is to study if the risk spreads and the CDS premia are significantly associated with each other in a regression. When two series have been characterized as having unit roots, the existence is demonstrated of a relationship of equilibrium between them, by applying the degree of cointegration test proposed by Johansen[1].

Decision criteria:

- *H_0: r = 0. Vectors of cointegration do not exist.*
- *H_1: r = 1. A vector of cointegration does exist.*

Decision rules:

- *Reject H_0 when the value of the Trace statistic or the Maximum Eigenvalue is greater than the critical value selected, normally that of 5%.*
- *Accept H_0 when the value of the Trace statistic or the Maximum Eigenvalue is less than the critical value selected, normally that of 5%.*

If the null hypothesis (H_0: the matrix of coefficients has a complete range equal to 2, a vector of cointegration does not exist) is rejected, the two series are cointegrated; and it can be stated that a relationship of equilibrium exists between them.

Table 6. Degree of cointegration of Johansen of the spreads and the CDS

	Spreads-CDS (likelihood ratio)
Spain	90.97
France	22.45
Italy	50.93
United Kingdom (EUR)	No cointegration
Japan (EUR)	23.28
Japan (USD)	No cointegration
Argentina	205.53
Brazil	32.73
Chile	38.47

[1] The test of cointegration of Johansen is calculated for all the countries, with exception of Germany and the United States, since the German and US bonds are taken as risk-free assets for the calculation of the differential.

Presented in Table 6 are the results of the degree of cointegration test of Johansen; it can be deduced from the test that the differentials of the bonds and the CDS premia are cointegrated in most of the countries studied, although to different degrees. The existence of equilibrium between the markets for CDS and for bonds provides evidence that the premia of the contracts and the differentials of the bonds tend to converge, despite the pressures deriving from the frictions in the respective markets and from other technical factors.

From a statistical perspective, in Spain the null hypothesis is rejected since the value of the ratio of likelihood is 90.97 (Table 6), greater than 19.96 and 24.60, that are the critical values at 5 and 1% respectively. Similar deductions can be made for the rest of the countries, except for Japan (USD) and the United Kingdom (EUR) where this relationship in the long term between the two measures of sovereign risk is not found. Once again, the different yield curves may be the cause of the lack of cointegration in the parameters for these two countries.

It could be thought that cointegration should not exist in the cases of Argentina, Brazil and Chile; the EMBI Global Diversified may not be a sufficiently representative instrument in some cases. In other words, the CDS premia and the bond differentials could be expected to converge when these have similar maturities; and, in this case, the average maturity of the portfolio of bonds represented by the EMBI would not usually coincide with that of the CDS. However, despite this reasoning, positive results are obtained for these countries in the test of cointegration of Johansen; it should also be recalled that the EMBI is always referred to bonds issued in dollars.

3.3. Causality tests. The objective of causality theory is to describe dynamic interactions between time series and to reveal their dependent movements.

As already argued, the cointegration of two variables does not necessarily imply causality; for this reason the test of Granger is applied to find the direction of the possible causal relationship between them. This test incorporates an enlarged concept of correlation to find causalities, but despite a positive result from the test of Granger, it must never be concluded that, if X causes Y, the variable Y is necessarily the effect of variable X. In this part of our work the objective is to explain the relationships of causality between the risk spreads and the CDS premia of the analyzed countries[1].

In statistical terms, this test involves ascertaining if the results of a variable serve to predict another variable, and if this relationship is unidirectional or bidirectional in character. To do this, it must be analyzed if the current and past behavior of a time series A predicts the behavior of a time series B. If this prediction is confirmed, it is said that "result A" causes, in the sense of Wiener-Granger, "result B"; the behavior is unidirectional. If the preceding prediction is confirmed, and equally "result B" is found to predict "result A", the behavior is bidirectional; in this case "result A" causes "result B", and "result B" causes "result A". With this type of test, results in the previous analysis of a regression procedure can be anticipated.

Decision criteria:

- *H_0: Variable X is not the cause of Y. Causality does not exist.*
- *H_1: Variable X is the cause of Y. Causality exists.*

Statistics for the test:

Eviews calculates the *F*-statistics like that of Wald, with the object of testing the null hypothesis and the probability associated with this statistic.

Decision rules:

- *Reject H_0 if the probability associated with the F-statistics is < 0.05 (probability of 95%) or if the probability associated with the F-statistics is < 0.01 (probability of 99%).*
- *Accept H_0 if the probability associated with the F-statistics is > 0.05 (probability of 95%) or if the probability associated with the F statistic is > 0.01 (probability of 99%).*

Cases:

1. Unidirectional causality: spread causes CDS premium.
2. Unidirectional causality: CDS premium causes spread.
3. Bidirectional causality: feedback between spread and CDS premium.
4. Causal independence: causality between spread and CDS premium does not exist.

In the light of Table 7, it can be deduced that the premia of the CDS cause the spreads for almost all the countries[2]; the lagged values of the CDS premia have a significant impact, at 99%, on the spreads and the null hypothesis "CDS premia do not cause the spreads" is rejected. The null hypothesis is rejected only in the case of 10-day lagged values for the United Kingdom, at a level of confidence of 95%, instead of 99%. There are several exceptions because of which it is not possible to reject the null hypothesis (that is, the CDS premia are not the cause of the spreads) in United Kingdom, Brazil and Chile for a lagged value of one day.

[1] This part of the study is based also on that carried out by Chan-Lau and Sook (2004).

[2] In the column on the right, the probabilities associated with the *F* statistic (p) are < 0.01, in almost all cases.

Table 7. Granger's test of causality in function of the time lags

Null hypothesis		
Time lags (days)[1]	The spreads of the bonds do not cause the premia of the CDS	The premia of the CDS do not cause the spreads of the bonds
Spain		
1	35.58 (2.9E-09)***	82.36 (0.00)***
5	5.41 (6.0E-05)***	46.93 (0.00)***
10	2.18 (0.01668)**	24.12 (0.00)***
20	1.74 (0.0220)**	13.19 (0.00)***
France		
1	1.017 (0.31334)	26.96 (2.9E-09)***
5	10.52 (2.9E-09)***	57.45 (0.00)***
10	7.17 (2.9E-09)***	31.09 (0.00)***
20	8.30 (0.00)***	16.27 (0.00)***
Italy		
1	1.69 (0.1931)	80.29 (0.00)***
5	3.29 (0.00576)***	111.64 (0.00)***
10	4.03 (2.9E-09)***	58.10 (0.00)***
20	4.32 (2.9E-09)***	29.57 (0.00)***
United Kingdom		
1	0.23 (0.6284)	0.51 (0.4737)
5	1.72 (0.1255)	3.26 (0.0062)***
10	2.30 (0.0111)**	2.24 (0.0135)*
20	1.60 (0.0437)	2.33 (0.008)***
Japan (EUR)		
1	0.81 (0.3661)	12.09 (0.005)***
5	2.93 (0.0119)**	10.96 (2.9E-09)***
10	1.75 (0.0636)	6.03 (2.9E-09 ***
20	1.61 (0.0421)**	3.31 (2.9E-09)***
Japan (USD)		
1	1.73 (0.1879)	21.92 (2.9E-09)***
5	0.68 (0.6364)	5.82 (2.9E-09)***
10	0.83 (0.5970)	3.77 (2.9E-09)***
20	1.58 (0.0481)**	2.45 (0.003)***
Argentina		
1	7.46 (0.0063)***	111.279 (0.00)***
5	7.73 (2.9E-09)***	47.486 (0.00)***
10	26.88 (0.00)***	3.887 (2.9E-09)***
20	18.02 (0.00)***	3.69 (2.9E-09)***
Brazil		
1	20.48 (2.9E-09)***	0.76 (0.3805)
5	29.70 (0.00)***	5.71 (2.9E-09)***
10	19.03 (0.00)***	3.58 (2.9E-09)***
20	13.74 (0.00)***	6.49 (0.00)***
Chile		
1	34.63 (2.9E-09)***	0.33 (0.5653)
5	7.62 (2.9E-09)***	5.42 (2.9E-09)***
10	5.33 (2.9E-09)***	4.65 (2.9E-09)***
20	4.54 (2.9E-09)***	6.34 (0.00)***

Source: Thomson Reuters Datastream.

Notes: This table shows the *F*-statistics and *p*-values (italics, degree of probability of compliance with the null hypothesis) corresponding to the Granger's test of causality applied to the spreads of the bonds and the premia of the CDS. * Significant at 90%. ** Significant at 95%. *** Significant at 99%.

[1] Provided a large number of observations is available, Granger's test of causality is more appropriate the larger the number of lags, measured in days, that are incorporated.

On analyzing, in Table 7, if the spreads cause the CDS premia (left column), other conclusions can be drawn. This causality relationship has a lower weight; only in Argentina, Brazil and Chile is the null hypothesis rejected with a probability of 99% and for all the time-lagged values studied. In France and Italy the spreads cause the CDS premia with a probability of 99%, except for a 1-day lagged value in which it is not possible to accept this relationship; in contrast, in Spain this relationship is more significant for time lags of 1 and 5 days, and less for time lags of 10 and 20 days. In the United Kingdom and Japan the null hypothesis is accepted for almost all the time lags analyzed.

Although the causal relationship runs in both directions, it is manifested especially in favor of the CDS premia; in the developing countries the bidirectional relationship is stronger.

If the CDS premia precede the risk spreads of bonds, the conclusion can be drawn that the use of these insurance contracts is the better form of measuring the sovereign risk, since if the CDS premia move before the spreads, it must be because they react more rapidly to changes in the market variables of the country in question.

To study the impact of the crisis, the series of data analyzed up to now can be divided in two periods, as considered next. In accordance with the data of Table 8 and the corresponding interpretation, it can be concluded that the relationship of causality between the CDS premia and the bond spreads presents differences in behavior before 2008 and after this date, when the financial crisis can be considered to have started. Before 2008, it seems that these variables were fairly independent: the spreads preceded the CDS premia only in Spain, France, Japan and Brazil. In the rest of the countries, no causal relationship is demonstrated between these variables, which behave independently.

Table 8. Causality test of Granger: period 1 (up to 31/12/2007), period 2 (1/01/2008-31/12/2011), time lag = 1 day

Null hypothesis		
Period	The spreads of the bonds do not cause the premia of the CDS	The premia of the CDS do not cause the spreads of the bonds
Spain		
1	5.53 (0.0189)**	0.096 (0.7558)
2	1.04 (0.3081)	79.69 (0.00)***
France		
1	15.16 (0.0011)***	0.17 (0.6722)
2	0.16 (0.6813)	17.54 (2.9E-09)***
Italy		
1	1.29 (0.2551)	0.31 (0.5766)
2	0.77 (0.3789)	48.11 (2.9E-09)***
United Kingdom		
1	1.46 (0.2358)	1.76 (0.1941)
2	0.19 (0.6608)	0.02 (0.8776)
Japan (EUR)		
1	4.20 (0.0407)**	7.96 (0.0049)***
2	0.31 (0.5748)	16.84 (2.9E-09)***
Japan (USD)		
1	2.36 (0.1246)	0.14 (0.7015)
2	6.54 (0.0106)**	0.13 (0.7195)
Argentina		
1	0.01 (0.9188)	2.14 (0.1437)
2	48.08 (2.9E-09)***	1.42 (0.2327)
Brazil		
1	22.23 (2.9E-09)***	1.49 (0.2223)
2	34.09 (2.9E-09)	4.74 (0.0295)**
Chile		
1	2.95 (0.08581)	0.06 (0.8028)
2	23.66 (2.9E-09)***	0.51 (0.4724)

Source: Thomson Reuters Datastream.

Notes: This table shows the F-statistics and p-values (italics, degree of probability of compliance with the null hypothesis) corresponding to the causality test of Granger applied to the spreads of the CDS and bonds. * Significant at 90%. ** Significant at 95%. *** Significant at 99%. The period number 1 starts on different dates according to the data available for each country: Spain 27/04/2005, France 16/08/2005, Italy 11/03/2005, United Kingdom 13/11/2007, Japan 10/03/2005, Argentina 01/06/2005, Brazil 10/03/2005 and Chile 10/03/2005.

From 2008 it appears that this tendency changes; in Spain, France, Italy and Japan (EUR), the CDS premia predict the changes of the risk spreads, with a probability of 99%. The fact that the CDS premia nearly always anticipate the risk spreads of bonds demonstrates that, given variations in the market, the CDS react more rapidly. They can thus be regarded as rather better estimators of the sovereign risk in times of financial volatility and turbulence.

For the countries that are not seen as directly damaged by the financial crisis, another deduction can be made; in both Argentina and Chile the bond market leads the CDS market, from 2008, whereas in the period prior to then, the two markets remained independent.

According to the International Monetary Fund (2013) both CDS premia and bond spreads exhibit similar and significant dependence on key economic fundamentals and financial market risk factors. But, in spite of that, new information seems to be incorporated faster in CDS markets than in sovereign bond markets, in particular during periods of crisis or stress. On the other hand, the more liquid is the CDS market the more rapidly it incorporates information relative to bond markets.

Our results seem to be in line with the analysis of the IMF as reflected in the fact that, in general, CDS premia cause bond spreads in the sense of Granger.

Conclusions

In this research study an assessment has been made of the relationship between the differentials of sovereign bonds (spreads) and the market for CDS, for eight countries in different economic situations (Spain, France, Italy, the United Kingdom, Japan, Argentina, Brazil and Chile) and for the period of 2004-2011.

It is necessary to determine if the CDS premia represent an alternative means for estimating changes in sovereign risks, and if they might serve to estimate the probability of non-compliance of a country.

Before this present crisis, the risks of default by the developed economies could not be measured using the CDS since this market lacked liquidity. After the start of the crisis of public debt, in May 2010, there was an increase in both the dealing volumes and the premia quoted; the largest increases were in respect of Ireland, Greece and Portugal, and those of the United States, France and Germany were less. Therefore, in the sovereign CDS markets, a discrimination of assets has been recorded that was not occurring before the financial crisis. According to data of the BIS, the proportion of the total CDS market accounted for by sovereign debt CDS was 13% in 2010, compared with 6% in 2007.

The two principal reasons why CDS should be considered as measures of sovereign risk, in times of crisis, are:

1. With the differentials of debt we are not analyzing, in absolute terms, the evolution of a particular sovereign issue, since this depends on the asset of reference chosen as risk-free. For this reason we have added to the spread the premium of the CDS of Germany or the United States, according to the case.
2. The yields on bonds may be an inadequate measure of sovereign risk in times of crisis because they may be "contaminated" by effects such as the investors' "flight to quality", which biases the risk spreads of the most solvent countries towards lower values.

The scope of this last argument is analyzed by submitting the debt differentials of the eight countries selected for study and their corresponding CDS premia to a cointegration test as proposed by Johansen.

The results of this analysis suggest that a relationship over the long term between the two measures of sovereign risk is found in Spain, France, Italy, Argentina, Brazil and Chile, but not in the United Kingdom or Japan. One explanation for this difference may be the "flight to quality" by investors, in the case of the United Kingdom and Japan and also the different currencies involved.

It could be thought that cointegration should not exist in Argentina, Brazil and Chile, since the EMBI Global Diversified may not be a sufficiently representative instrument of the public debt of a particular country. In other words, the CDS premia and the bond differentials could be expected to converge when these have similar maturities; and, in this case, the average maturity of the portfolio of bonds represented by the EMBI would not usually coincide with that of the CDS. Despite this reasoning, positive results are obtained in the cointegration test of Johansen for the three countries cited.

On analyzing the causality in general, the conclusion is reached that this is manifested more in favor of the CDS; that is, the CDS contracts constitute better instruments of measurement of sovereign risk because their prices (i.e. premia) react more rapidly to changes in the market. However it should be borne in mind that the econometric results suggest a certain bidirectional relationship of causality, which is manifested more strongly in the countries with developing economies.

On studying the causality existing between the variables analyzed, it can be deduced that the relationship between the CDS premia and the bond spreads presents differences in behavior before and after the year 2008, which is when the financial crisis is considered to have started. Before 2008, it seems that these variables were fairly independent: the bond spreads preceded the CDS premia only in Spain, France, Japan and Brazil. In the rest of the countries, no causal relationship is demonstrated between these variables, which behave independently.

From 2008 it appears that this tendency changes; in Spain, France, Italy and Japan (EUR), the CDS premia predict the changes of the risk spreads, with a probability of 99%. The fact that the CDS premia nearly always anticipate the risk spreads of bonds demonstrates that, given variations in the market, the CDS react more rapidly. They can thus be regarded as rather better estimators of the sovereign risk in times of financial volatility and turbulence. In contrast, in Argentina and Chile, the risk spreads are the predictors of the CDS premia.

If the CDS precede the risk spreads, the conclusion we can draw is that the use of credit contracts is the better way of measuring the sovereign risk, since they react more rapidly when there are changes in the market variables of the country in question.

One of the disadvantages of using the CDS premia as a measure of sovereign risk is the relatively small size of this market; however, the evolution of the CDS market in recent years is reducing this disadvantage.

In summary, a certain relationship of cointegration exists between the spreads of sovereign bonds and the premia of CDS; it has also been demonstrated that the CDS premia act to cause the sovereign risk spreads in the majority of cases. In the light of the data and their corresponding interpretation, we can conclude that contracts in the CDS market contain clear and fairly useful information on the sovereign risk of a country, and that CDS trading have become a leading rather than a lagging market with respect to the determination of the prices of public debt bonds.

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