"Market exuberance in sovereign credit default swaps: assessing the EU regulatory framework and trading profit opportunities"

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Market exuberance in sovereign credit default swaps: assessing the EU regulatory framework and trading profit opportunities

Abstract

Sovereign credit default swaps (SCDSs) have been at the core of the Euro Area (EA) debt crisis, particularly in its periphery. Both EU politicians and a wide range of EU academics have asked for tighter regulation of these over-the-counter (OTC) derivatives, following similar pressures to the ones that had resulted from the 2008 financial crisis for corporate reference entities. As such, the SCDSs regulatory framework experienced a number of changes from 2009 to 2014, in the EU. This paper provides a seminal assessment on whether these new rules have succeeded in preventing SCDSs exuberance episodes in the EU. Using daily data for 5 years maturity Greek SCDSs, comprising the period between the latest regulatory reform, in September 2014, and mid-March 2015, we find clear evidence of explosive behavior in SCDSs spreads, and even in upfront quotes. The authors take advantage of the new Phillips et al. (2015a, 2015b) test for multiple exuberance episodes, which had rarely been used in derivatives markets, and conduct an event study to conclude that Greek elections, in early 2015, and the associated turmoil has led to a surge in momentum trading, with significant potential returns for SCDSs buyers. The regulatory measures aiming at deleveraging these markets, standardizing contracts, and dissociating sovereign and banking risk, do not seem to have achieved their purposes, as the political and financial anxiety in Greece, starting in December 2014, has led to explosive behavior episodes in the market for Greek SCDSs, of the type regulators had tried to avoid.

Keywords: sovereign credit default swaps, explosive roots, financial regulation, euro debt crisis, momentum trading, market exuberance.
JEL Classification: C15, C22, F33, G01, G12, G18.

Introduction

Credit default swaps (CDSs) are OTC credit insurance derivatives concerning a certain reference entity (corporate or sovereign). The protection buyer agrees to pay periodic amounts (coupons) during the agreement's lifetime. The seller makes no payments, unless a credit event, related to the underlying reference entity, occurs. Credit events are defined by the International Swaps and Derivatives Association (ISDA). Currently, they include bankruptcy, failure to pay, obligation default or acceleration, repudiation, restructuring and government initiated bail ins for financial sector reference entities (ISDA, 2014). CDSs quotes usually refer to spreads, expressed in basis points (bps, where 1 bps is (1/100)%). An increase in the spread is perceived to represent worsening credit quality of the reference entity.

For a long time, CDSs were mostly used to hedge buyers' longpositions in bonds markets. Notwithstanding, since 2005, CDSs usage for trading, by investors, who did not hold bonds of the underlying entity (uncovered or "naked" CDSs), increased significantly (Bannier et al., 2014). Uncovered CDSs buyers expect spreads to increase, in which case they

would profit from selling[1]. Explosive spreads growth would be an opportunity for huge gains by naked CDSs traders.

However, for highly financially distressed reference entities[2] CDSs may be quoted in points upfront, expressed as percentages. In that case, a CDS buyer pays the seller an initial amount equal to upfront × notional value. An uncovered CDS buyer expects the upfront to increase, so that his return rate, when selling, is the difference between the quotes. Although points upfront have a natural upper bound, making explosiveness less likely, opportunities for very significant trading gains also exist in this setting, if they grow in a meaningful way: e.g. an investor buying a 5 years maturity Greek SCDS with notional value of 10 million Euro (14.4484 million USD[3]), on the 14th of April 2011, and selling on the 28th of August, would have had a gain of approximately 20% of the CDS notional, that is, 2 million € (2.8986 million USD).

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[1] If a dealer has bought a CDS contract at a spread of 110, with a fixed coupon of 100 bps, and the spread rises to 125, the dealer may sell with a profit of 15 bps × PV01, where PV01 is the expected sum of all discounted cashflows paying 1 bp. This implies that when buying the CDS the dealer has made an upfront payment of 10 bps, due to the difference between the par spread and the fixed coupon. Coupon payments are netted out, and if a credit event occurs, the dealer has hedged his position.

[2] The periodic payments should reflect the reference entity's risk level. This would occur if they varied with the par spread. For fixed coupons, as in the previous example, these should also be set reflecting that, in order to compensate sellers for the risk they are taking, and to diminish counterparty risk for the buyer (the likelihood that a seller will default, causing the buyer to lose all periodic payments made, and, if he had bought CDS for hedging, exposing him to risk of default by the reference entity).

[3] Using historical exchange rates for the days in this example.

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Finally, if a credit event occurs before the buyer has closed his position, the CDS is triggered and he receives[4] (100% − recovery rate) × notional value, where the recovery rate should reflect the ratio of market to nominal values of the defaulted bond.

Traditionally, CDSs had been dominated by corporate reference entities. SCDSs were mostly relevant for emerging economies (e.g. Chiarella et al., 2015). However, since the onset of the financial crisis in 2007, SCDSs markets in developed countries have increased significantly in liquidity and trading volume (Broto and Perez-Quiros, 2015). The outstanding amount of SCDSs increased from 6% of all CDSs, in 2007, to 13% in 2010 (BIS, 2010). The EA crisis is also at the core of the SCDSs surge: by June 2012, the top 15 sovereign reference entities, by gross notional, included 6 EA countries, 4 of which under financial distress: Italy, Spain, Greece and Portugal. In fact, Italy and Spain occupied the top two positions (Bannier et al., 2014).

SCDSs spreads for some EA countries rose sharply during the financial turmoil. Most noticeably, 5 years[5] maturity Greek SCDSs spreads increased widely between late 2009 and the Greek debt restructuring on March 2012 (Figure 1). Furthermore, during the 2008-2012 period, there are two patterns in EA countries SCDSs spreads: they move jointly (except for Ireland) until the first Greek bail out, but quickly become much higher in periphery countries afterwards (Figure 2). De Grauwe and Ji (2013) observe similar behavior in EA 10-year government bond rates. This similarity further suggests linkages between the SCDSs surge and the EA crisis. Accusations supporting the idea that SCDSs were propelling the crisis, possibly being used for speculation, rising the yields of the EA periphery, were made at the political and the academic level (e.g. Stulz, 2010; Damette and Frouté, 2010). A vivid discussion around CDSs had also occurred in the US, due to systemic implications of counterparty risk, following the AIG near bankruptcy in 2008.
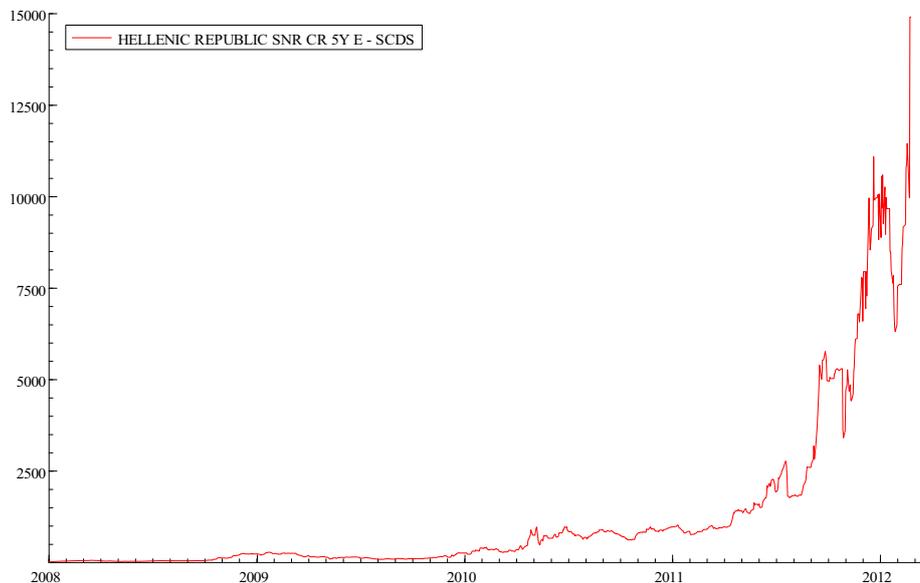

Fig. 1. 5 year SCDSs spreads for Greece until the credit event of 2012

For the first time, in their 20 years of existence, CDSs were on the spotlight. Political and public pressure led to SCDSs regulatory changes in the EU, as it had happened, for both corporate and sovereign CDSs, following the financial crisis. In fact, the current EU SCDSs regulatory framework is shaped by the standardization measures taken after the financial crisis episodes in the last months of 2008 (particularly the rules set in the Big Bang Protocol and in the Small Bang Protocol, in 2009), the EU ban on naked SCDSs, in 2012, and the extension of credit event definitions, in 2014.

With respect to the 2009 protocols, some of their main implications for the current EU regulatory design are the definition of fixed coupons (EU SCDSs are currently traded with coupons of either 25 bps, 100 bps or 500 bps) and a full first period accrual; the establishment of auction settlement mechanisms, even for restructuring credit events (the most relevant for sovereign reference entities) and the creation of Determination Committees. Concerning naked SCDSs, EU Regulation 236/12, implemented on the 1st of November, forbids buying SCDSs with an EU member-state as a reference entity, if the buyer is not exposed to such country's sovereign debt. The extension of credit events came into effect on the 22nd of September 2014. Government-initiated bail ins of financial institutions were added to the list of events already considered (ISDA, 2014). This is of particular

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[4] Irrespective of whether CDSs were being quoted in spreads or upfront points.
[5] The most liquid in CDSs markets.

relevance to the EU, since the new banking restructuring and resolution norms, enforced from the 1st of January 2016 onwards, contemplate the bail in as one of the tools to be used.

In spite of these changes, no evaluation of the current regulation in the EU has been made in the literature (as acknowledged, inter alia, by Ismailescu and Phillips, 2015).
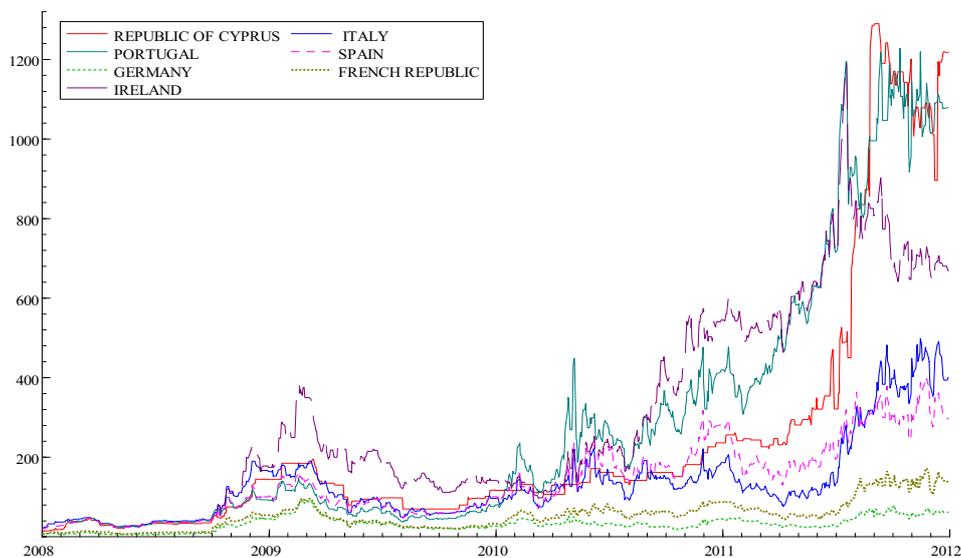

Fig. 2. 5 year SCDSs spreads for EA countries in the 2008-2012 period

This paper improves on the literature, by providing a first rigorous assessment on whether the current regulatory framework of SCDSs in the EU is able to avoid excess reactions, even under extreme market anxiety. In order to do so, we take advantage of the new test for multiple market exuberance episodes developed by Phillips et al. (2015a, 2015b). To the best of our knowledge, this is the first application of this test in the debt capital markets literature and in the structured finance literature. It is also one of the first empirical applications in the derivatives literature[6]. In this sense, this paper introduces a new method for researchers interested in excess reaction of CDSs spreads. In fact, Coudert and Gex (2010) have used a contagion based approach, by noting an increased correlation in automobile firms CDSs spreads, after the surge in those of GM and Ford. However, there is no threshold for them to identify a "surge" episode. Andritzky and Singh (2006) have calibrated a CDS pricing model to conclude that changes in the recovery rate may induce huge increases in CDSs spreads, although the meaning of "huge increase" is unclear. Thus, no proper statistical test had been used to conclude as to explosive reactions, prior to this paper.

Adding to this, our data, referring to 5 years maturity Greek SCDSs, with daily observations from the end of September 2014 to mid-March

2015, offers unique advantages. Firstly, the latest SCDSs regulations to date had already been implemented. Secondly, this period comprised extreme market anxiety, with the Greek political crisis in December 2014, resulting in a general election in January 2015, leading to a government with a highly defiant speech towards both the EA rules and the terms of the second Greek bail out, and that threatened to default on external debt payments, and to leave the Euro. Financial uncertainty is noticeable, with interest rates on government ten year bonds rising to 10.6% by the 7th of January, from 5.3% in late September, and with the ATHEX index losing 30% in this period. It's hard to envisage a more adverse setting for the EA regulatory framework to be tested.

Finally, we also innovate by assessing not only the behavior of spreads but also of quotes in points upfront, and by doing so for different fixed coupons. This is most relevant since, in spite of the fact that Greek SCDSs have been quoted in points upfront in recent years, the extensive literature on SCDSs and the Greek debt crisis has only been focused on spreads. Moreover, the literature never refers to possible differences in behavior under different coupons, for the same maturity and reference entity.

This paper is organized as follows. The next section reviews the literature on the linkages between SCDSs and the EA crisis, and on possible regulatory measures. Section 2 details the hypotheses formulated and the methodology used. Section 3 describes the data and provides foundations for the

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[6] In fact, the other examples pertaining to derivatives are exclusively focused on some commodities: crude oil futures (Tsevetanov et al., 2015), non-ferrous metals futures (Figuerola-Ferretti et al., 2015) and agricultural futures (e.g. Etienne et al., 2015).

choices made. Section 4 presents and discusses the empirical results. Final Section summarizes and concludes the paper.

1. Literature review

This section addresses the literature on the three major channels through which SCDSs might propel the crisis: the direct relationships between SCDSs and their underlying reference entities, the sovereign bonds; the relationship between CDSs, sovereign risk and banking risk, when sovereign bonds are a part of banks' assets; the systemic risk posed by the opaqueness of OTC derivatives, such as CDSs.

1.1. SCDSs and sovereign bond markets in the EA. SCDSs are highly leveraged financial instruments. Investors may take uncovered CDS positions, often without any initial outlay (Coudert and Gex, 2013). Compared with the bonds market, where an investor has at least to borrow in order to buy bonds, investment in SCDSs is cheaper, propelling momentum trading, if investors expect the credit quality of the reference country to deteriorate. If such expectation persists for some time, SCDSs spreads may rise explosively, since spreads do not have an upper bound, due to the theoretical impossibility of perfect arbitrage between SCDSs and the bonds markets (Duffie, 1999). Palladini and Portes (2011) provide empirical evidence showing that CDSs and bonds spreads are cointegrated, but the long run equilibrium parameters' estimates are not compatible with perfect arbitrage, and short run deviations persist for long periods. Excess reaction or explosiveness of CDS spreads is in fact not only possible, but well documented (Andritzky and Singh, 2006; Coudert and Gex, 2010). Chiarella et al. (2015) have shown that, for financially distressed economies, trading momentum played a fundamental role in determining SCDSs spreads. Adding to the likelihood of excess reaction, evidence of Granger causality from SCDSs spread movements, to movements in sovereign bonds spreads (e.g. Damette and Frouté, 2010), that Delatte et al. (2012) translate into a leading role of the SCDSs market over the sovereign bonds market in the price discovery process, raised the possibility that high yields in fragile economies were being caused by speculative attacks on SCDSs markets. Damette and Frouté (2010) made this claim explicitly and called for regulatory intervention.

In short, the literature identified the high leverage of SCDSs as the fundamental driver of the problems above, as spreads excess reactions were more likely, inducing higher bond yields. The impact of the speculation argument has led the literature to debate mainly one strategy to reduce leverage: banning naked SCDSs. Regulation suggestions by, *inter alia*, Posner and Weyl (2013), point to banning naked CDSs, in order to guarantee that buyers have an insurable interest.

On the other hand, Beber and Pagano (2013) and Ismailescu and Phillips (2015) have argued that whenever naked CDSs were banned a loss of liquidity in bonds markets had occurred. The conclusion that increases in SCDS spreads Granger caused increases in bond spreads (Damette and Frouté, 2010) was challenged on the basis of the absence of similar evidence in other sample periods studied (IMF, 2013). Furthermore, the idea of banning naked SCDSs was criticized for regulating a financial instrument, instead of addressing the problems of fragile economies. Adding to this, Heinz and Sun (2014) have shown that the lower volatility in sovereign bond yields on the second half of 2012 was a result of a global decrease in risk aversion, with no need for naked SCDSs bans.

1.2. Sovereign and banking risk, with bank's exposure to government bonds. This strand of the literature has been developed as a result of two observable facts of the EA crisis: banks owned large portfolios of government bonds; there was a period in the financial crisis and in the EA debt crisis (from 2008 to 2012) when distressed banks were likely to be bailed out. The argument in this literature usually goes as follows: if SCDSs spreads for a periphery EA country were rising sharply, causing a rapid growth in sovereign bond yields, banks with significant exposure to that country's debt would suffer losses in the value of their assets; as banks' default risk was rising, the need for recapitalization became clearer, making a bail out likely. Irrespective of whether the public recapitalization was done issuing new government bonds, or with public borrowing from EU institutions, investors clearly understood the bail out represented a significant increase in sovereign risk[7]. Therefore, SCDSs spreads would further increase after a bank bail out, implying that government bond yields would rise even more, lowering the price of sovereign bonds, and imposing additional losses on banks. The likelihood of further banks' recapitalizations would increase. This vicious circle is well documented. Alter and Schüller (2012) highlight the role, in the negative amplification cycle, of banks' CDSs and SCDSs, in the EA. Bruneau et al. (2014) argue that banks' CDSs were the drivers of SCDSs markets' sentiments.

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[7] An example of this perception is the downgrading of Spanish sovereign bonds by Moody, in June 2012, following a loan of 100 billion € (126.38 billion USD) by the European Stability Mechanism for bank recapitalization (Moody's Investor Service, 2012).

One could argue that the linkage between SCDSs and banks' CDSs had been broken as the EU moved from bail outs to contingent convertible bonds, and even bail ins with hair-cuts on bank bond holders and depositors. In fact, the bail in is set to be generalized in the EA, from January 2016 onwards (European Commission, 2014). Klimek et al. (2015) established that under no scenario public funded bank bail outs outperform bail ins with private sector involvement. In short, one might think banking regulation would have solved the problem, with no need for CDSs' regulation.

Notwithstanding, the 2013 Cyprus bank bail in episode[8] suggests that bail ins may also increase sovereign default probabilities, as a result of capital flights, by depositors and bond holders (Parigi, 2014). A negative cycle may still exist: increasing SCDSs spreads may cause losses to banks, augmenting the probability of another bail in.

The EU is aware that the deposits insurance side is to be solved by banking regulation (European Commission, 2014). Minimum levels are defined, below which deposits would not be converted into capital or used to pay creditors. However, for bank bond holders, a solution should go through some type of extensions of CDSs protection.

1.3. CDSs opaqueness: OTC products and systemic risk. Finally, with respect to the opaqueness of OTC products such as CDSs, the literature has suggested a channel through which they could increase systemic risk. Angelini (2012) argues that CDSs negatively affected the stability of the banking sector due to moral hazard, as riskier portfolio choices were made under the idea that assets were insured by CDSs. The problem becomes clear in economic downturns, where a number of CDSs are likely to be triggered, as credit events are more frequent (Rowe, 2011). The concentration of major CDSs sellers in a few banks, combined with the existence of naked CDSs, fosters counterparty risk to unknown levels, exposing the financial sector to serious systemic default risk (e.g. Gai et al., 2011). Banks' recapitalization needs would increase sharply. Even under the new EU banking regulation, increases in sovereign risk, with a possible negative loop, might well occur.

On the regulation side, lack of information on OTC products could be overcome by means of central clearing. Loom and Zhong (2014) argue that this would increase market transparency and reduce counterparty risk. Standardization of SCDSs agreements could also increase transparency and liquidity, while mitigating counterparty risk.

2. Research hypotheses and methodology

2.1. Main research question and associated research hypotheses. As stated in the introduction, the research question we address in this paper refers to whether or not the SCDSs regulatory framework currently prevailing in the EU has managed to prevent excess reactions in SCDSs behavior. Following the previous two sections, we are now adding additional research hypotheses, derived from the fundamental one, as subquestions. We also intend to test these. In particular, we shall look at 4 specific hypotheses:

H1: Are quotes in upfront points immune to excess reaction episodes for financial distressed countries, as their upper bound, and the lower leveraging of SCDSs by non-negligible initial outlays for buyers, suggest?

H2: Has the introduction of fixed coupons, with standardized reference values reflecting different likelihoods of a credit event, avoided excess reaction episodes for distressed economies, as SCDSs would be deleveraged, since buyers have higher periodic payments, and, even for spread quotes, are more likely to have initial outlays?

H3: Has the inclusion of government initiated bail ins in ISDA's credit event definitions, jointly with the abandonment of bank bail outs, prevented SCDSs excess reaction episodes in economies with a fragile banking system, under heavy financial distress and high market anxiety?

H4: Has the ban on naked SCDS with EU member states as reference entities, enforced by EU Regulation 236/2012, prevented subsequent episodes of excess reaction, even under high market anxiety, as SCDSs would be less leveraged?

2.2. Methodology. In order to address the research questions formulated, the Phillips et al. (2015a, 2015b) double recursive, right-tailed alternative, unit root test shall be used. In practice, this is a test for explosive roots in financial time series, based on the standard ADF regression,

$$\Delta x_t = \mu + \beta x_{t-1} + \sum_{j=1}^{J} \phi_j \Delta x_{t-j} + \varepsilon_t. \qquad (1)$$

Where $\{x_t\}$ is the time series of interest. Standard assumptions are made: $E(\varepsilon_t) = 0$, $E(\varepsilon_t^2) = \sigma^2$. The null hypothesis entails the unit root case H_0: $\delta = 0$, and the alternative refers to an explosive root H_1: $\delta > 0 => p > 1$, (as usual, $\delta = p - 1$). For a recursive test, one needs to define an initial window size, r_0. Equation (1) is estimated recursively, with the first observation as the starting point, and subsets of sample data increased by one observation stepwise. For a subsample starting at the initial observation, and letting r_2, with $r_0 < r_2 \le 1$, be the fractional size of the full sample

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[8] For details of the Cyprus banking crisis see, e.g., Orphanides (2014).

(normalized to the unit interval), the corresponding ADF test statistic is denoted by ADF_{r_2}. Letting r_2 vary in the interval $[r_0; 1]$, the sequence of observed test statistics, $\{ADF_{r_2}\}$, is obtained.

A test for periodically collapsing bubbles might be based on this sequence, as Phillipsn et al. (2011) had earlier suggested. Their SADF test statistic is defined as:

$$SADF(r_0) = \sup_{r_2 \in [r_0;1]} \{ADF_{r_2}\}. \tag{2}$$

Evidence of explosive behaviour existed if the observed SADF statistic was bigger than the right critical value for a given significance level. Homm and Breitung (2012) show that the SADF test performs well with periodically collapsing bubbles. Its shortcoming is that the starting point is fixed: the first sample observation. It is argued (e.g. Bettendorf and Chen, 2013), that when two bubbles exist in the sample, if the second is overpowered by the first, detection of the second with the SADF test may fail. Phillips et al. (2015a) have addressed this by nesting the SADF test in a loop which increments the starting point, r_1, with $r_1 \in [0; r_2 - r_0]$. The Generalized SADF statistic (GSADF) is therefore the largest ADF statistic in the double recursion over all feasible values of r_1 and r_2,

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0,1] \\ r_1 \in [0;r_2-r_0]}} \{ADF_{r_1}^{r_2}\} \tag{3}$$

(a) SADF Test   (b) GSADF Test
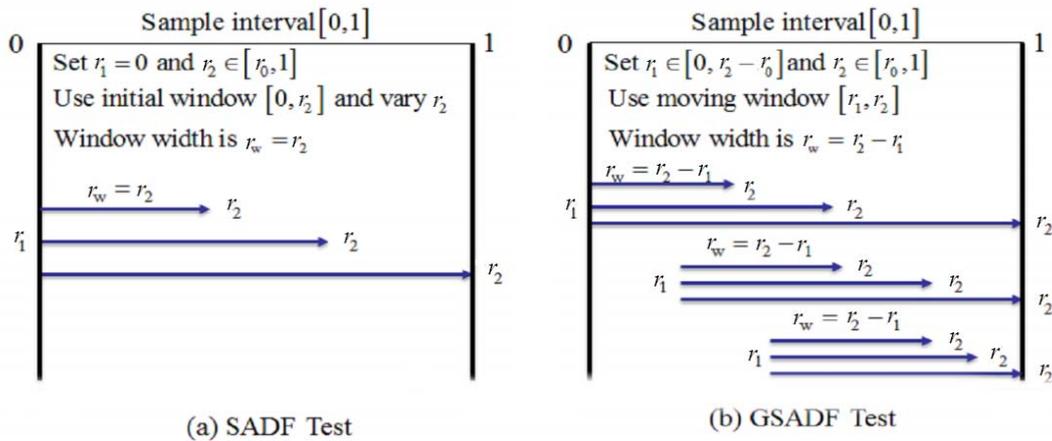
Source: Phillips et al. (2015a).

Fig. 3. The sample sequences and window widths of the SADF test and the GSADF test

Figure 3 illustrates the different sample sequences in the SADF and the GSADF tests. The GSADF test covers significantly more subsamples of data, with increased window flexibility, thus being more efficient in detecting multiple bubble episodes, when they occur in a given time series.

Phillips et al. (2015a) show that the limiting distribution of the GSADF test statistic is given by:

$$\sup_{\substack{r_2 \in [r_0,1] \\ r_1 \in [0;r_2-r_0]}} \left\{ \frac{\frac{1}{2} r_w [B(r_2)^2 - B(r_1)^2 - r_w] - \int_{r_1}^{r_2} B(r)dr [B(r_2) - B(r_1)]}{r_w^{\frac{1}{2}} \left\{ r_w \int_{r_1}^{r_2} B(r)^2 dr - \left[\int_{r_1}^{r_2} B(r)dr\right]^2 \right\}^{\frac{1}{2}}} \right\}. \tag{4}$$

Where, $r_w = r_2 - r_1$ and B is a standard Wiener process.

The asymptotic distributions of the SADF and the GSADF test statistics depend on a nuisance parameter: the smallest possible window size r_0. In practice, r_0 can be thought of as a function of the total number of obervations T. If T is small, r_0 needs to be large enough to guarantee that there are enough observations for initial estimation, in the recursions. Phillips et al. (2015a) have conducted simulation studies, and suggested the heuristic rule given by equation (5) for practitioners to choose r_0:

$$r_0 = 0.01 + \frac{1.8}{\sqrt{T}}. \tag{5}$$

Critical values are provided for some sample sizes in Philips et al. (2015a), but the recommended practice is to simulate the sequence of these for conventional 1%, 5% or 10% significance levels, in each empirical study.

Further, Philips et al. (2015a) developed a backwards strategy to obtain the GSADF statistic, with the purpose of dating the beginning and the end of multiple bubbles within a series. The

backwards strategy allows for such date estimators to be consistent (see Phillips et al., 2015b, for detailed proofs).

The backwards SADF test (BSADF) performs a sup ADF test on a backwards expanding sample sequence, where the end of the sample is fixed at r_2, and recursively regressing up to the starting point, that varies from 0 to $r_2 - r_0$ (the sample fraction corresponding to the origination of the window). Hence, the test statistic is given by (6):

$$BSADF_{r_2}(r_0) = sup_{r_1 \in [0; r_2 - r_0]} \{ADF_{r_1}^{r_2}\}. \qquad (6)$$

Hence, the GSADF test starts from the implementation of the backwards sup ADF test repeatedly for each value $r_2 \in [r_0; 1]$, leading the test statistic to be based on the sup value of the backwards sup ADF sequence.

$\{BSADF_{r_2}(r_0)\}_{r_2 \in [r_0; 1]}$, as in (7):

$$GSADF = sup_{r_2 \in [r_0; 1]} \{BSADF_{r_2}(r_0)\}. \qquad (7)$$

3. Data description

We have obtained 125 daily observations for spreads and quotes in points upfront of 5 years maturity Greek SCDSs. We have collected series both for ISDA 2014 and ISDA 2003 credit event definitions. This is only possible since Greece has maintained both types of SCDSs after the 2014 regulatory change. All series were collected for SCDSs with coupons of 100 and 500. The sample comprises the period between the 22nd of September 2014 and the 16th of March 2015. That is, we have daily observations for spreads and for points upfront, each of which under the new and the old credit definitions, for both coupons. The resulting 8 series were obtained from Markit®[9].

The start date of our sample matches the beginning of SCDSs trades with the ISDA 2014 definitions. The end date allows us to capture significant episodes of the Greek political crisis. In particular, this sample period comprises the announcement, on the 8th of December 2014, of the need to elect a new President, the three failed attempts of such an election in the Greek parliament (the last being on the 27th of December), the announcement of a general election on the 29th of December, the extremely favorable polls for the defiant left wing

party Syriza, anxiety episodes in the bonds market in early January, the outcome of the elections on the 25th of January, the announcement of parliament support of a Syriza government on the 5th of February 2015, and the first month of the newly elected government.

4. Empirical results and discussion

In this section, we shall present and discuss the results obtained from applying the Phillips et al. (2015a, 2015b) testing and date-stamping methodology to each of the eight series in our sample. Our objective is to provide an answer to the research question this paper addresses. In particular, we shall investigate whether or not the current EU regulatory framework, described briefly in Introduction, has succeeded in the objective of avoiding explosive behavior in SCDSs quotes. The implications of such excess reactions have been discussed in detail in section 1.

In order to properly address the question, we have chosen a sample period complying with two requirements: the most recent developments in the EU regulatory framework were already implemented, and the sovereign reference entity was under extreme political pressure, and market anxiety. As detailed in section 2, we have defined a subgroup of 4 research hypotheses that will allow a richer answer for our main research question.

Given our sample size $T = 125$, equation (5) leads us to choose $r_0 = 0.17$, implying a minimum window length of 21 observations for recursive estimation. Relevant quantiles of the GSADF statistic were obtained by Monte Carlo simulation, with $M = 1000$ iterations. Table 1 presents the observed GSADF test statistics and corresponding p-values, for spread and upfront quotes of Greek SCDSs with a coupon of 100. All results are presented both for SCDSs traded under the 2003 and the 2014 ISDA credit event definitions.

Table 1. GSADF explosive root test for coupon 100

	ISDA 2003		ISDA 2014	
	Upfront	Spread	Upfront	Spread
GSADF statistic	1.224045	2.314981	2.433846	4.032572
p-value	0.2710	0.0220	0.0170	0.0000

Results in Table 1 are sufficient to conclude with respect to research hypothesis *H3*, concerning the impact of the inclusion of government initiated bail ins in ISDA's credit event definitions, on the behavior of SCDSs. The expectation underlying *H3* was that the extended definitions would help avoiding excess reactions in SCDSs quotes. However, this expectation is not confirmed by the data. In fact, the rejection of the null hypothesis of Phillips et al. (2015a, 2015b)

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[9] The authors have downloaded historical data on SCDSs for the EA from Markit®. Thus, daily data for spreads and/or quotes in points upfront are available, along with a range of credit risk metrics, since 2008. For each country, data are obtained for all traded coupons and for all traded credit event definitions. For each coupon and ISDA credit event definition, data for 7 different SCDSs maturities (ranging from 6 months to 30 years), are available. For CDSs, Markit®'s database is of the highest quality, given the firm's leading role in financial information services for fixed income securities.

test, both under ISDA 2014 and ISDA 2003, for SCDS spreads, provides evidence that excess reactions may occur irrespective of credit event definitions. With respect to ISDA 2003, table 1 allows to reject the null at 5% significance (*p*-value is 2.2%), and, for ISDA 2014, rejection occurs even at 1% significance (*p*-value is approximated to 0.0%). Nonetheless, although spreads are relevant for traders as a tool to estimate default probabilities for the reference entity, Greek SCDSs are quoted in points upfront, rendering spreads meaning less to determine trading profits of buyers that close their SCDSs position before a credit event. Hence, the relevance of the new definitions should also be assessed on the basis of upfront points.

Results in table 1 show that the null of a unit root is not rejected (*p*-value of 27.1%) for 5 years maturity Greek SCDSs upfront quotes under ISDA 2003. However, for SCDSs under ISDA 2014, the null is rejected, at 5%, in favor of an explosive root in points upfront quotes (*p*-value of 1.7%). Hence, exuberance is found in upfront quotes for SCDSs traded under the new credit event definitions, but not under the previous ones. In conclusion, research hypothesis *H3* is dismissed[10].

Table 2. GSADF explosive root test for coupon 500

	ISDA 2003		ISDA 2014	
	Upfront	Spread	Upfront	Spread
GSADF statistic	1.648358	2.314981	3.075606	4.032572
p-value	0.0860	0.0150	0.0020	0.0000

Research hypothesis *H1* refers to the possibility that upfront quotes would be immune to explosive behavior, due to the upper bound at 100, and to the deleveraging effects of the initial outlay. Evidence from Tables 1 and 2 for upfront quotes shows that the null of a unit root is rejected in favor of explosiveness, in three of the four series studied. For coupon 500, the null is rejected for both credit definitions. For coupon 100, it is rejected for the new definitions. Hence, 5 years maturity Greek SCDSs upfront quotes exhibit explosive behavior during the sample period, dismissing the conjecture *H1*.

Research hypothesis *H2* is based on the conjecture that a higher fixed coupon would discourage momentum trading, avoiding excess reactions. An answer may be achieved with Table 2 alone, as it refers to SCDSs with a coupon of 500 (Table 1 refers to a coupon of 100). The null hypothesis of a unit root is rejected against an explosive alternative, for both spreads and points upfront, and for both ISDA definitions. Thus, the reference coupon for distressed sovereign

entities is unable to avoid episodes of explosive behavior. *H2* is false.

Finally, research hypothesis *H4* was related to the conjecture that the EU ban on buying naked SCDSs with member-states as reference entities, would deleverage these instruments, preventing excess reaction episodes. The ban was implemented on the 1st of November 2012, so it is valid during our sample period. The evidence we have discussed so far, allows us to conclude that the ban did not prevent explosiveness in SCDSs behavior. In fact, tables 1 and 2 show that an explosive root exists in 7 of our 8 series[11].

An answer to the fundamental research question in this paper has been achieved. The overwhelming evidence in favor of the existence of explosive roots in all but 1 series, leads us to conclude that the current EU regulatory framework is unable to fully prevent exuberance episodes in SCDSs markets.

In order to properly document our conclusion, we shall take advantage of the output from the Phillips et al. (2015a, 2015b) consistent date-stamping methodology to estimate the starting dates of SCDSs exuberance episodes in the sample period. The 4 graphics in figures 4 and 5 illustrate the behavior of the BSADF test statistic that we shall use for this purpose.

Figure 4 refers to coupon 100 SCDSs, and figure 5 to coupon 500. In each figure, the first graphic refers to behavior under ISDA 2003 definitions, and the bottom one to behavior under the ISDA 2014 conventions. For all plots, the blue line represents the BSADF observed test statistic sequence for spreads, the red line represents the BSADF observed test statistic sequence for quotes in points upfront, and the green line represents the sequence of simulated critical values, at a 5% significance level.

A common feature of all four graphics is the huge increase in the BSADF test statistic in early December 2014. Retrieving the numerical sequences, the increase started on the 8th of December, the day of the announcement of the presidential election. The Phillips et al. (2015b) date-stamping method shows that exuberance was estimated to begin on the 9th of December. 3 other exuberance episodes exist that are common to all spreads series. The estimated starting dates are the 6th of January, as anxiety grew in the bonds market, the 27th of January, following the election results, and the 6th of February, the day after the Syriza government received parliament support.

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[10] Table 2 leads to the same conclusion, with evidence showing explosive roots in upfront quotes under both credit event definitions, considering a significance level of 10% for ISDA 2003.

[11] Interestingly, the only case in the 2 tables where the null of the GSADF test is not rejected occurs for SCDSs with upfront quotes, under ISDA 2003, and with a coupon of 100.
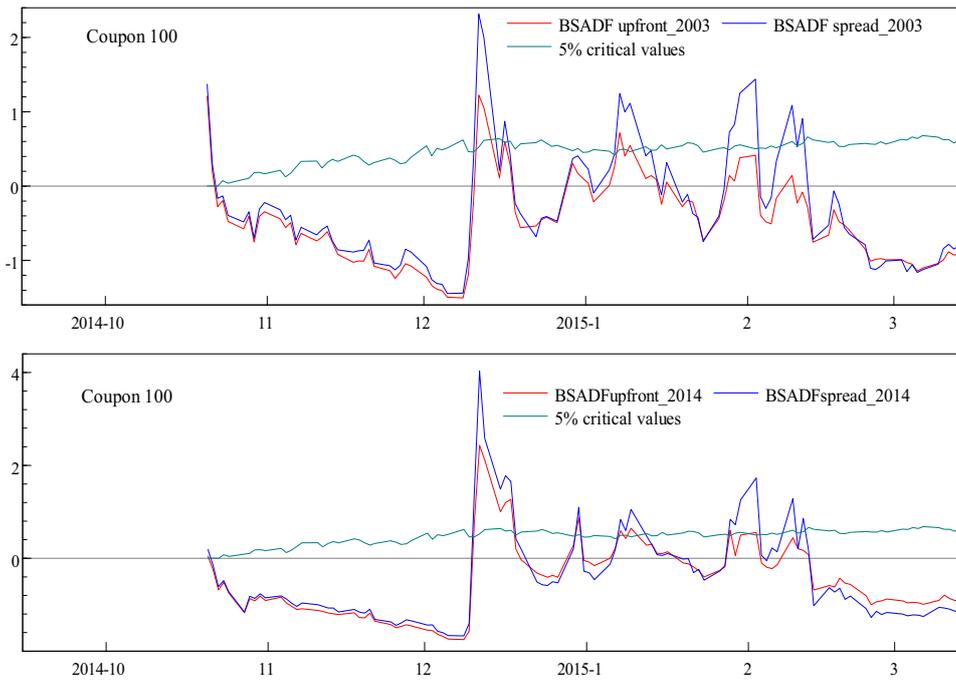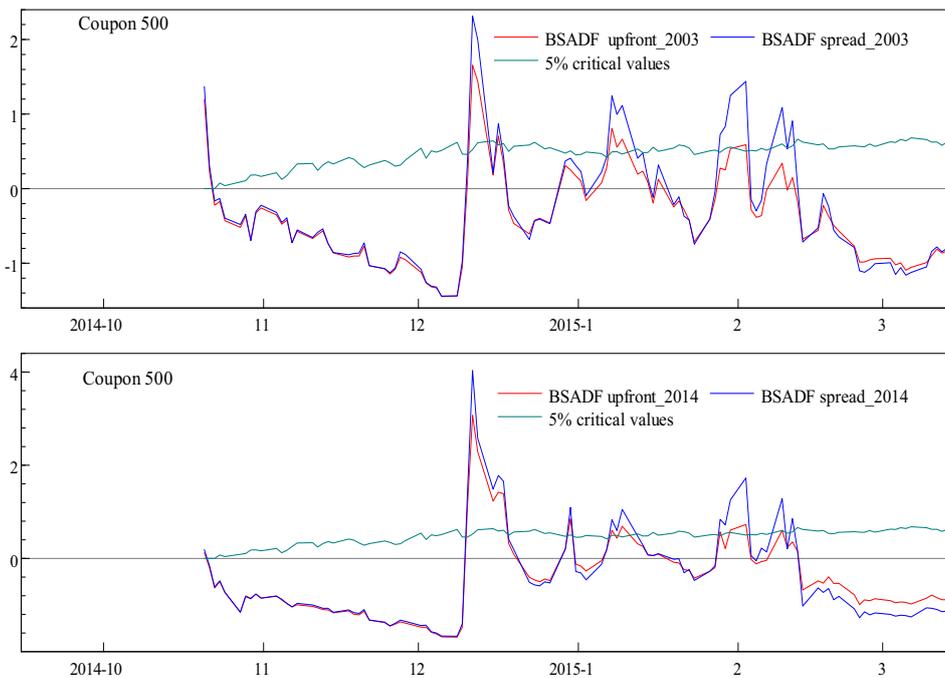
Fig. 4. BSADF test: coupon 100

Fig. 5. BSADF test: coupon 500

In contrast, only one detected exuberance episode is common to all upfront series, with estimated starting date on the 9th of December. The conclusion is that, in spite of its lack of immunity to explosiveness, there are significantly fewer explosive episodes for quotes in upfront points than for spreads. In fact, the parliament support to the new government is never suggested as explosive behavior for upfront quotes. The election period is marginally found in some cases. The financial anxiety of early January is estimated to be an exuberance episode for SCDSs with coupon 500, under ISDA 2003, with estimated starting date on the 6th of January.

In conclusion, not only have we shown that explosive SCDSs behavior is possible, under the current EU regulatory framework, but we have also succeeded to date stamp them for Greece, in our sample period. This second step provides evidence that the market exuberance found is actually meaningful when assessed looking at the relevant dates of the Greek political crisis.

Conclusion

In this paper, we have questioned the possibility of the occurrence of excess reaction episodes in SCDSs markets, under the current EU regulatory framework. Results from section 5 imply that SCDSs exuberance is not avoided, for a distressed country subject to a period of particular political uncertainty and financial anxiety. The path we have followed also allows us to conclude that explosive behavior is found even for the highest fixed coupon, for points upfront quotes, for the augmented credit events list, and in spite of the EU ban on naked SCDSs. We have made no claims on whether explosiveness is due to insufficient measures or mistaken options, nor have we suggested other regulatory measures. Those topics are outside the scope of this paper.

Our results improve on the literature since this is the first paper to provide a rigorous assessment of the current EU regulatory framework, in spite of the large literature that has recently emerged on SCDSs and the EA crisis. Adding to this, to the best of our knowledge, the SCDSs literature had never studied upfront quotes' behavior in detail, had never attempted to discriminate behavior according to the fixed coupon, and had never tried to assess the implications of different credit event definitions. Furthermore, with respect to banning naked SCDSs, the scarce literature is focused on liquidity implications alone.

A natural extension of this paper, with respect to topics discussed in section 1, will be to study explosiveness in Greek sovereign bond spreads. If these are found, it seems natural to us to investigate whether there is co-explosiveness between bond spreads and SCDSs spreads, following the suggestions in Engsted and Nielsen (2012) and Nielsen (2010).

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