Are there any Animal Spirits behind the Scenes of the Euro area Sovereign Debt Crisis?

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TABLE OF CONTENTS

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ABSTRACT

This paper reveals the underlying market's preferences over the on going Euro area sovereign debt crisis. It builds on a loss function with reference to the *'basis'*, the difference between the spread over swap and Credit Default Swap (CDS) for sovereign bonds. This loss function is general and flexible as it nests both a lin-lin and quad-quad functional form. The sample covers those Euro area member states most at risk of default namely: Greece, Portugal, Ireland, Spain and Italy. Results show that market's preferences for some Euro area countries, in particular Greece, have shifted towards pessimism post the Emergency Financing Mechanism (EFM) and troika. If anything, market's reading of Euro area debt crisis points to the direction of serious misalignments post EFM and troika fuelled by growing pessimism and thus uncertainty. Having derived market's preferences, we explore the impact of some specific market characteristics and fiscal rules and fiscal institutions on those preferences. Fiscal rules and institutions appear to improve market's perception over fiscal sustainability, whilst the 3M Euribor, 3M Eurepo, outstanding debt to GDP, and iTraxx main investment grade index also shape market's preferences.

Keywords: Euro area debt crisis, spreads, CDS, loss function, rationality

JEL Classifications: E43, E44, G00, G01, G10.

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Are there any Animal Spirits behind the Scenes of the Euro area Sovereign Debt Crisis?

1. Introduction

Unraveling Ariadne's thread of the Euro area debt crisis is by no means an easy task. Undoubtedly though, one cannot fail to notice that the Euro area sovereign debt crisis has open Pandora's box with far reaching implications. The debt crisis in the last two years has been escalated with some Euro area Member States being under enormous pressure to finance their debt, whilst others experiencing unprecedented low cost to serve their sovereign debt. Rather than attempting to disentangle the causes of this crisis, that has been the norm in the literature to date, we opt to focus on revealing the underlying market's preferences based on the notion of arbitrage opportunities. To this end, our attention is directed towards the echo that comes out of sovereign debt market in light of the on-going fiscal sustainability crisis. To capture this echo, we employ a novel approach that builds on a loss function with reference to the *'basis'*, the difference between the sovereign spread over swaps and sovereign Credit Default Swaps (CDS). Moreover, this paper assesses whether the market behaves rationally as it would do if there exist a symmetric underlying loss function or all interest parties share the same loss function.[1]

[1]Based on Elliott et al. 2005 rationality in sovereign bonds would imply that the underlying loss function, whether linear or non-linear, is symmetric.

The assumption that market's participants should have a symmetric loss function and thus behave rational so as to exclude the possibility of market failure is of key importance. Most previous studies (Crowder and Hamed, 1993; Moosa and Al-Loughani, 1994; and Peroni and McNown, 1998, and Kellard et al. 1999) argue that this assumption is plausible. In absence of market imperfections one would expect that CDS spreads and sovereign bond spreads of the same maturity should be bounded by no-arbitrage conditions. This in turn, implies that the buyer of the sovereign bond could also buy protection for this bond in the CDS market so as to hedge against the default. No-arbitrage would imply that the price of the CDS equals the sovereign bond yield spread. To model the loss function, we opt for a generalised loss functional form proposed by Elliot et al. (2005). The shape parameter of this loss function is a-priori unknown and could reveal information regarding market's preferences. One of the advantages of this methodology is that it is not necessary to observe the underling model of forming sovereign bond spreads and CDS in order to test for asymmetries in preferences.

The corner stone of our analysis lies within the *'basis'*. Blanco et al. (2005) show that there is a long run linear relationship between US corporate bond and CDS (see also for EU markets Norden and Weber, 2004; Zhu, 2006; and De Wit, 2006). However, the existence of this long-run relationship may not imply that short run arbitrage opportunities do not exist. Levin et al. (2005) show that market frictions generate non-zero *'basis'* between CDS and bond spread. Systematic and idiosyncratic factors can explain market frictions (De Wit, 2006, Levin et al., 2005). In a recent paper Favero et al (2010) argue that yields deferential in the Euro area increase in liquidity and risk. Setting aside those systematic and idiosyncratic factors, the documented short run frictions would imply arbitrage opportunities as reflected in the *'basis'*. This paper builds on the perception of market frictions and the resulted arbitrage opportunities that could emerge.

The data set used in this paper comes from Bloomberg and covers 5 years maturity for daily and weekly sovereign spreads over swap and CDS. We focus on those countries in the Euro area mostly at risk of default, namely: Greece, Ireland, Portugal, Spain and Italy. This is the first time in the literature that evidence is provided for the shape parameter of the underlying loss function for those member states with difficulties to finance their long term obligations. The empirical evidence is robust across information sets and shows that overall loss preferences lean towards pessimism and thus asymmetry for most countries, and in particular for Greece. This could be interpreted that for certain Member States sovereign bond market is not *'quite'* rational in terms of its underlying loss preferences as the present empirical evidence reveals that market imperfections prevail, unless all share the same underlying loss function.

In addition, as part of sensitivity analysis, we explore a novel methodology proposed by Giacomini and Rossi (2009) to assess whether there exist structural breakdowns in sovereign bonds market's preferences over time. Such breakdowns could be caused by unexpected events, but also institutional interventions aiming at alleviating sovereign debt crisis in Euro area. Such interventions could alter market's preferences and thus the shape of the loss function. This would essentially mean that the underlying loss function for some member states might not remain stable over time. In a second stage, based on breakdowns tests, we estimate the shape parameter of the loss function for the sub-periods identified so as to investigate whether those breaks in time have an impact on market's behavior. For example, post May 2010, the month the Emerging Financing Mechanism (EFM thereafter) and the memorandum of understanding with strong policy conditionality was signed by Greek Republic, arbitrage opportunities appear to be reinforced and markets clearly lean towards pessimism regarding the prospects of Euro area sovereign debt crisis.

Having derived market's preferences over, we subsequently study the impact of fiscal policy institutions and fiscal rules on those preferences in recent years. Over the last decade the number of fiscal rules in the Euro area has substantially increased (Public Finances in EMU, 2006 and 2007). The empirical evidence shows that there is a link between fiscal rules and market's expectations. Fiscal rules appear to improve market's perceptions over the long-term sustainability of public finances. In terms of fiscal institutions, providing an independent assessment of compliance with existing national fiscal rules also improves market's preferences. The results demonstrate that enhancing fiscal governance plays an important role in shaping market behaviour towards optimism, as it is perceived to contain debt crisis. In addition, market specific characteristics such as 3M Euribor, the spread between Euribor and Eurepo of the same duration, and iTraxx Main Investment Grade index also play a detrimental role in shaping market preferences.

This paper contributes to the literature in several aspects. First, we fit a loss function in sovereign bonds of those Euro area member states under debt pressure for the first time in the literature. Second, we estimate the shape parameter of the underlying generalized flexible loss function. Third, given the shape of the loss function we test for structural breakdowns over time. Fourth, we re-examine asymmetries in the shape of loss function for periods identified by breakdowns tests. Fifth, we explore the impact of specific market characteristics on shape parameter of the underlying loss function. Lastly, we also assess the impact of fiscal rules and fiscal institutions on underlying market's preferences over sovereign bonds.

The remainder of the paper is organized as follows. The second section presents some recent stylized facts about the Euro area sovereign debt crisis. Section three provides the methodology of the loss function. Sections four and five report the data and discuss empirical results respectively. The last section offers some concluding remarks.

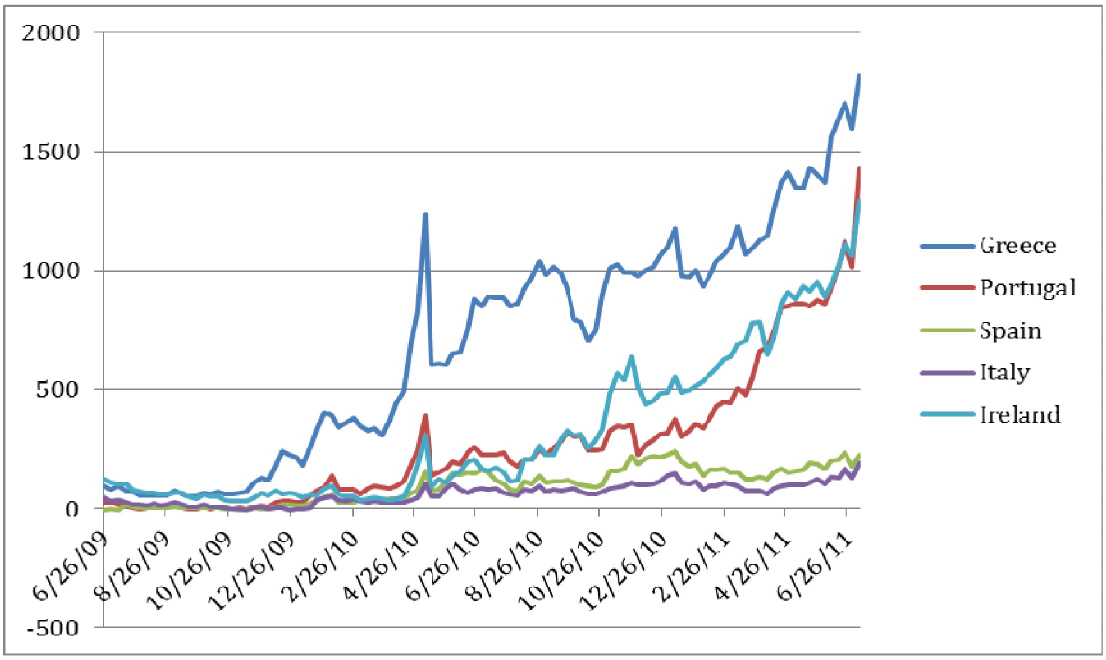
2. Stylized facts of the Euro area sovereign debt crisis

Back in spring 2007 there was hardly any evidence of the storm in sovereign bonds that was about to break. At the time sovereign bonds across euro area Member States appeared to be on track for convergence in terms of yields. Moreover, the yield on the 10-year German sovereign bond was even somewhat lower than the Irish equivalent in July 2007. Alas, a dramatically different picture surfaced not long thereafter. As investors searched for safety German bonds started to appear to them whilst Euro area Member States of south periphery and Ireland, for whom the subprime crisis was detrimental in exposing their perilous state of their fiscal balances, faced the harsh reality of rising borrowing costs. By December 2009 it became clear that the Greek economy faced with the blink reality of not being able to finance its sovereign debt. The five years Greek sovereign bonds spread was 215 basis points above the swap rate at the end of December 2009. The equivalent spread for Ireland was about 45 basis points, whilst it was 28 basis points for Portugal. Those spreads continued to rise ever since, and reached their pick in March 2011 at the height of the euro crisis when the Greek spread jumped to above 1100 basis points, the Irish and Portuguese spreads reached 772 basis points and 636 basis points respectively. There have been some fluctuations thereafter but overall the sovereign spreads of southern euro area and Ireland have remained at high levels ever since. These dramatic developments led to the Euro area debt crisis and have raised questions regarding the viability of the euro.

In some detail, there exist some distinct episodes in the euro area sovereign debt crisis. In the beginning, as early as mid-2007 the subprime crisis did not bite into euro sovereign spreads, giving the false impressions to national governments at the time that they had weathered out the crisis. The collapse of Lehman Brothers and the resulted credit crunch triggered a widening of spreads of the weakest economies within the euro area, in particular towards the end of 2009. During this period sovereign spreads for some southern Euro area member states and Ireland showed stark divergence from triple A economies such as Germany. Then, in spring 2010, the Greek sovereign debt crisis burst that led spreads and CDS to record high levels. Hikes in Greek sovereign yields and CDS feast in to the rest of fiscally vulnerable southern euro area countries whilst Ireland followed suit, though in the latter case it was due non-performing loans of private banks that has to be rescued.

Diagram 1 presents the Euro area spreads over time for the southern periphery and Ireland. In May 2010, the month that Greece applied for financial assistance to the Euro area and the IMF, the spread between the spread on a 5-year Greek spread reached values higher than 1100 basis points.

DIAGRAM 1: Spreads over Swaps, 5 years maturity, weekly



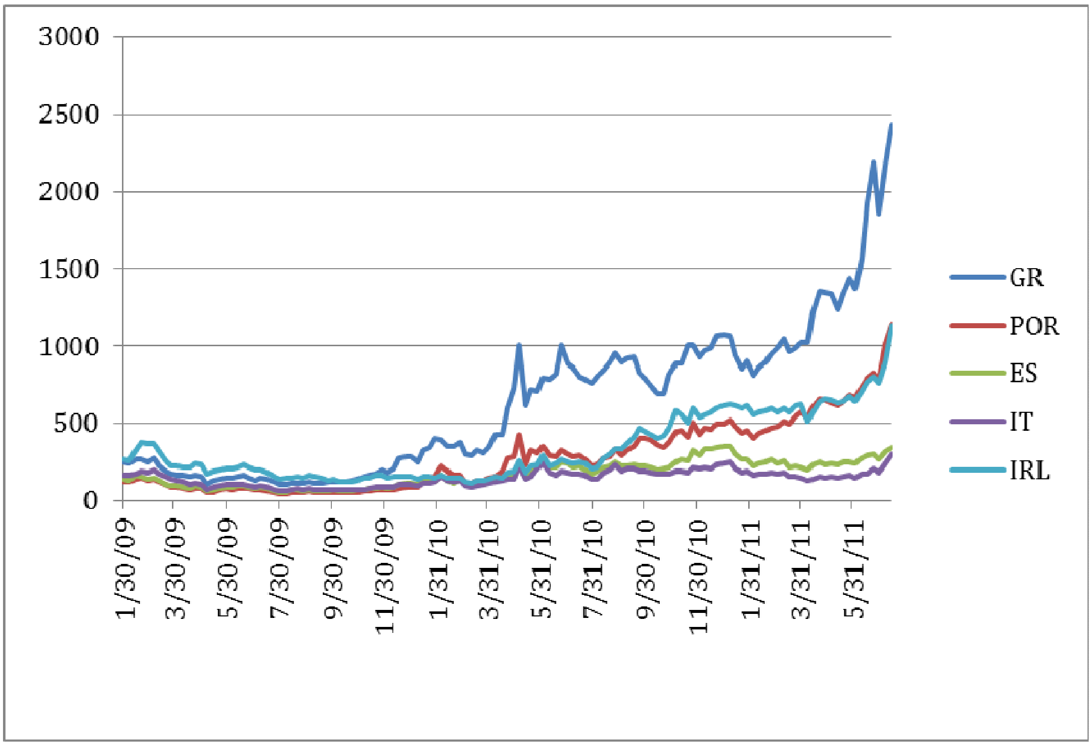
Source: Bloomberg

The Greek memorandum of understanding contained strong policy conditionality of Emergency Financing Mechanism (EFM thereafter), a joint initiative of the IMF, the EU Commission and the ECB, and it was signed in May 2010. Following the EFM, the Greek spread fell to around 607 basis points in end May 2010. Alas, markets found hard to accept that the EFM could act as a therapy to the sovereign credit crisis and thereby sovereign spreads started to rise once more in summer of 2010.

By 2011, the Greek spread reached levels as high as 2000 basis point whilst it went beyond this threshold late in 2011. Likewise, the spreads for Portugal and Ireland sharply climbed up in 2011.

In parallel with sovereign spreads that provide guidance over the credit risk CDS could act as warning signal within a risk management framework. CDS reflect the premium investors are willing to pay to insure against a credit event. Diagram 2 presents recent developments in Euro area CDS and shows that there have been hikes similar in pattern with the ones of spreads. It is factual to observe that prior to the Greek debt tragedy, sovereign CDS for Euro area have not been that interesting, as there was hardly any sign of a viable market. Once the Greek sovereign default became a real threat sovereign CDS market for Euro area has sparked into life. Duffie (2010) argues that hikes in CDS could show remarkably obstinacy in the aftermath of credit crunch. He suggests that there are several reasons behind these hikes, such as: severe depletion of capital, large distortions in arbitrage, funding risk and market liquidity risk, whilst counterparty risk and default risk could also play a role but not as significant. Fontana and Scheicher (2010) argue that short-term expectations regarding sovereign yields in the light of imminent increases in sovereign bond issuance, together with market's expectations regarding the probability of default, could contribute to high CDS. Favero et al (2010) demonstrate that liquidity and risk affect government bonds yields in the Euro area. What the literature fail to account is that the 'basis' could echo some market's concerns, preferences over the unfolding Euro area debt crisis.

DIAGRAM 2: Credit Default Swaps, 5 years maturity, weekly



Source: Bloomberg

Undoubtedly, the dramatic developments of Euro area sovereign debt crisis warrant a study of underlying market's preferences that, in turn, could shed new light. However, most studies examine the role of fiscal imbalances (Sgherri and Zoli, 2009, Mody, 2009, Haugh et al., 2009), of market liquidity or market integration (Manganelli and Wolswijk, 2009), of migration risk (rating downgrades), and to less extend the risk of outright default (Fontana and Scheicher, 2010). Fontana and Scheicher (2010) and Favero et al (2010) were the first to study the movement of Euro area sovereign spreads and CDS using various covariates. The authors build on the earlier study of Blanco et al. (2005) where a long run linear relationship between US corporate bond and CDS is found, whilst Levin et al. (2005) show that market frictions generate non-zero CDS-bond spread *'basis'*.

In this paper we opt for a different methodology as we aim not to study the arbitrage conditions of sovereign debt but to reveal the underlying market preferences that ultimately would affect such conditions. We build on the notion of *'basis'* as a result of market frictions and arbitrage opportunities in the short run (Blanco et al, 2005). This would imply that an investor with a long position in sovereign bond could also buy protection in CDS market to hedge against the risk of default given liquidity constrains and equal maturity in both the bond and CDS. In the event of no-arbitrage the CDS should equal the sovereign bond spread over swap. [2]

3. Methodological Framework of the Underlying Loss Function

We model the *'basis'* between sovereign spread and CDS as the main component of market's generalized loss function given there are short run frictions and as result misalignment in prices. Moreover, the main variable of such market's loss function is its shape parameter *'alpha',* '*α alpha'* thereafter*,* that would reveal whether the loss function is symmetric or otherwise asymmetric. To model the generalised loss function, we opt for a functional form as in Elliot et al. (2005). The shape parameter of this loss function is not known and could reveal

[2] There are numerous trading strategies in the sovereign CDS market. First, a trader could take a long and short position simultaneously to exploit misalignments in prices. Second, one could sell CDS protection on sovereign bonds and buy CDS protection on corporate bonds in the same country. Third, one could be net buyer of sovereign CDSs. The last case is particularly popular among hedge funds. Fourth, portfolio managers could buy sovereign CDSs to hedge against macroeconomic risks. There are also synthetic options such as first to default CDSs on sovereign risk. These strategies are only a portion of the existed ones and point out to the direction of complexities one could face attempting to disentangle the impact of market's expectations on sovereign CDS spreads. For example, the recent hikes in CDS spreads could be the outcome of expectations regarding future increases in sovereign bond issuance.

information regarding market preferences. Note that there is not a prerequisite to observe the model of forming sovereign spreads and CDS so as to estimate the shape parameter of the loss function.

Moreover, following Elliott et al. (2005) we define $CDS_t \equiv \vartheta' W_t$ be the CDS conditional on the information set F_t in which ϑ is an unknown *k*-vector of parameters, $\vartheta \in \Theta$, with Θ compact in R^k, and W_t is an h-vector of variables that are F_t measurable.[3] Essentially, W_t represents the full set of factors and is known to the market at time *t* and could affect their preferences.

When the CDS_t are formed we assume that, given the $Spread_t$ and W_t, the market follows a generalized flexible loss function *L*, which could reveal their preferences, defined by

$$L(p,\alpha) \equiv [\alpha + (1-2\alpha)1(Spread_t - CDS_t < 0)]\left|Spread_t - CDS_t\right|^p \quad (1)$$

where *p* takes values 1,2, if *p*=1 the loss function is linear and for *p*=2 is quadratic, whilst $\alpha \in (0,1)$ and depicts the shape parameter of the loss function. **1** is an indicator and ($Spread_t$ -CDS_t) is the difference between the spread over swap and CDS, implying an error, which represent market imperfections and thus short run arbitrage opportunities.

The key parameter in equation (1) is $\alpha \in (0,1)$, the '*alpha'*, as it contains information regarding the shape of the loss function and thus its symmetry or asymmetry.

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[3] Within this framework it is not necessary to know the underlying model of forming spreads and CDS. CDS could be considered as forward-looking prediction of spread plus a premium (Blanco et al, 2005). The premium is considered as fixed, and thus exogenous to the loss function.

By observing the sequence of CDS_t, τ≤t<T+τ the estimate of *'α'* is given using a linear GMM Instrumental Variable estimator[4] $\hat{\alpha}_T$, as follows:

$$\hat{\alpha}=\frac{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t\left|Spread_t-CDS_t\right|^{p_0-1}\right]'\hat{S}^{-1}\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t\mathbf{1}(Spread_t-CDS_t<0)\left|Spread_t-CDS_t\right|^{p_0-1}\right]}{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t\left|Spread_t-CDS_t\right|^{p_0-1}\right]'\hat{S}^{-1}\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t\left|Spread_t-CDS_t\right|^{p_0-1}\right]} \quad (2)$$

where v_t is a dx1 vector of instruments which is a subset of the information set used to generate f, while $\hat{S}$ is given by[5]:

$$\hat{S}=\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t v_t'(\mathbf{1}(Spread_t-CDS_t<0)-\hat{\alpha}_\tau)^2\left|Spread_t-CDS_t\right|^{2p_0-2} \quad (3)$$

As in Elliott *et al.* (2005) the estimator of α_T is considered to be asymptotically normal and a J-statistic follows $X^2(d-1)$ for d>1 and takes the form:

$$J=\frac{1}{T}\left[\begin{array}{l}\left(\sum_{t=\tau}^{T+\tau-1} v_t\left[\mathbf{1}(Spread_t-CDS_t<0)\right]\left|Spread_t-CDS_t\right|^{p_0-1'}\right)\hat{S}^{-1}\\ \times\left(\sum_{t=\tau}^{T+\tau-1} v_t\left[\mathbf{1}(Spread_t-CDS_t<0)-\hat{\alpha}_T\right]\left|Spread_t-CDS_t\right|^{p_0-1}\right)\end{array}\right]\sim X^2_{d-1} \quad (4)$$

If preferences were asymmetric then CDS_t under the generalised loss function of equation 1 would be an optimal forward looking of $Spread_t$ if and only if the following first order optimality condition is met:

[4] In the empirical part of the paper three instruments are opted, a constant, the lagged difference between CDS and spread, and the lagged difference of CDS.

[5] $\hat{S}$ depends on α_T and as a result the estimation takes place iteratively, assuming $\hat{S}$ =I in the first iteration to estimate α_T until convergence.

$$E\left[W_t\left(\mathbf{1}_{(\text{Spread}_t - CDS_t<0)} - \alpha\right)\left|Spread_t - CDS_t\right|^{p-1}\right] = 0 \quad (5)$$

where W_t is as above the full set of factors and are known to the market at time t and a is the loss asymmetry parameter. Once *'α'* and p are known the market could use the first order condition to define CDS_t in a unique way as proved by Elliott et al (2005). In another step, once CDS_t is identified one could employ first order condition (5) to retrieve *'α'* in a unique way. Moreover, Elliott et al. (2005) proves in Lemma 2 that the above first order condition is necessary to estimate *'α'* employing a sub vector V_t of W_t.

4. The Data Set

The sovereign spread for Greece, Ireland, Portugal, Italy and Spain at time *"t"*, ($Spread_t$) is measured as the difference between secondary-market yield on the country's 5-year bond and the swap rate. Since the swap rate is widely regarded by the markets as a *'risk-free'* rate, the spread is considered as premium against risk of default. On the other hand, CDS echoes insurance premium against risk of default. Thus, CDS is forward-looking with regards to spreads. All variables are derived from Bloomberg and where missing from Datastream.

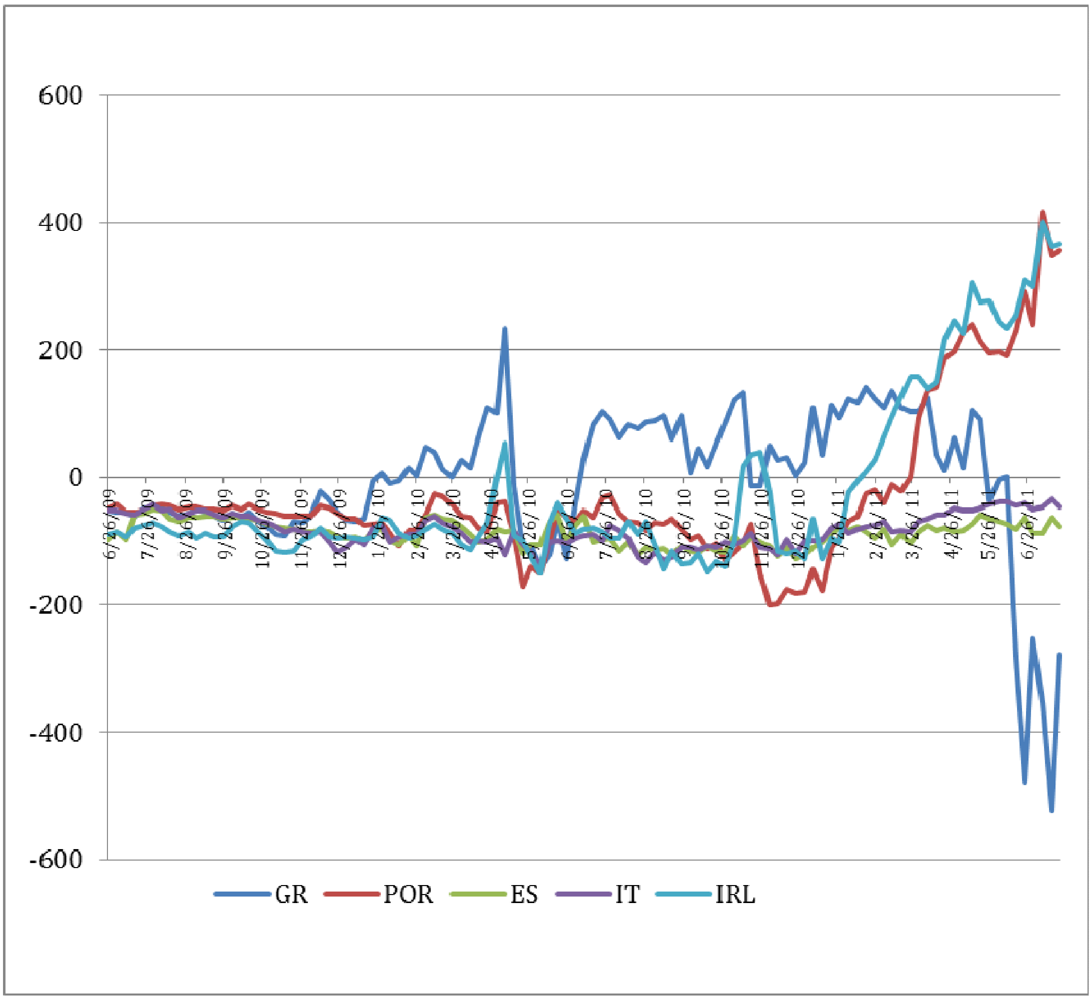
Moreover, the CDS market is set so as the seller pays the buyer in the event of default before maturity of the contract. What defines a default event is not always forthright. Default events could take the form of bankruptcy, failure to pay, obligation default or acceleration, repudiation or moratorium (for sovereign entities), and restructuring. Albeit *restructuring*, as it is demonstrated by the Greek case, may not constitute default. Based on the 1999 International Swaps and Derivatives Association (ISDA) documentation *restructuring* establishes '*a default event if either the interest rate or principal paid at maturity are reduced or delayed, or an obligation's ranking in payment priority is lowered or there is a change in currency or composition of any payment*'.

The sovereign CDS also is a trading instrument and not a pure insurance instrument. Moreover, taking an outright position on spreads depends on traders' expectations over a short horizon. To this end, CDS could be used for hedging macroeconomic uncertainty or risks. That is CDS could be used as a relative-value trading instrument by taking a short position in country X and a long position in country Y. This may also result to arbitrage trading that is sovereign bonds versus CDS.

The observed high CDS premium during crisis could imply underling declining risk appetite, falling market liquidity, credit rating downgrades (migration risk) (Fontana and Scheicher, 2010), or even '*economic catastrophe risk*' (Berndt and Obreja, 2010), and not so much principal losses on outstanding debt.

For example, when the *'basis'* is negative sovereign bonds are costlier than CDS, implying that bond spreads are lower than CDS (see Diagram 3). This, in turn, means that profit could be realised if *'basis'* trade takes place that is to buy bond and CDS protection. In reality liquidity constraints do not abate and as a result buying bonds to short-sell, via a repo transaction, is not inexpensive. In addition, in case repo rates are low hedging positions is costly as bonds are hard to get and short-sell. The main drawback of costly bonds is that not all deliverable bonds could be necessarily due and payable should restructuring occur. Some deliverable bonds could be cheaper, whilst deliverable bonds with long maturity or convertible bonds would be traded at a discount to short maturity bonds.

DIAGRAM 3: The *'"basis"'* (Spread$_t$ -*CDS$_t$*), 5-years maturity, weekly



<u>Source</u>: Bloomberg

Moreover, the negative *'basis'* strategy (see Greece) requires funding for buying bond position. During market turbulence traders are unwilling to enter such a position due to the price volatility, therefore *'haircuts'* for the position could prove to be volatile and sizable. Gorton and Metrick (2009) show that repo market haircut takes central part during financial crisis. Note the striking difference between movements in the *'basis'* of Greece compared to Portugal and Ireland in recent months.

To make things even more complicate what constitutes a default event is not an easy task. For example, concerning the histrionic Greek case, ISDA communication on 31th of October 2011 EU over the restructuring of the Greek sovereign debt argues: *'Based on what we know now, it appears from news reports that the Eurozone proposal involves a voluntary exchange that would not be binding on all holders.'* On 1st March 2012 ISDA in another communication argues that in the case of Greece and the voluntary haircut '…*a Restructuring Credit Event has not occurred under Section 4.7(a) of the 2003 Definitions.*' Alas, on 9th March 2012 ISDA declared that '…*that the invoking of the collective action clauses by Greece to force all holders to accept the exchange offer for existing Greek debt constituted a credit event under the 2003 ISDA Credit Derivatives Definitions.*' In legal terms, Greek sovereign has defaulted in March 2012. Since then, there are no market data for Greek CDS and sovereign bonds other than treasury bills.

5. Empirical Results

5.1 Asymmetry parameter estimates

We estimate equations (2) and (3) using GMM with instruments for both the linear (*p*=1, linin-lin) and non-linear case (*p*=2, quad-quad). Three instruments are opted: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3).

Table 1 reports results. Our estimated loss function parameters are all statistically different from zero. For most cases *'α'* takes values somewhat higher than 0.5 but close to 0.5 (see lin-lin case for D=1 and D=2 and quad-quad case for D=3), indicating rational loss preferences associated with a symmetric loss function. However, there is some variability for different set of instruments and also for the quad-quad case. Moreover, for the case of D=2 in quad-quad *'α'* takes values below 0.5 and away from symmetry. When the shape parameter *'α'* takes values less than 0.5 it indicates optimistic preferences associated with an asymmetric loss function.

TABLE 1: Asymmetric loss function for Greek Spreads over swap - 5 yr CDS, weekly

Linear case, 05/09/2008 to 22/07/2011						
	$\hat{a}$	**SE**	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.5285	0.0204	4.8027	180.1242	1.9396	136.038
D=2	0.5479	0.0204	120.569	201.0684	123.4258	162.605
D=3	0.5818	0.0146	273.8411	268.36	371.627	302.5771
Non-Linear case						
	$\hat{a}$	**SE**	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.5951	0.0235	1.81E-27	139.8045	14.6803	75.0237
D=2	0.45	0.0234	177.9079	149.6734	183.0547	165.9722
D=3	0.4937	0.0079	208.5826	160.4143	264.9902	285.5281

Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (*p*=1) and non-linear case (*p*=2).

J-statistics are distributed as X^2 (D-1 for D>1) $J_{\hat{a}}$ and X ^{2}(D) for the remaining J.

Critical values for X2 (2): at 1% 9.21, at 5% 5.99, and at 10% 4.60.

Note that for *'α'* greater than 0.5 the slope of the generalised loss function would be steeper for positive *'basis'*, which would imply that the market preferences would support higher CDS than spread. If this is so, the perceived loss by the market is much higher when the CDS, the insurance premium against default, is lower than the spread. A rising CDS would in turn highlight that the Greek sovereign debt crisis would be far from over and higher yields would be requested. On the other hand, if *'α'* is lower than 0.5, once more we would have observed asymmetry but this time marker preferences would suggest that the loss of a negative *'basis'* is high, and as result Spread should be higher than CDS.

Elliott et al (2005) argue that deviations from symmetry would lead to deviations from rational behaviour unless all interest parties share the exact same loss function. This is something that will be hard to meet as different parties have different objectives. However, rationality could still be achieved if the underlying market loss function for sovereign debt is revealed to all interest parties so they, then, can adjust their preferences accordingly. This paper for the first time reveals the underlying preferences for a key market that has been in the epicentre of a financial turmoil in recent years.

We also report *J-statistics* for three alternative null hypotheses, $H_0 : a = \hat{a}$ (from the estimation), *α=0.2*, and *α=0.8*, the latter two representing optimistic and pessimistic preferences respectively. In particular for the non-linear loss function and for *'α'* that are statistically different from 0.5 the likelihood to reject the null of 0.8 is lower.

TABLE 2: Asymmetric loss function for Spreads-5 yr CDS, weekly, 05/09/2008 to 22/07/2011

Portugal Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.4807	0.0086	3.1425	813.4794	5.0607	983.4059
D=2	0.4802	0.0086	42.5789	820.3134	48.1276	990.8552
D=3	0.3755	0.0083	1.4403	1.24E+03	1.54E+03	1.37E+03
Portugal Non-Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.471	0.0124	2.2327	349.5264	5.56E+00	534.039
D=2	0.4147	0.0119	214.9597	357.4935	2.35E+02	575.0179
D=3	0.297	0.0102	405.8339	386.6739	5.83E+02	621.9189

Italy Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.4807	0.0086	3.14E-25	813.4794	5.0607	983.4059
D=2	0.4802	0.0086	42.5789	820.3134	48.1276	990.8552
D=3	0.3755	0.0083	1.44E+03	1.24E+03	1.54E+03	1.37E+03
Italy Non-Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.471	0.0124	2.23E-27	349.5264	5.56E+00	534.039
D=2	0.4147	0.0119	214.9597	357.4935	2.35E+02	575.0179
D=3	0.297	0.0102	405.8339	386.6739	5.83E+02	621.9189

Spain Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.4807	0.0086	3.14E-25	813.4794	5.0607	983.4059
D=2	0.4802	0.0086	42.5789	820.3134	48.1276	990.8552
D=3	0.3755	0.0083	1.44E+03	1.24E+03	1.54E+03	1.37E+03
Spain Non-Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.471	0.0124	2.23E-27	349.5264	5.56E+00	534.039
D=2	0.4147	0.0119	214.9597	357.4935	2.35E+02	575.0179
D=3	0.297	0.0102	405.8339	386.6739	5.83E+02	621.9189

Ireland Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.2507	0.0417	23.4132	1.4211	27	66.6735
D=2	0.0587	0.0226	23.4065	48.509	69.3296	70.9639
D=3	0.0574	0.0224	23.4966	51.2218	87.4611	88.375
Ireland Non-Linear case						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.4073	0.0613	1.11E-29	7.6663	2.6042	45.7133
D=2	0.1364	0.0398	15.2392	19.6943	59.2447	69.7312
D=3	0.0899	0.028	16.0958	30.7642	71.9806	83.7809

Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (*p*=1) and non-linear case (*p*=2).

J-statistics are distributed as X^2 (D-1 for D>1) $J_{\hat{a}}$ and X^2(D) for the remaining J.

Critical values for $X^2(2)$: at 1% 9.21, at 5% 5.99, and at 10% 4.60.

5.2 A test for structural breakdowns

As we are dealing with a long time period, one could reasonably argue that during this period there must have been events that could alter the shape parameter, *'α',* of the underlying loss function of both spread and CDS. In order to assess the existence of such events in time series we opt for a novel methodology proposed by Giacomini and Rossi (2009) that tests breakdowns over time and builds on the framework of generalized loss function similar to the one used above.

Following Giacomini and Rossi (2009) we consider $Z \equiv \{Z_t : \Omega \rightarrow R^{s+1}, s \in N, t = 1,\ldots,T\}$ a stochastic process defined on a complete probability space *(Ω, F, P),* and partition the observed vector Z_t as $Z \equiv (Spread_t, X_t^{'})^{'}$, where $Spread_t : \Omega \rightarrow R$ is the variable of interest, that is the spread, and $X_t : \Omega \rightarrow R^s$ is the vector of variables that form spreads, including CDS.

This methodology builds a succession of τ-step-ahead $Spread_{t+\tau}$ using an out of sample process that encompasses dividing the sample T into an in-sample size *m* and an out-of-sample size *n=T-m-τ+1*. As in Giacomini and Rosi (2009) we allow for three schemes of forming spreads: (i) a fixed scheme, where the in-sample window at time *t* contains observations indexed 1,…,m; (ii) a rolling scheme, where in-sample window at time *t* contains observations indexed *t-m+1,…,t*; and (iii) a recursive scheme, where the in-sample window includes observations indexed *1,…,t*.

The time *t* future, $\varphi_t(\hat{\beta}_t)$, is produced by estimating a model over in-sample window at time *t*, with $\hat{\beta}_t$ indicating the *kx1* parameter estimate. Then the spread is evaluated by a loss function *L( ),* with each out-of-sample loss $L_{t+\tau}(\hat{\beta}_t) \equiv L(f_{t+\tau}, \varphi_t(\hat{\beta}_t))$ corresponding to in-sample losses $L_j(\hat{\beta}_t) \equiv L(P_j, \hat{p}_j(\hat{\beta}_t))$.

Now given the in-sample and the out-of-sample loss we define *'surprise loss'* as the difference between the out-of-sample loss at time t + τ and the average in-sample loss:

$$SL_{t+\tau}(\hat{\beta}_t) = L_{t+\tau}(\hat{\beta}_t) - \bar{L}_t(\hat{\beta}_t) \text{ for } t=m,\ldots,T\text{-}\tau. \quad (6)$$

where $\bar{L}_t(\hat{\beta}_t)$ is the average in-sample loss computed over the in-sample window.

The out-of-sample mean of the surprise losses is:

$$\overline{SL}_{m+n} \equiv n^{-1}\sum_{t=m}^{T-\tau} SL_{t+T}(\hat{\beta}_t) \quad (7)$$

We could state that out-of-sample mean of the surprise loss is simply:

$$SL_{t+\tau} = L_{t+\tau} - \bar{L}_t \text{ for } t = m,\ldots,T-\tau \quad (8)$$

where the out-of-sample loss is given by

$$L_{t+\tau} = L\left(Spread_{t+\tau} - CDS_{t+\tau}\right) \quad (9)$$

The average in sample loss $\bar{L}_t$ would be estimated by certain underlying schemes, such as

Fixed Scheme: $\bar{L}_t = \frac{1}{m}\sum_{j=1}^{m-\tau} L\left(Spread_{j+\tau} - CDS_{j+\tau}\right)$

Rolling Scheme: $\bar{L}_t = \frac{1}{m}\sum_{j=t-m+1}^{t-\tau} L\left(Spread_{j+\tau} - CDS_{j+\tau}\right)$

Recursive Scheme: $\bar{L}_t = \frac{1}{t}\sum_{j=1}^{t-\tau} L\left(Spread_{j+\tau} - CDS_{j+\tau}\right)$

(10)

Based on equation (6), and given the underlying schemes (10), CDS as forward-looking information could be employed to define spread. If this is the case a test should show that the mean of equation (6) is close to zero. That is the test has a null hypothesis:

$$H_0 : E\left(n^{-1} \sum_{t=m}^{T-\tau} SL_{t+T}(\beta^*) \right) = 0$$, for all *m, n*. (11)

And, the structural breakdown test statistic is:

$$t_{m,n,\tau} = \sqrt{nSLm,n} / \hat{\sigma}_{m,n}$$ [6] (12)

The main advantage of the methodology of Giacomini and Rossi (2009) is the robustness to the presence of unstable regressors. Next we test for breakdowns in spreads based on the above test statistic.[7] Such breakdowns are defined as unexpected events, exogenous to the market, which could lead to default. In the event that a breakdown in spreads would arise the out-of-sample performance of the spread model is significantly worse than its in-sample performance.

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[6] For information regarding the construction of the asymptotic variance estimator $\hat{\sigma}_{m,n}$ see Giacomini and Rossi (2009).

[7] Giacomini and Rossi (2009) have applied their method on the Phillips curve for the economy of US.

5.3 Results of Structural breakdowns

After observing our time series we perform tests for structural breaks in the spreads for the following date: 07/05/2010, marking the date of signing the Emergency Financing Mechanism and the memorandum of understanding regarding policy conditionality. This has been a joint initiative of the IMF, the EU Commission and the ECB, aiming to provide financial assistance to Greece.

The time horizon for spreads is considered as $\tau=1$, $\tau=5$ and $\tau=10$ weeks ahead and we use several choices of lags.

TABLE 2: t-stat and p-values of structural break in the loss function of the difference between 5 yr Greek Spreads over swaps and CDS, weekly.

Structural break on 07/05/2010		
	$t_{m,n,\tau}$	p-values
	$\tau=1$	
Scheme=1	3.2298	0.0116
Scheme=2	3.7866	0.0269
Scheme=3	3.6310	0.0552
	$\tau=5$	
Scheme=1	3.1160	0.0138
Scheme=2	3.5863	0.0347
Scheme=3	3.4595	0.0586
	$\tau=10$	
Scheme=1	2.9718	0.0377
Scheme=2	3.3474	0.0846
Scheme=3	3.2508	0.0978

Scheme 1 is the fixed scheme, where the in-sample window at time t contains observations indexed 1,…,m; scheme 2 is a rolling scheme, where in-sample window at time t contains observations indexed $t-m+1,\dots,t$; and last scheme 3 is a recursive scheme, where the in-sample window includes observations indexed $1,\dots,t$. The lag for the Newey-West estimator is opted as $n^{1/3}$ of the asymptotic variance.

Based on the evidence reported in Table 2 there are structural breaks. Moreover, under all schemes and for all time horizons the null of no structural breakdown is rejected. This result implies that the spread series do not remain stable over time, and this may result to changes in the shape parameters of the loss function. As part of sensitivity analysis, we should re-examine the shape parameter for the different periods identified by breakdown tests.

5.4 Asymmetry in the loss function in sub-periods

Table 3 and Table 4 presents parameter estimates of*'α'* for spreads for the sub periods from 05/09/2008 to 27/04/2010 and from 05/09/2008 to 07/05/2010 respectively, the latter marking the period post Emergency Financing Mechanism (EFM thereafter).

For the first sub-period, as reported previously, an asymmetric loss function that clearly leans towards optimism exists. In detail, *'α'* takes a value lower than 0.5. For the non-linear case *'α'* takes even lower values than 0.3.

Interestingly, in the aftermath of the Emergency Financing Mechanism preferences seem to dramatically shift towards pessimism as *'α'* is much higher than 0.5 in all cases. In the case of using three instruments (D=3) the non-linear loss function exhibits the highest value of asymmetry; *'α'* = 0.97.

TABLE 3: Asymmetric loss function for 5 yr Greek Spreads over swap and CDS, weekly

Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.4606	0.0274	8.2529	70.8429	2.0485	104.5333
D=2	0.142	0.0192	146.8465	153.2434	111.3308	117.1562
D=3	0.0442	0.0113	150.7396	212.9208	191.0684	137.5088
Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.7625	0.0258	1.6828	173.871	74.36	2.3913
D=2	0.7604	0.0257	0.1497	173.8844	74.5431	2.4975
D=3	0.9403	0.0143	56.3048	187.6885	187.5612	121.6407
Non-Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.279	0.027	7.4429	9.9429	35.413	86.9294
D=2	0.023	0.0075	110.0927	70.0733	37.5096	101.9112
D=3	0.0208	0.0045	109.9094	125.0005	89.8798	102.2421
Non-Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.8088	0.0259	2.0328	145.0907	80.3412	0.1141
D=2	0.8362	0.0232	5.6679	145.0964	84.7474	7.861
D=3	0.9761	0.0069	41.0372	145.2198	145.5484	138.649

Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (*p*=1) and non-linear case (*p*=2).

J-statistics are distributed as X^2 (D-1 for D>1) $J_{\hat{a}}$ and X^2(D) for the remaining J.
Critical values for X^2 (2): at 1% 9.21, at 5% 5.99, and at 10% 4.60.

TABLE 4: Asymmetric loss function for 5 yr Greek Spreads over swap and CDS, weekly

Linear case, period from 05/09/2008 to 07/05/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.3465	0.0262	1.089	2.851	31.0061	156.5886
D=2	0.2994	0.0253	38.6074	43.3944	89.9243	168.7441
D=3	0.0853	0.0154	103.6182	156.8048	238.2036	208.511
Linear case, period from 07/05/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.7765	0.0256	4.3E-28	173.4414	80.7424	0.8364
D=2	0.7795	0.0255	1.4317	173.541	82.3179	2.0246
D=3	0.9456	0.014	50.0866	186.8996	188.9191	121.003
Non-Linear case, period from 05/09/2008 to 07/05/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.2844	0.0318	3.923	6.5131	42.6959	142.4559
D=2	0.1792	0.0202	15.4318	17.1666	113.7006	163.3697
D=3	0.0931	0.0136	48.8528	90.0204	163.7189	170.6493
Non-Linear case, period from 07/05/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.8135	0.0261	1.4528	143.904	80.9995	0.2669
D=2	0.8545	0.0227	9.8816	143.9304	86.8275	14.5188
D=3	0.9786	0.0066	37.5591	144.1306	145.9172	139.4704

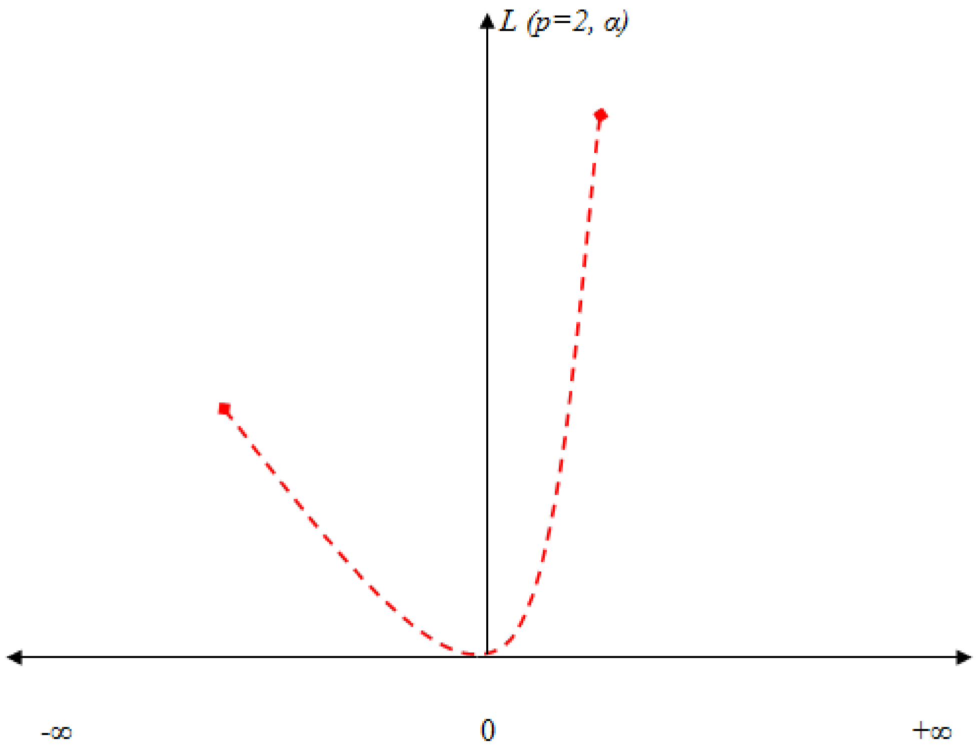
Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (*p*=1) and non-linear case (*p*=2).

J-statistics are distributed as X^2 (D-1 for D>1) $J_{\hat{a}}$ and X^2(D) for the remaining J.
Critical values for X^2 (2): at 1% 9.21, at 5% 5.99, and at 10% 4.60.

In addition, we use *J-statistics* for three null hypotheses, $H_0 : a = \hat{a}$ (from the estimation), *α=0.2*, and *α=0.8*, the latter two representing optimistic and pessimistic preferences respectively. In particular for the non-linear loss function and for *'α'* that are statistically different from 0.5 the likelihood to reject the null of 0.8 is lower. Indeed, in many specifications, the asymmetric *J-stat* of the null of *α*=0.8 is not rejected. This is evidence in favour of the hypothesis of pessimism.

Moreover, these results indicate that post May 2010 market assigns higher loss for the case that CDS is lower than the spread that is for positive values in the difference between spread and CDS (see Diagram 4, right hand scale of the horizontal axis). Moreover, Diagram 4 depicts the asymmetry of the loss function as estimated post May 2010.

DIAGRAM 4: Asymmetric loss functions (*α*>0.5)



<u>Note</u>: horizontal axis shows *Spread$_t$-CDS$_t$*, whilst on the vertical axis is the quadratic loss function, *L(p=2,α)*.

Note, that post May 2010, the slope of the loss function is steeper for positive values in the difference between spread and CDS. This implies that the loss for the market is much higher when the CDS, the insurance premium against default, is lower than the spread. Thus, post May 2010 the market clearly exhibits a preference towards higher CDS than Spreads. This may not imply departure from prudency, but rather a safety mechanism against higher probability of default. Moreover, this revealed preference could suggest that according to the market the Greek sovereign debt crisis would eventually lead to default.

A question might arise then; could this result in the detection of a realignment of in market's expectations in recent months? Note that assigning higher loss for the case that spread is higher than the CDS suggests that the market sees arbitrage opportunities in the case of Greek sovereign debt that are too good to miss out. To this end, an asymmetric loss function that leans towards pessimism could be considered under those preferences to reflect prudency, as it reveals the market's perception that the Greek economy eventually will default to some extent, though at the first site it deviates from rational behaviour and thus efficiency. However, note that unless all participants of Greek sovereign bonds share the same underlying loss function, asymmetry and thus pessimism would indicate deviation from rationality.

5.5 Explaining *Alpha*

The sensitivity analysis of last session shows breakdowns in the Greek sovereign bond spreads post May 2010. Since May 2010 the underlying martket's preferences show a clear shift towards higher loss for the case that CDS is lower than spread. This implies that market preferences of Greek sovereign bonds have shifted clearly towards pessimism. This asymmetry in the underlying loss function of Greek sovereign bond spreads insinuate arbitrage opportunities, also reflecting sizeable risks regarding long- term sustainability of Greek public finances.

Having derived market's expectations over the Euro area sovereign debt crisis, as reflected by the shape parameter *'alpha'*, '*α*', we examine the impact of fiscal policy institutions and fiscal rules on those expectations in recent years; from 1st quarter 2009 to 2nd quarter of 2011. The sample includes Greece, Portugal, Ireland, Italy and Spain. Over the last decade the number of fiscal rules in the Euro area has substantially increased (Public Finances in EMU, 2006 and 2007). There are many different fiscal rules, i.e. on the revenue side, on the expenditure side, on the central and on the general sovereign. We adopt the classification of fiscal rules as appears in Public Finances in EMU (2006). In addition, we examine the impact of fiscal institutions on markets perceptions over sovereign debt sustainability.

Moreover, following the methodology of Deroose, Moulin, and Wierts (2005) EU Commission constructs a Fiscal Rule Index based on certain criteria (see EU Commission, DG ECFIN, Fiscal Rules, 2009). In this paper we shall follow this methodology and adopt EU Commissions Fiscal Rule Index as our fiscal rule variable. Similarly, for the fiscal institutions variable we shall follow the data set of EU Commission that describes such institutions in the form fiscal councils. Moreover, for the present version of this paper we shall focus on fiscal councils that comply with the characteristic of providing an independent assessment of compliance with existing national fiscal rules.

Fiscal rules and fiscal institutions to the extent that one should assume that they would improve perceptions over the fiscal sustainability of sovereign shall assert a negative impact on 'α'. Higher *'α'* translates into higher loss for the case that spread is higher than the CDS. This asymmetry in the underlying loss function insinuates a shift towards pessimism regarding long-term fiscal sustainability.

Table 5 reports empirical evidence of a random effect regression of *'α'* with respect to fiscal rules and fiscal institutions but also specific market characteristics. Both fiscal rules and fiscal institutions assert a negative impact on 'α' implying that improve market's expectations regarding fiscal sustainability.

In addition, we also include several Z-variables to account for general economic and financial conditions, Euribor 3 M, iTraxx Main Investment Grade index, outstanding bonds as a ratio to GDP, spread (defined as Euribor-Eurepo).[8]

[8] Euribor 3M accounts for the risk free rate. The risk free rate could assert a negative impact on spreads as an increase in risk-free rate would decrease the present value of the expected future cash flows. The iTraxx Main Investment Grade index counts for corporate credit risk. As a measure of fiscal sustainability issues we opt for the total outstanding bonds as percentage to GDP. Bloomberg reports the amount of bonds outstanding on a monthly frequency.

TABLE 5: Random Effect Panel regression for ‘α’

	Coef.	Std. Err.	Z	P>|z|
Euribor 3M	0.030304	0.054622	0.55	0.618
Spread	0.140923	0.137924	1.02	0.382
Itrx	-0.00013	0.000298	-0.44	0.687
Debt	-0.02275	0.016005	-1.42	0.25
FR	-0.212110	0.012417	-11.46	0.001
FI	-0.020596	0.018511	-1.112	0.848
C	0.542409	0.108786	4.99	0.016
R^2	0.4629			

The Random Effect GLS estimation is used and the sample covers the period from from Q1 2009 to Q2 2011. The regression of the *alpha* is:

$\alpha_{it} = \beta_0 + \beta_1\, Euribor_t + \beta_2\, (Euribor\text{-}Eurepo)_t + \beta_3\, iTraxx_t + \beta_4\, FR_{it} + \beta_5 FI_{it} + \beta_6\, Debt_{it}$

Spread is the difference between *Euribor* and *Eurepo*, *FR* counts for fiscal rules, whilst *FI* for fiscal institutions.

The sample includes the following countries: Greece, Ireland, Portugal, Spain and Italy.

A common criticism on random effect panel regression analysis hints to issues of static nature of such analysis and endogeneity. To deal with these issues we also run Dynamic Panel Analysis that uses an instrumental variable GMM estimation (Arellano and Bover, 1995). Table 6 reports empirical evidence of DPD panel regressions. As above, both fiscal rules and fiscal institutions assert a negative impact on ‘α’.

Fiscal rules and fiscal institutions assert a negative impact on ‘α’. This implies that enhancing fiscal governance would improve market’s expectations over fiscal sustainability.

Similarly, the Euribor-Eurepo spread asserts a positive impact on *‘α’*. This result also implies that when the repo rate is lower that the Euribor then it is costly to implement negative ‘’basis’’ trade, buying sovereign BOND AND CDS.

TABLE 6: Dynamic Panel Data regression for α

	Coef.	Std. Err.	Z	P>|z|
α_{t-1}	-0.19572	0.169839	-1.15	0.249
Euribor 3M	-0.19522	3.026098	-0.06	0.949
spread	-0.31373	3.060508	-0.1	0.918
itrx	0.000149	0.000667	0.22	0.823
FR	-0.254	0.075804	-3.35	0.001
FI	-0.05824	0.061229	-0.95	0.341
Debt	1.69E-11	8.23E-12	2.05	0.041
C	1.437415	0.449672	3.2	0.001
Wald chi2(7)	16.27	Prob > chi2	0.0227	

The Dynamic Panel Data regression is based on Arelano and Bover estimation and uses quarterly observations from Q1 2009 to Q2 2011. The regression equation takes the form:
$\alpha_{it} = \beta_0 + \beta_1\ alpha_{it-1} + \beta_2\ Euribor_t + \beta_3\ (Euribor\text{-}Eurepo)_t + \beta_4\ iTraxx_t + \beta_5\ FR_{it} + \beta_6 FI_{it} + \beta_7\ Debt_{it}$
Spread is the difference between *Euribor* and *Eurepo*, *FR* counts for fiscal rules, whilst *FI* for fiscal institutions.
The sample includes the following countries: Greece, Ireland, Portugal, Spain and Italy.

The empirical evidence of random effect panel regression and dynamic panel analysis shows that there is a link between fiscal rules, fiscal institutions and market's expectations. Moreover, fiscal rules and institutions appear to improve expectations over the long term sustainability of public finances in five member states of the Euro area, namely Greece, Portugal, Ireland, Spain and Italy. In some detail, fiscal rules have a much stronger in terms of magnitude impact on market's preferences than fiscal institutions. Thus, fiscal governance plays an important role in shaping preferences over the current sovereign debt crisis. Improving fiscal governance will also improve market's expectations.

5.6 Panel-VAR model

Next, we will extend our analysis using a Panel-VAR analysis. All variables within the panel VAR enter as endogenous. Thus, the underlying causality between the estimated *'α'* and fiscal rules and institutions, as well as market specific variables would be identified. For assisting the exposition we consider a first order 4x4 panel-VAR model:

$$X_{it} = \mu_i + \Phi X_{it-1} + e_{i,t}, \quad i = 1,\ldots, N, \; t = 1,\ldots,T. \tag{13}$$

where X_{it} is a vector of four random variables, that is, *'*α_{it}*'* and fiscal rules (FR_{it}) as well as a market specific variable EURIBOR ($EUbor_{it}$) and debt measured as outstanding bonds over GDP, (D_{it}).Thus, Φ is an 4x4 matrix of coefficients, μ_i is a vector of m individual effects and $e_{i,t}$ are iid residuals.

The panel-VAR takes the following form:

$$\begin{aligned}
\alpha_{it} &= a_{10} + \sum_{j=1}^{J}\beta_{11j}\alpha_{1it-j} + \sum_{j=1}^{J}\beta_{12j}FR_{1it-j} + \sum_{j=1}^{J}\beta_{13j}D_{1it-j} + \sum_{j=1}^{J}\beta_{14j}EUbor_{1it-j} + e_{1i,t} \\
FR_{it} &= a_{20} + \sum_{j=1}^{J}\beta_{21j}\alpha_{1it-j} + \sum_{j=1}^{J}\beta_{22j}FR_{1it-j} + \sum_{j=1}^{J}\beta_{23j}D_{1it-j} + \sum_{j=1}^{J}\beta_{24j}EUbor_{1it-j} + e_{2i,t} \\
D_{it} &= a_{30} + \sum_{j=1}^{J}\beta_{31j}\alpha_{1it-j} + \sum_{j=1}^{J}\beta_{32j}FR_{1it-j} + \sum_{j=1}^{J}\beta_{33j}D_{1it-j} + \sum_{j=1}^{J}\beta_{34j}EUbor_{1it-j} + e_{3i,t} \\
EUbor_{it} &= a_{40} + \sum_{j=1}^{J}\beta_{41j}\alpha_{1it-j} + \sum_{j=1}^{J}\beta_{42j}FR_{1it-j} + \sum_{j=1}^{J}\beta_{43j}D_{1it-j} + \sum_{j=1}^{J}\beta_{44j}EUbor_{1it-j} + e_{4i,t}
\end{aligned} \tag{14}$$

The moving averages (MA) form of the above model sets α_{it}, FR_{it}, D_{it} and $EUbor_{it}$ equal to a set of present and past residuals e_1, e_2, e_3 and e_4 from the panel-VAR estimation.[9]

[9]The moving averages (MA) form of the model sets α_{it}, FR_t, D_{it} and $EUbor_{it}$ equal to a set of present and past residuals e_1, e_2, e_3 and e_4 from the panel-VAR estimation. The endogeneity

Panel-VAR estimations

Following Lutkepohl (2006) we test for the optimal lag order j. As optimal lag we opt for order of one based on the Akaike Information Criterion (AIC) and Arellano-Bond AR tests.[10] Additional lags are added when testing for autocorrelation. Sargan tests show that for lag ordered one the null hypothesis is accepted. Normality tests for the residuals based on Sahpiro-Francia W-test have been also applied.[11]

The impulse response functions (IRF) derived from the unrestricted panel-VAR in the case of *'α'* are reported in Diagram 5.

---

assumption implies residuals are correlated and therefore one cannot interpret the coefficients of the MA representation. Thus, residuals are orthogonalised by multiplying the MA representation with the Cholesky decomposition of the covariance matrix of the residuals ε_1, ε_2, ε_3 and ε_4. The orthogonalized, or structural, representation is:

$$\begin{pmatrix} \beta_{11j}\beta_{12j}\beta_{13j}\beta_{14j} \\ \beta_{21j}\beta_{22j}\beta_{23j}\beta_{24j} \\ \beta_{31j}\beta_{32j}\beta_{33j}\beta_{34j} \\ \beta_{41j}\beta_{42j}\beta_{43j}\beta_{44j} \end{pmatrix} = \begin{pmatrix} b_{11j}b_{12j}b_{11j}b_{12j} \\ b_{21j}b_{22j}b_{23j}b_{24j} \\ b_{31j}b_{32j}b_{33j}b_{34j} \\ b_{41j}b_{42j}b_{43j}b_{44j} \end{pmatrix} P \begin{pmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \\ \varepsilon_{4it} \end{pmatrix} = P^{-1} \begin{pmatrix} e_{1it} \\ e_{2it} \\ e_{3it} \\ e_{4it} \end{pmatrix}$$

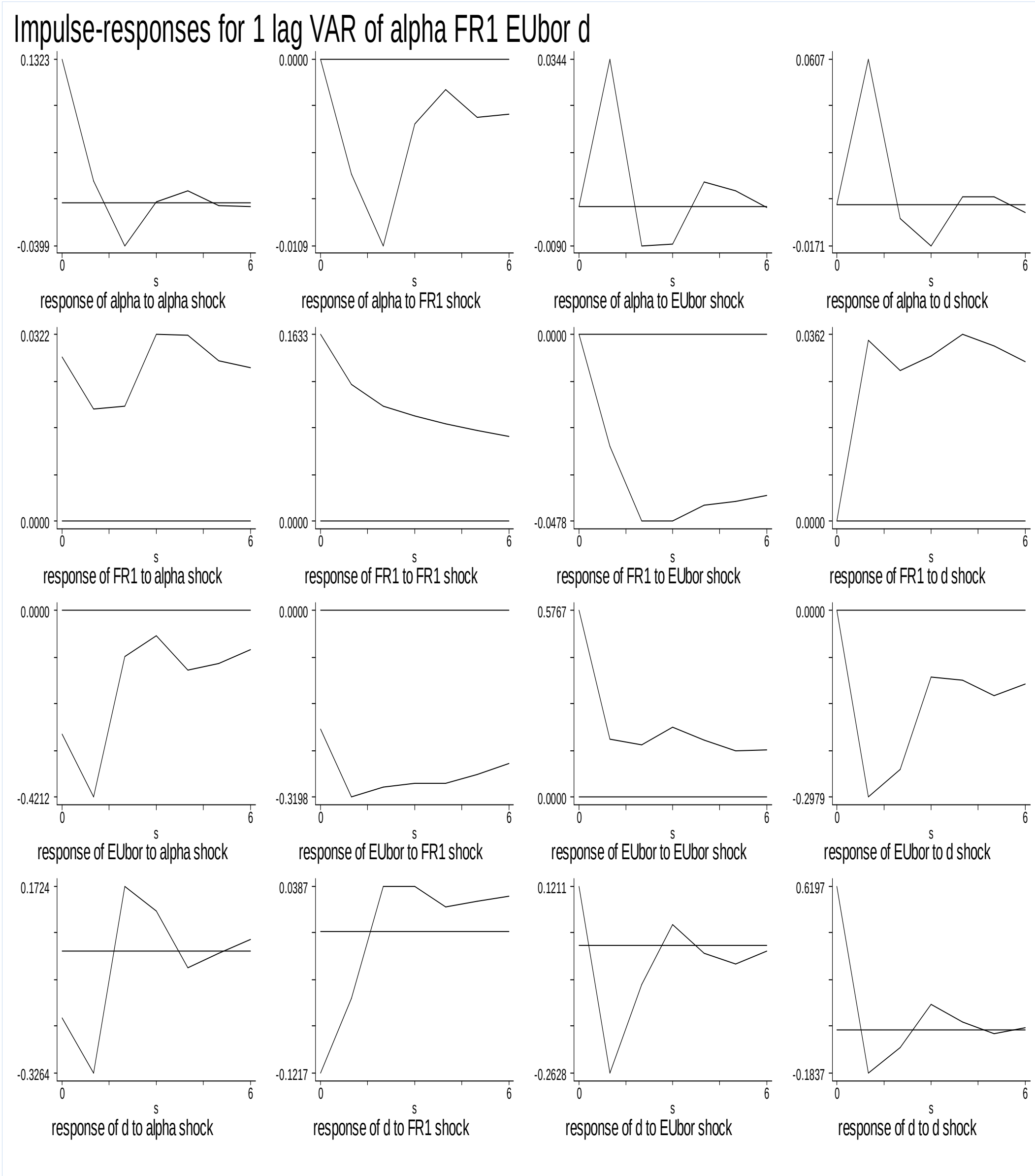
where P is the Cholesky decomposition of the covariance matrix of the residuals:

$$\begin{pmatrix} Cov(e_{1it}, e_{1it}) Cov(e_{1it}, e_{2it}) Cov(e_{1it}, e_{3it}) Cov(e_{1it}, e_{4it}) \\ Cov(e_{2it}, e_{1it}) Cov(e_{2it}, e_{2it}) Cov(e_{2it}, e_{3it}) Cov(e_{2it}, e_{4it}) \\ Cov(e_{3it}, e_{1it}) Cov(e_{3it}, e_{2it}) Cov(e_{3it}, e_{3it}) Cov(e_{3it}, e_{4it}) \\ Cov(e_{4it}, e_{1it}) Cov(e_{4it}, e_{2it}) Cov(e_{4it}, e_{3it}) Cov(e_{4it}, e_{4it}) \end{pmatrix} = PP^{-1}$$

[10] Results are available upon request.

[11] The results do not show violation of the normality. Panel Var results are available under request. Note that we follow Love and Zicchino (2006) and apply forward mean-differenced using the Helmert procedure in all variables within the VAR. In addition, we report standard errors for impulse response functions (IRF) generated with Monte Carlo simulations.

DIAGRAM 5: Impulse Response Function (IRF) for ‘α’, *FR*, *EUbor* and *d*



Note: ‘α’ counts for the shape parameter of the underlying loss function, *FR1* counts for fiscal rules as measured by the Fiscal Rule Index of the EU Commission, *EUbor* is the Euribor 3M and *d* is the outstanding debt.

The plots report the response of each variable in the panel-VAR, ‘α’, fiscal rules (*FR*), Euribor 3M (*EUbor*) and outstanding debt (*d*), to its own innovation and to the innovations of the other variables.

The first row shows the response of *‘α’* on a one standard deviation shock in *FR*, *EUbor* and *d*. It is clear from the graph that the response of *'α'* to FR is negative over the whole period, reaching a pick after two periods and converges towards equilibrium thereafter. On the other hand, a shock in *EUbor* and *d* asserts a positive impact on *'α'*. Note that there is also some reverse causation, notably in the case of response of Euribor to a shock in *'α'*, which is negative and substantial in magnitude. Similarly, the response of outstanding debt to *'α'* is negative and substantial though after two periods reverses to positive and converges to zero thereafter. On the other hand the response of fiscal rules on a shock in *'α'* is quite small, yet it is positive.

Table 7 presents the variance decomposition (VDC) estimations. These results are consistent with the impulse response functions (IRF) and provide further evidence of the importance of fiscal rules in explaining the variation in 'α'.

TABLE 7: Variance Decompositions (VDCs) for 1 lag of 'α', *Fiscal rules, Euribor 3M* and *Debt*

	S	'α'	Fiscal Rules	Euribor 3M	Debt
'α'	10	0.776505	0.008763	0.055136	0.1595
Fiscal Rules	10	0.056447	0.750145	0.120463	0.0729
Euribor 3M	10	0.17881	0.390184	0.302408	0.1285
Debt	10	0.247488	0.03368	0.127624	0.5912
'α'	20	0.775178	0.009923	0.055376	0.1595
Fiscal Rules	20	0.06233	0.720926	0.135091	0.0816
Euribor 3M	20	0.160606	0.433296	0.28055	0.1255
Debt	20	0.246447	0.037461	0.127977	0.5881

Note: s defines the periods ahead of VDCs.

Specifically, close to 1% of forecast error variance of 'α' after 10 years is explained by fiscal rules. Note, however, the outstanding debt has the dominant contribution, close to 15%, in the variation of 'α'. Furthermore, Euribor 3M explains 5.5% of the variation of 'α' efficiency. Overall, the VDC analysis confirms the importance of fiscal rules to 'α'.

Duffie (2010) suggest that banks tend to be undercapitalised during financial crisis and this in effect would lead to arbitrage opportunities. In an earlier paper Mitchell and Pulvino (2009) demonstrate that during the credit crunch of 2008 illiquid markets contributed to rising costs of holding sovereign bonds due to possible high haircuts. In turn, worsening liquidity conditions would feed up into higher sovereign bonds spreads and CDS. The IRFs and VDCs would imply that a shift towards pessimism has taken place during debt crisis that could be the outcome also of liquidity constraints that the Euro area member states face. Enhancing fiscal governance and strengthening fiscal rules could reverse this spiral, as it appears, improve market's expectations over the fiscal sustainability as depicted by asymmetries in the underlying loss function of the *'basis'.* [12]

6. Conclusion

In the early days of the euro, the risk premiums on the Euro area sovereign bonds were narrowed, whilst exhibiting low volatility. The market judged, back then, the probability of sovereign default was

[12] Note that the revealed underlying preferences of the *'basis'* due to credit ratings in illiquid market conditions would also have financial stability implications. Negative feedback effects have emerged together with counterparty risk (creditworthiness of protection providers) that in turn could feed back to the *'α'* dynamics. In general as risk in the inter-bank sector increases default protection becomes less valuable.

negligible. Since 2009 market's perception has been dramatically shifted towards asserting very high probabilities of default for several Euro area member states, with Greece reaching at times the highest probability of default worldwide.

Our results provide a new source of information for understanding the market's preferences regarding the sovereign debt crisis in the Euro area. Often it is referred that the market speculates and that this is the main reason that the spreads are driven upwards. This paper reveals that market behavior over time have clearly shifted towards pessimism, insinuating that the risk attitude of major market participants has been altered. We find asymmetry in the underlying loss function of the market with regards to some member states, in particular for Greece, sovereign bonds. The growing pessimism of markets over time and despite the financial assistance put in place, in particular for Greece, leaves little space of having any sign of reducing Euro area sovereign debt uncertainty any time soon. This comes in contrast with recent communications of some signals that would be interpreted as possible recovery from the on going sovereign debt crisis in the Euro area. Our results show that markets have not been convinced and remain rather pessimistic.

An increase in pessimism could be considered under certain conditions, such as periods of intense uncertainty, to reflect prudent preferences. Therefore, assigning higher loss when the spread is above CDS could improve market efficiency. Alas, as there is no *'one size fits all'* case judgement over what is prudent behaviour away from a symmetric loss function must be applied with extreme caution. Moreover, to the extent that not all participants of sovereign bond markets share the same underlying loss function, asymmetry and thus pessimism would indicate deviation from rationality.

Regarding the impact of fiscal rules and institutions on market behaviour, empirical findings show that they improve market's expectations over fiscal sustainability. As a result, enhancing fiscal governance could reduce the degree of market's pessimism regarding the Euro area sovereign debt crisis.

Appendix

TABLE A1: t-stat and p-values of structural break in 5 yr CDS, weekly

PORTUGAL - Structural break in March 2010		
	$t_{m,n,\tau}$	p-values
	τ=1	
Scheme=1	3.2183	0.0111
Scheme=2	3.9286	0.0269
Scheme=3	3.1584	0.0552
	τ=2	
Scheme=1	2.2064	0.0380
Scheme=2	2.8162	0.0347
Scheme=3	2.5665	0.0586
	τ=12	
Scheme=1	2.0909	0.0137
Scheme=2	2.3749	0.0846
Scheme=3	2.2941	0.0978
IRELAND - Structural break in March 2010		
	$t_{m,n,\tau}$	p-values
	τ=1	
Scheme=1	3.1022	0.0135
Scheme=2	2.4243	0.0772
Scheme=3	3.3398	0.0901
	τ=2	
Scheme=1	2.0901	0.0177
Scheme=2	2.3890	0.0824
Scheme=3	2.3129	0.0946
	τ=12	
Scheme=1	1.9680	0.0665
Scheme=2	2.0831	0.0649
Scheme=3	2.0645	0.0614

Scheme 1 is the fixed scheme, where the in-sample window at time t contains observations indexed 1,…,m; scheme 2 is a rolling scheme, where in-sample window at time t contains observations indexed t-m+1,…,t; and last scheme 3 is a recursive scheme, where the in-sample window includes observations indexed 1,…,t. The lag for the Newey-West estimator is opted as n1/3 of the asymptotic variance.

TABLE A2: t-stat and p-values of structural break in 5 yr CDS, weekly

ITALY - Structural break in March 2010		
	$t_{m,n,\tau}$	p-values
	τ=1	
Scheme=1	2.2183	0.0611
Scheme=2	2.9286	0.0269
Scheme=3	2.1584	0.0552
	τ=2	
Scheme=1	2.2064	0.0618
Scheme=2	2.8162	0.0347
Scheme=3	2.5665	0.0586
	τ=12	
Scheme=1	2.0909	0.0677
Scheme=2	2.3749	0.0846
Scheme=3	2.2941	0.0978
SPAIN - Structural break in March 2010		
	$t_{m,n,\tau}$	p-values
	τ=1	
Scheme=1	2.1022	0.0652
Scheme=2	2.4243	0.0772
Scheme=3	2.3398	0.0901
	τ=2	
Scheme=1	2.0901	0.0618
Scheme=2	2.3890	0.0824
Scheme=3	2.3129	0.0946
	τ=12	
Scheme=1	2.9680	0.0265
Scheme=2	2.0831	0.0611
Scheme=3	2.0645	0.0623

Scheme 1 is the fixed scheme, where the in-sample window at time t contains observations indexed 1,…,m; scheme 2 is a rolling scheme, where in-sample window at time t contains observations indexed t-m+1,…,t; and last scheme 3 is a recursive scheme, where the in-sample window includes observations indexed 1,…,t. The lag for the Newey-West estimator is opted as n1/3 of the asymptotic variance.

TABLE A3: Asymmetric loss function for 5 yr Spreads over swap and CDS, weekly

ITALY

Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.447	0.01	0.00	258.47	593.72	666.15
D=2	0.446	0.01	0.03	258.57	593.72	666.15
D=3	0.401	0.00	31.34	585.96	621.37	667.09
Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.606	0.00	0.00	529.76	563.11	569.51
D=2	0.606	0.00	0.00	529.76	563.11	569.51
D=3	0.66	0.00	21.00	546.04	618.70	635.31

SPAIN

Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.416	0.012	0.000	46.201	422.486	587.367
D=2	0.480	0.010	30.463	88.452	426.965	587.509
D=3	0.402	0.002	81.862	623.770	596.035	599.454
Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.739	0.005	0.000	325.484	508.293	547.332
D=2	0.739	0.005	0.000	325.484	508.293	547.332
D=3	0.701	0.000	65.560	490.085	512.173	580.552

PORTUGAL

Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.553	0.019	0.000	240.039	8.067	141.671
D=2	0.548	0.018	229.437	276.338	241.219	216.936
D=3	0.413	0.011	312.004	321.020	439.682	406.725
Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.668	0.020	0.000	186.394	49.060	45.437
D=2	0.668	0.020	0.000	186.394	49.060	45.437
D=3	0.758	0.005	202.515	190.197	257.023	304.226

IRELAND

Linear case, period from 05/09/2008 to 27/04/2010						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.268	0.017	0.000	16.556	153.944	422.716
D=2	0.267	0.017	2.575	18.050	156.806	422.930
D=3	0.136	0.004	187.357	488.949	452.898	450.988
Linear case, period from 27/04/2010 to 22/07/2011						
	$\hat{a}$	SE	$J_{\hat{a}}$	$J_{\alpha=0.2}$	$J_{\alpha=0.5}$	$J_{\alpha=0.8}$
D=1	0.165	0.015	0.000	5.395	202.167	314.081
D=2	0.165	0.015	0.000	5.395	202.167	314.081
D=3	0.111	0.002	127.702	269.430	256.504	353.170

Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (that is D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (*p*=1) and non-linear case (*p*=2).

J-statistics are distributed as X^2 (D-1 for D>1) $J_{\hat{a}}$ and X^2(D) for the remaining J.
Critical values for X^2 (2): at 1% 9.21, at 5% 5.99, and at 10% 4.60.

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