Revealing market animal spirits of the Euro-area sovereign debt crisis using a generalised loss function: the role of fiscal rules and fiscal institutions.

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November 2011

This paper examines the underlying market behaviour for euro-zone sovereign bonds as depicted by the difference between the spread over swaps and Credit Default Swaps (CDS). Our sample covers those euro-zone member states most at risk of default namely; Greece, Portugal, Ireland, Spain and Italy. Moreover, a generalised flexible, can either be linear or non-linear, loss function is employed so as to reveal the behaviour of market participants. Within this framework, prior knowledge of underlying fundamentals is not required. The results show that that market behaviour over euro-zone sovereign debt have shifted towards pessimism post the Emergency Financing Mechanism (EFM). Interestingly, although the EFM was perceived as a sovereign debt stabilisation mechanism, the market appears to judge otherwise. If anything, market's reading of the euro-zone sovereign debt crisis points to the direction of ongoing price misalignments fuelled by growing uncertainty. Having derived market's preferences over the euro-zone sovereign debt crisis, we examine the impact of fiscal policy institutions and fiscal rules on those preferences for the period from third quarter of 2008 to second quarter of 2011. The empirical evidence shows that there is a clear relationship between fiscal rules-institutions and market's preferences with the direction of causality running from the former to the latter. Moreover, fiscal rules appear to improve market's perception over fiscal sustainability in the euro-zone. In terms of fiscal institutions, providing an independent assessment of compliance with existing national fiscal rules also improves market's perception. In addition, market specific characteristics as reflected by 3M Euribor, 3M Eurepo, outstanding debt to GDP, and iTraxx main investment grade index also shape maket's preferences.

Keywords: Euro-zone sovereign debt crisis, spreads, CDS, fiscal rules, fiscal institutions.

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

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Non-technical summary

In July 2007, the yield on the 10-year maturity Irish government bond was lower than the yield on a comparable German bond. Since 2008, the Greek rates, followed by those of Ireland, Portugal and other euro-zone member states with high public debts, have steadily risen compared to German rates. Is this development due to external factors? Global financial stress has fed through to the euro-zone government bonds. But common factors do not explain the increased dispersion of spreads. Domestic factors play also important role. The main implication is that high spreads for some euro-zone member states persist whilst financial vulnerabilities and weaker growth reinforce each other.

This paper for the first time reveals underlying market behaviour over Euro-group sovereign debt crisis as depicted by the so-called *'basis'*. The *'basis'* is the difference between the five-year maturity spread of euro-zone sovereign bonds over swap and the five-year credit default swaps (CDS) spread. Our sample comprises weekly and daily observations on the five-years CDS spreads and bond yields over swaps of ten Euro area countries. The sample period is from September 2008 to July 2011.

To this date, the sovereign CDS market for euro-zone member states has not been the focus of much research, thought the CDS market for private firms has been extensively studied (see Duffie, 1996, Duffie, 1999, Kellard et al. 1999, Duffie et al., 2002, Blanco et al. 2005, and Duffie et al., 2007). One would not have thought only two to three years ago that a euro-zone member state could default. Alas, since late in 2009 sovereign default in the euro-zonehas attracted both research and economic policy attention. Recently, Dieckmann and Plank (2010), Fontana and Scheicher (2010), Fontana (2010) and Ejsing and Lemke (2010) examine the pricing of sovereign CDS with a focus on the private-public risk transfer using a simple reduced form regression analysis for a panel of countries.

We depart from this literature as we reveal for the first time the underlying market's preferences regarding the sovereign debt crisis of the euro-area. It is frequently taken for granted that market's participants behave rational so as to exclude the possibility of market failure. Previous studies (Crowder and Hamed, 1993; Peroni and McNown, 1998, and Kellard et al. 1999, Duffie et al., 2002 and Duffie et al., 2007) argue that the rational behavior hypothesis is plausible. Based on this hypothesis, and 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 terms, implies that the buyer of the government bond could also buy protection for this bond in the CDS market so as to hedge against the default (Duffie et al., 2007). No-arbitrage means that the CDS spread equals the sovereign bond spread. In this analysis we call the difference between the CDS and sovereign bond spread the *'basis'* in line with Duffie et al. (2002), Blanco et al. (2005), Duffie et al., (2007), and Fontana and Scheicher (2010). Under no-arbitrage conditions the '*basis*' should be equal to zero. Blanco et al. (2005) show that there is a long run linear relationship between US corporate bond and CDS markets (see also for EU corporate bonds 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. For example, Levin et al. (2005) show that market frictions generate non-zero CDS-bond spread basis.

Given these market frictions this paper employs a generalised flexible loss function of the *'basis'* so as to reveal the underlying preferences of market participants. The existence of short run frictions away from non-arbitrage opportunities insinuate that

the loss function may not be symmetric as the standard rational behavior hypothesis could dictate (Duffie et al. 2002).

Moreover, for the first time in the literature, we estimate the shape of the underlying loss function of the market over the '*basis*' of the sovereign debt for all euro-zone member states. The shape is determined by a parameter, '*alpha'*, that we estimate using a GMM estimator as in Elliot et al. (2005). The CDS spread, given that it is forward looking, is acting essentially as a price discovering mechanism for the sovereign debt credit risk and thus for the sovereign debt spread (Fontana and Scheicher, 2010, Fontana, 2010, and Ejsing and Lemke, 2010). This implies that a generalised loss function with a shape parameter, 'a*lpha',* could reveal sovereign debt market's preferences. This parameter takes a value from zero to one, with 0.5 being the standard symmetric rational behaviour hypothesis loss function case. Using this framework prior knowledge of fundamentals is not required.

The empirical evidence show that market's preferences over one particular euro-zone member state, that is Greece, are clearly pessimistic post May 2010, reflecting sizeable risks regarding the sustainability of public finances. In addition, as part of sensitivity analysis, we follow a novel methodology proposed by Giacomini and Rossi (2009) to assess whether there exist structural breakdowns in the euro-zone sovereign bonds over time. Such breakdowns could be caused by systematic and idiosyncratic factors. Structural breaks have been dictated for a number of euro-zone member states, namely Greece, Ireland and Spain.

Having derived market's behaviour over the euro-zone sovereign debt crisis, as reflected by the shape parameter '*alpha*', we examine the impact of fiscal policy institutions and fiscal rules on those expectations in recent years; from first quarter 2009 to second quarter of 2011. Over the last decade the number of fiscal rules in the euro-zone 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 government. We adopt the classification of fiscal rules as appears in Public Finances in EMU (2006). Empirical evidence shows that there is a link between fiscal rules - fiscal institutions and markets' preferences. Moreover, fiscal rules appear to improve markets' perceptions over the long-term sustainability of public finances in the euro-zone. In terms of fiscal institutions, providing an independent assessment of compliance with existing national fiscal rules also improves expectations. Thus, the results demonstrate that prudent fiscal rules and governance plays an important role in shaping markets' preferences and could prevent escalation of sovereign debt crisis. In addition, market specific characteristics as reflected by 3M Euribor, 3M Eurepo, and iTraxx Main Investment Grade index also play a detrimental role.

Overall, the shape parameter of the loss function '*alpha*' over time reveals a shift in preferences towards pessimism during the debt crisis, in particular for Greece. It appears that inadequate fiscal rules and governance has contributed to this shift in market's preferences. As sovereign risk increases actions against default becomes less credible. Strengthening fiscal rules and governance could alleviate the problem as both improve market's perceptions over the sustainability of public finances of the euro-zone in a timely manner.

1. Introduction

We examine whether spreads of 5-years government bonds over swap are the outcome of rational behaviour as based on a symmetric underlying loss function.[2] The assumption that market's participants should behave rational so as to exclude the possibility of marker 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. Moreover, in absence of market imperfections one would expect that CDS spreads and government bond spreads of the same maturity should be bounded by no-arbitrage conditions. This, in terms, implies that the buyer of the government 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 government bond yield spread.

Blanco et al. (2005) show that there is a long run linear relationship between US corporate bond and CDS markets (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. To this end, Levin et al. (2005) show that market frictions generate non-zero CDS-bond spread basis. Market frictions can be explained by systematic and idiosyncratic factors.

It is exactly because of the documented short run frictions away from non-arbitrage opportunities that we believe that a generalized flexible loss function of the difference between government bond spreads and CDS could reveal market preferences.

To this end, this paper examines empirically whether the underlying loss function is indeed symmetric. To model the loss function, we opt for the methodology proposed by Elliot et al. (2005). The shape parameter of this loss function is a-priori unknown and could reveal information regarding market preferences. One of the advantages of this methodology is that it is not necessary to observe the underling model of forming government bond spreads and CDS in order to test for asymmetries in preferences.

The data set used in this paper comes from Bloomberg and covers 5 year daily and weekly euro-zone sovereign spreads over swap, namely for the countries Greece, Ireland, Portugal, Spain and Italy. This is the first time in the literature that empirical evidence is provided for the shape parameter of the loss function for those euro-zone 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 euro-zone 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.

In addition, as part of sensitivity analysis, we follow a novel methodology proposed by Giacomini and Rossi (2009) to assess whether there exist structural breakdowns in the euro-zone sovereign bonds over time. Such breakdowns could be caused by unexpected events, but also institutional interventions aiming at alleviating sovereign

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

debt crisis in the euro-zone. 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 of the euro-zone 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 regarding policy conditionality were formed, arbitrage opportunities appear to be reinforced and markets clearly lean towards pessimism regarding the prospects of the Greek sovereign debt crisis.

Having derived market's expectations over the euro-zone sovereign debt crisis, as reflected by the shape parameter '*alpha*', we examine the impact of fiscal policy institutions and fiscal rules on those expectations in recent years; from first quarter 2009 to second quarter of 2011. Over the last decade the number of fiscal rules in the euro-zone 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 markets' perceptions over the long-term sustainability of public finances in the euro-zone. In terms of fiscal institutions, providing an independent assessment of compliance with existing national fiscal rules also improves market's expectations. Thus, the results demonstrate that prudent fiscal governance plays an important role in shaping market behaviour, as it is perceived to act as a preventive mechanism against 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.

Thus, this paper contributes to the literature in several aspects. First, we fit a loss function in sovereign bonds of some member states of euro-zone under pressure for the first time in the literature. Second, we estimate the shape parameter of the underlying generalized flexible loss function. Third, given the asymmetry of the loss function we test for structural breakdowns over time. Fourth, we re-examine asymmetries in the shape of the loss function for periods identified by breakdowns tests. Fifth, we examine the impact of fiscal rules and fiscal institutions on the underlying markets' preferences over sovereign bonds of some member states of the euro-zone. Lastly, we also investigate the impact of specific market characteristics on the shape parameters of the underlying loss function.

The remainder of the paper is organized as follows. The second section presents some recent stylized facts about the euro-zone 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-zone sovereign debt crisis

Back in July 2007, at the beginning of the subprime crisis the yield on the 10-year maturity Irish sovereign bond was lower than the yield on a comparable German sovereign bond. Then, as Irish rates started rising, German rates remained low, with a tendency even to fall as investors sought safety. The spread between Irish and German yields rose rapidly; in the last week of January 2009, the Irish sovereign bonds paid about 260 basis points more than the German bond. This spread has widely fluctuated ever since, but has remained at high levels. The spreads are a measure of a country's risk of default. In recent months, the sharp hikes in spreads of the south euro-zone member states point to the direction that higher risk premium is warranted.

These striking developments follow several years of tranquility in euro-zone bond markets. After the introduction of the euro in January 1999 and up until the subprime crisis hit global financial markets in mid-July 2007, spreads on bonds of euro-zone members had partly converged as some differences member states remained. Nevertheless, the stability and convergence of spreads was considered a trademark of successful financial integration within the euro-zone. The ongoing instability and divergence have raised far reaching questions. Some have even been led to question the viability of the euro as a common currency.

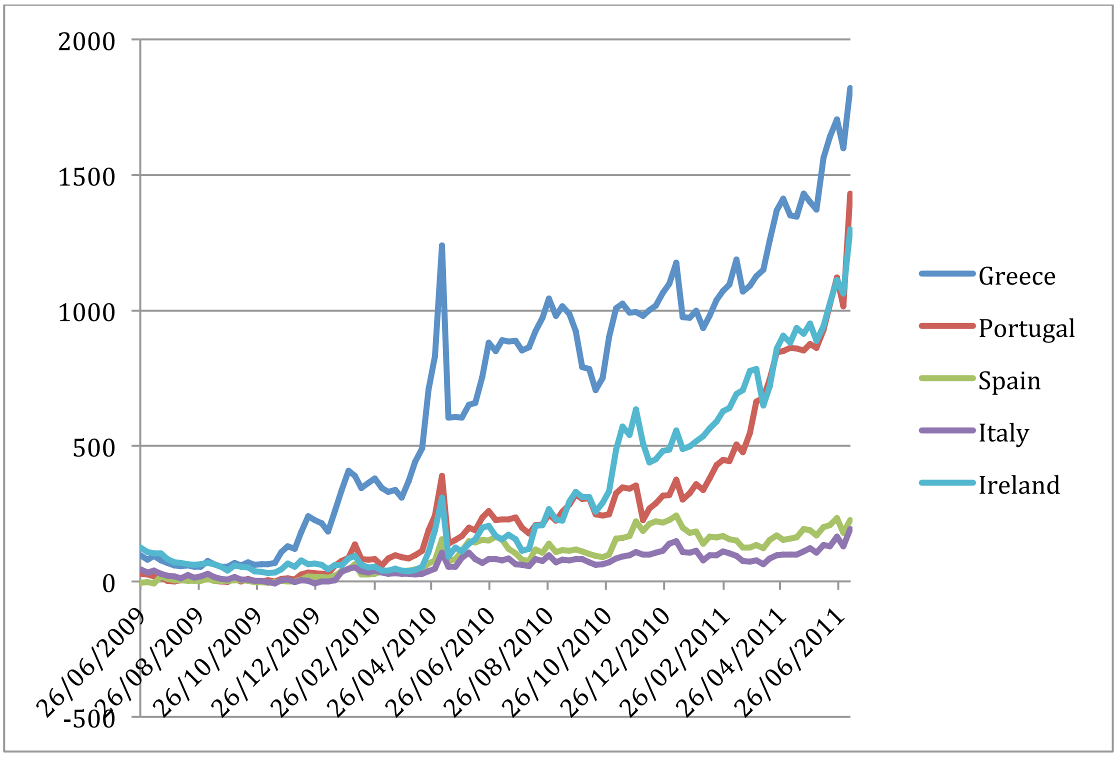
For policymakers, there may be some comfort in the recognition that the wider spreads are due, in the first instance, to external factors. Global financial stress, having infected a widening range of financial asset classes, has also fed through to the bonds of euro-zone sovereigns. If the potency of these common external factors is mitigated over time, spreads should come down. But while common factors have played their role, they do not explain the increased dispersion of spreads. Thus, the wider and more diverse spreads could also reflect domestic vulnerabilities. The implication is that higher spreads could persist since the financial vulnerabilities uncovered by the global crisis and weaker growth prospects have the potential to reinforce each other.

Moreover, four distinct phases can be identified. Between July 2007 and September 2008 marked the phase of financial crisis build-up, spreads remained within a relatively narrow, albeit widening, range. Between October 2008 and March 2009, there was a systemic outbreak due to the collapse of Lehman Brothers. It was in that period that sovereign spreads started diverging markedly. With the exception of German Bunds, euro-zone sovereign bond yields moved sharply above the swap yield, as problems in the banking sector spilled over to sovereign balance sheets. Between April and September 2009, characterised the systemic response phase, spreads converged, although at wider levels. As financial spillovers were contained and systemic risk subsided, all bond yields fell back closer to the level of the swap yield, particularly those that had gone up considerably in the earlier phase. Finally, since October 2009, rising idiosyncratic sovereign risk led to greater differentiation among countries, with the yields on specific government bonds climbing to record highs. Then, in December 2009, the Greek sovereign debt crisis burst that led spreads and CDS to unprecedented levels. For some time, from late 2009 to autumn 2011 markets have thought that the Greek case is unique; alas in recent months the Greek tragedy expands to other Member States of the Euro-area.

Following the Greek sovereign debt crisis and the vulnerabilities of the Irish banks, the euro area sovereign yields have exhibited an unprecedented degree of volatility. Moreover, in March 2009 the spread between the yield on a 10-year Greek government bond and the yield on a German Bund of equivalent maturity was as high as 280 basis points (bp). By September 2009 the same spread had dropped below 120 bp. In January 2010, it had climbed back up to over 380 bp. Alas, things got worst in

2010, in April 2010 the spread reached 670 bp only to climb even higher to the level of 1287 bp in May 2010, the month that Emergency Financing Mechanism (EFM thereafter) and the memorandum of understanding regarding policy conditionality, a joint initiative of the IMF, the EU Commission and the ECB were signed. In July 2010 it registered some decline to 770 bp, only to start rising again to above 820 bp. in August 2010. A year later the Greek spread reached levels as high as 2000 bp. (see Diagram 1), and in recent weeks above this threshold. Likewise, the spreads for Portugal and Ireland have sharply climbed up over time.

Diagram 1: Spreads over Swaps, 5 years maturity, weekly.

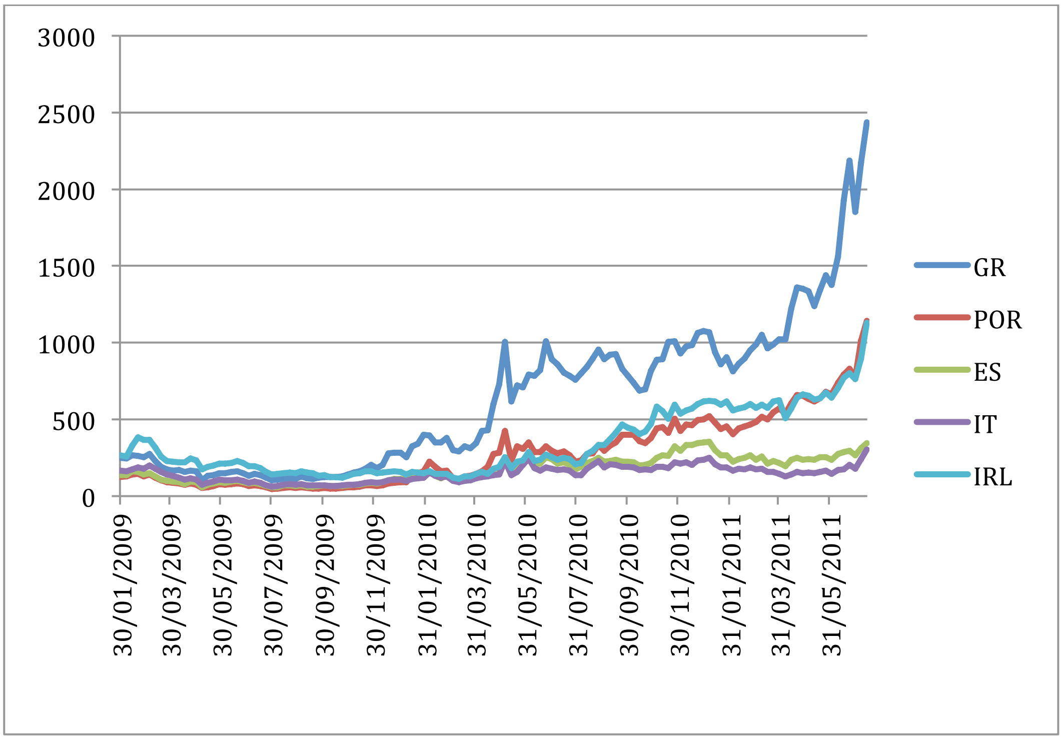


Source: Bloomberg.

The credit default swaps (CDS), the premium investors are willing to pay to insure against a credit event, follows similar path to the one of spreads (see Diagram 2). The recent hikes in CDS could be the outcome of many contributing factors. Duffie (2010) argues that high CDS persist after credit crunch due to severe depletion of capital and large distortions in arbitrage, and not so much due to counterparty risk or default risk. In addition, spreads are affected by funding risk and market liquidity risk. In addition, upwards trend in sovereign CDS could reflect short-term expectations regarding prices in the light of increases in sovereign bond issuance, and not only of market's expectations regarding the probability of default (Fontana and Scheicher, 2010). [3]

[3] 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

Diagram 2: Credit Default Swaps, 5 years maturity, weekly.



Source: Bloomberg.

Financial market theory suggests that CDS spreads and corporate bond spreads for the same entities are bound by no-arbitrage conditions. This implies that, ignoring differences in liquidity and assuming the maturity of the corporate debt equals that of the CDS, an investor who acquires a corporate bond and buys protection for the same reference entity in the CDS market hedges against the default. The implied no-arbitrage assumption between the two markets suggests that the price of buying such a protection against default in the CDS markets should equal the observed corporate bond yield spread.

Despite this worrying evidence of turbulence times in the euro-zone sovereign debt, to this day there is not a comprehensive account of what has happened in the market. The analysis of euro area sovereign bond markets mainly focused on the role of fiscal fundamentals (Sgherri and Zoli, 2009, Mody, 2009, Haugh et al., 2009), market liquidity or market integration (Manganelli and Wolswijk, 2009), migration risk (rating downgrades), and not so much on the risk of outright default (Fontana and Scheicher, 2010).

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.

3. Methodological Framework of the Underlying Loss Function

Following Elliott et al. (2005) we define $CDS_t \equiv \theta' W_t$ be the CDS conditional on the information set F_t in which θ is an unknown k-vector of parameters, $\theta \in \Theta$, with Θ compact in R^k, and W_t is an h-vector of variables that are F_t measurable.[4]

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 defined by

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

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, whish represent market imperfections and thus short run arbitrage opportunities.

By observing the sequence of CDS_t, $\tau \leq t < T+\tau$ the estimate of *'α'* is given using a linear GMM Instrumental Variable estimator[5] $\hat{\alpha}_T$, as follows:

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

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[6]:

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

Elliott *et al* (2005) show that the estimator of α_T is asymptotically normal and construct a J-statistic that follows $X^2(d-1)$ for d>1 and takes the form:

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[4] Within this framework it is not necessary to know the underlying model of forming spreads and CDS. CDS could be considered to represent predictions of spreads plus a premium. The premium is considered as fixed, and thus exogenous to the loss function.

[5] 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.

[6] $\hat{S}$ 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.

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

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. Since the swap rate is widely regarded by the markets as a *"risk-free"* rate, the spread is the premium paid for the risk of default. On the other hand, the CDS reflects an insurance premium paid by the market's participants against default. To this end, CDS provides a forward-looking path of spreads. Both the spread and the 5-year maturity CDS are derived from Bloomberg.

The CDS market is set so as the seller pays the default payment to the buyer if a default event happens before maturity of the contract. What defines a default event is not always a straightforward exercise. Default events could be bankruptcy; failure to pay; obligation default or acceleration; repudiation or moratorium (for sovereign entities); restructuring. The last event has been has been and remains a source of controversy. Based on the 1999 International Swaps and Derivatives Association documentation the restructuring constitutes 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.

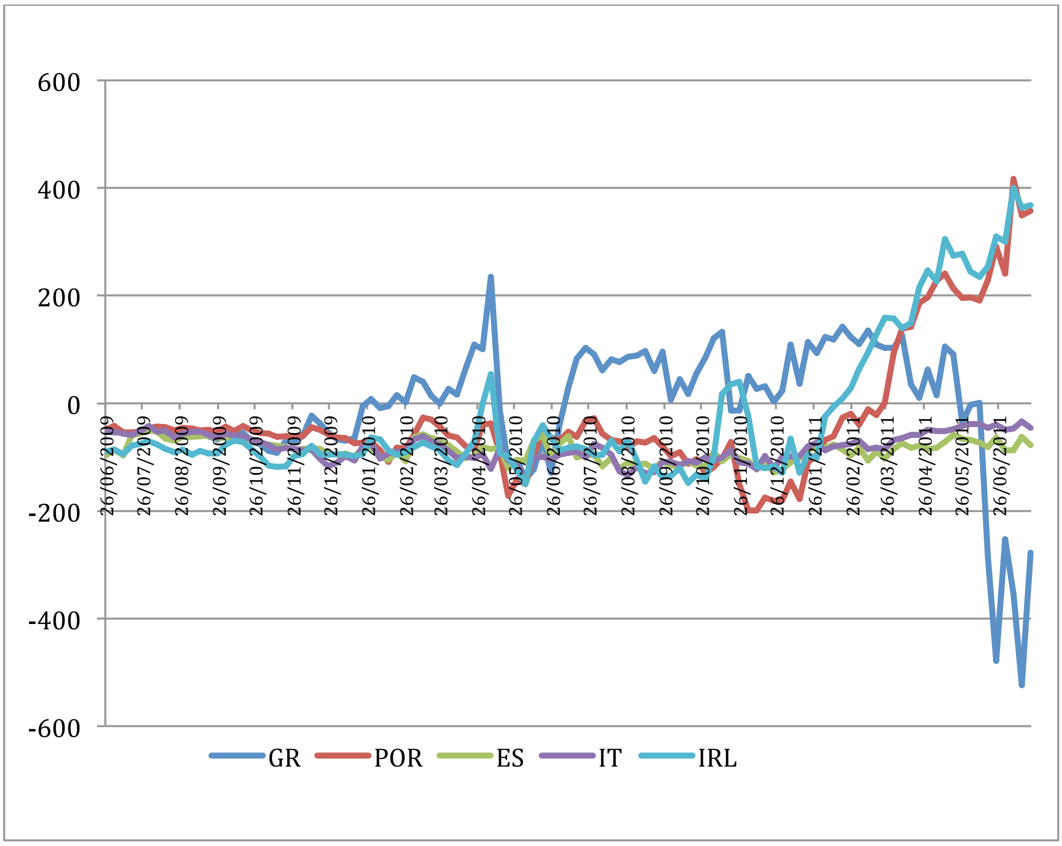
The sovereign CDS also is a trading instrument and not a pure insurance instrument. Moreover, taking an outright position on spreads depends on traders' expectations over a short horizon. To this end, CDS could be used for hedging macroeconomic uncertainty or risks. That is CDS could be used as a relative-value 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 government bonds are more expensive than CDS, implying that bond spreads are lower than CDS (see Diagram 3). This, in turn, means that profit could be gained by implementing a basis trade, buy bond, and buy CDS protection. However, in practice it is rather costly to obtain the bond, for example via a repo transaction, in order to short-sell it. Also if repo rates are low highly rated bonds are difficult to obtain to short-sell and thus for protection writers to hedge their positions has high cost.

In addition, the problem that could emerge is that not all deliverable assets necessarily due and payable should restructuring occur. Some deliverable obligations are cheaper than others, whilst deliverable assets very long-dated or convertible bonds that often trade at a discount to shorter-dated straight bonds.

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



Source: 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 Greek case, a recent ISDA documentation on the 27th of October 2011 EU decision over the restructuring of the Greek sovereign debt argues:

'The determination of whether the Euro-zone deal with regard to Greece is a credit event under CDS documentation will be made by ISDA's EMEA Determinations Committee when the proposal is formally signed, and if a market participant requests a ruling from the DC. Based on what we know it appears from preliminary news reports that the bond restructuring is voluntary and not binding on all bondholders..... it is important to note that the restructuring proposal is not yet at the stage at which the ISDA Determinations

Committee would be likely to accept a request to determine whether a credit event has occurred.'

5. Empirical Results

5.1 Asymmetry parameter estimates

We estimate equations (2) and (3) using GMM with instruments for both the linear (*p*=1) and non-linear case (*p*=2). 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. It is striking that the parameter *'α'* takes values somewhat higher than 0.5 in both linear and non-linear case, indicating rational loss preferences associated with an asymmetric loss function. The exception to this result being the non-linear loss function for the case of D=2 and D=3, where *'α'* takes values close to 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 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) or $J_{\hat{a}}$ and X^2(D) for the remaining J.

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 alphas that are statistically different from 0.5 the likelihood to reject the null of 0.8 is lower.

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 $Z \equiv \{Z_t : \Omega \to R^{s+1}, s \in N, t = 1,...,T\}$ 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 $Spread_t : \Omega \to R$ is the variable of interest, that is the spread, and $X_t : \Omega \to R^s$ is the vector of variables that form spreads, including CDS.

This methodology builds a sequence of τ-step-ahead $\text{Spread}_{t+\tau}$ using an out of sample procedure, which involves dividing the sample of size T into an in-sample window of size *m* and an out-of-sample window of 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:

$$SL_{t+\tau}(\hat{\beta}_t) = L_{t+\tau}(\hat{\beta}_t) - \bar{L}_t(\hat{\beta}_t) \text{ for } t=m,...,T-\tau. \quad (5)$$

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:

$$\overline{SL}_{m+n} \equiv n^{-1} \sum_{t=m}^{T-\tau} SL_{t+T}(\hat{\beta}_t) \quad (6)$$

Based on equation (6), if CDS could explain of the spread, a test should show that the mean of equation (6) is close to zero. That is the test has a null hypothesis:

$$H_0 : E\left(n^{-1} \sum_{t=m}^{T-\tau} SL_{t+T}(\beta^*) \right) = 0, \text{ for all } m, n. \quad (7)$$

And, the structural breakdown test statistic is:

$$t_{m,n,\tau} = \sqrt{nSLm,n} / \hat{\sigma}_{m,n}{}^{7} \quad (8)$$

---

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

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.[8] 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.

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, a joint initiative of the IMF, the EU Commission and the ECB, aiming to financially assist the Greek economy to overcome the sovereign debt crisis.

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 Spreads over swaps and CDS, weekly.
Structural break on 07/05/2010

	$t_{m,n,\tau\alpha}$	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.

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

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 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 (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) or $J_{\hat{a}}$ and X^2(D) for the remaining J.

Table 4: Asymmetric loss function for 5 yr 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

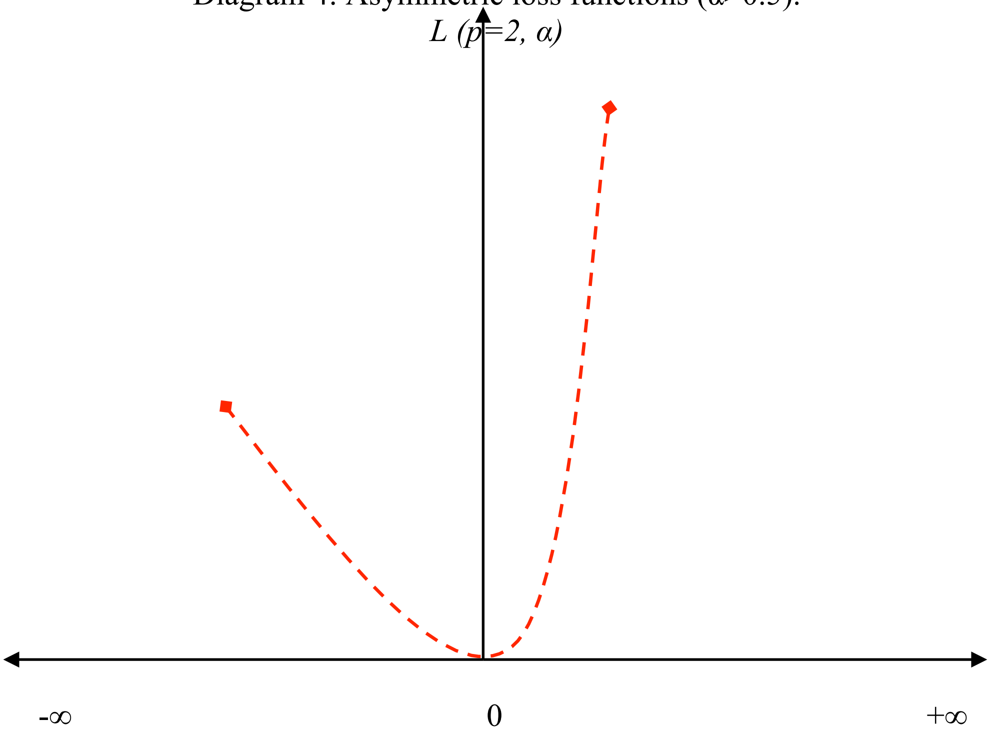
Estimates are based on D=1, 2, 3 instruments. The instruments are: a constant (D=1), lagged difference between Spread and CDS (D=2), as well as the lagged difference Spread (D=3). The equations (2) and (3) are estimated using GMM both the linear (p=1) and non-linear case (p=2).

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

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 alphas 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. 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.

Diagram 4: Asymmetric loss functions (α>0.5).



Note: horizontal axis shows *$Spread_t$-CDS_t*, whilst on the vertical axis is the quadratic loss function, *L(p=2,α)*.

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.

5.5 explaining alphas

The sensitivity analysis of last session shows breakdowns in the Greek government bond spreads post May 2010. Since May 2010 the underlying markets' 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-zone sovereign debt crisis, as reflected by the shape parameter '*alpha*', 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-zone 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 government. 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 '*alphas'*. Higher *'alphas'* 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 alphas with respect to fiscal rules and fiscal institutions but also specific market characteristics. Both fiscal rules and fiscal institutions assert a negative impact on *alphas* 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).[9]

[9] Following Fontana and Scheicher (2010) we opt for the Euribor 3M to account for the risk free rate. We expect that the risk free rate assert a negative impact on spreads as an increase in risk-free rate would decrease the present value of the expected future cash flows. To take into account market's perception over credit risk we opt for the iTraxx Main Investment Grade index. We use a measure to account for fiscal sustainability issues proxied by the total outstanding bonds relative as percentage to GDP. Bloomberg reports the amount of bonds outstanding on a monthly frequency. Lastly, as a measure of sovereign CDS market liquidity we opt for the bid-ask spread of the iTraxx Main Investment Grade index.

Table 5: Random Effect Panel regression for *alphas*.

	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 *alphas* is:

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

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 refers to the static nature of such analysis and possible issues of 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 *alphas*.

Fiscal rules and fiscal institutions assert a negative impact on '*alphas*'. This implies that enhancing fiscal governance would improve market's expectations over fiscal sustainability.

Similarly, the Euribor-Eurepo spread asserts a positive impact on alphas. This result also implies that when the repo rate is lower that the Euribor then there is high cost for negative basis trade, which is to buy sovereign bond and buy CDS.

Table 6: Dynamic Panel Data regression for alphas.

	Coef.	Std. Err.	Z	P>|z|
alphas(-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 on Arelano and Bover estimation and uses quarterly observations from Q1 2009 to Q2 2011. The regression equation takes the form: $alphas_{it} = \alpha + \beta_1\, alphaa_{it-1} + \beta_2\, Euribor_t + \beta_3\, (Euribor\text{-}Eurepo)_t + \beta_4\, iTraxx_t + \beta_5\, FR_{it} + \beta_6 FI_{it} + \beta_7\, Debt_{it}$

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-zone, 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 are considered as endogenous within the Panel VAR, without having to resolve into strong assumptions concerning causality issues. To this end, we examine the underlying causality links between the estimated *'alphas'* and fiscal rules and institutions, as well as market specific variables. In the first stage, a first order 4x4 panel-VAR model is opted:

$$X_{it} = \mu_i + \Phi X_{it-1} + e_{i,t}\,,\ i=1,\ldots,N,\ t=1,\ldots,T. \qquad (9)$$

,where X_{it} is a vector of four random variables, that is, *'alphas'* (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:

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

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. [10]

5.6.1 Panel-VAR estimations

As a first step in the panel VAR estimation we shall make a choice regarding the optimal lag order j for the right-hand variables in the system of equations (Lutkepohl, 2006). The Arellano-Bond GMM estimator is used for the lags of j=1, 2 and 3.[11] Optimal lag order of one is based on the Akaike Information Criterion (AIC), confirmed by Arellano-Bond AR tests. To test for autocorrelation, more lags are added. The Sargan tests show that for lag ordered one, the null hypothesis cannot be rejected and thus the VAR model is of order one. The lag order of one preserves the degrees of freedom and information, given the low time frequency of the data. In addition, normality tests for the residuals use the Sahpiro-Francia W-test.[12]

The impulse response functions (IRF) derived from the unrestricted panel-VAR in the case of *'alphas'* are reported in Diagram 5. The plots show the response of each variable in the panel-VAR, '*alpha*s', 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 *'alphas'* on a one standard deviation shock in *FR*, *EUbor* and *d*. It is clear from the graph that the response of *'alpha'* to FR is negative over the whole period, reaching a pick after two periods and converges towards

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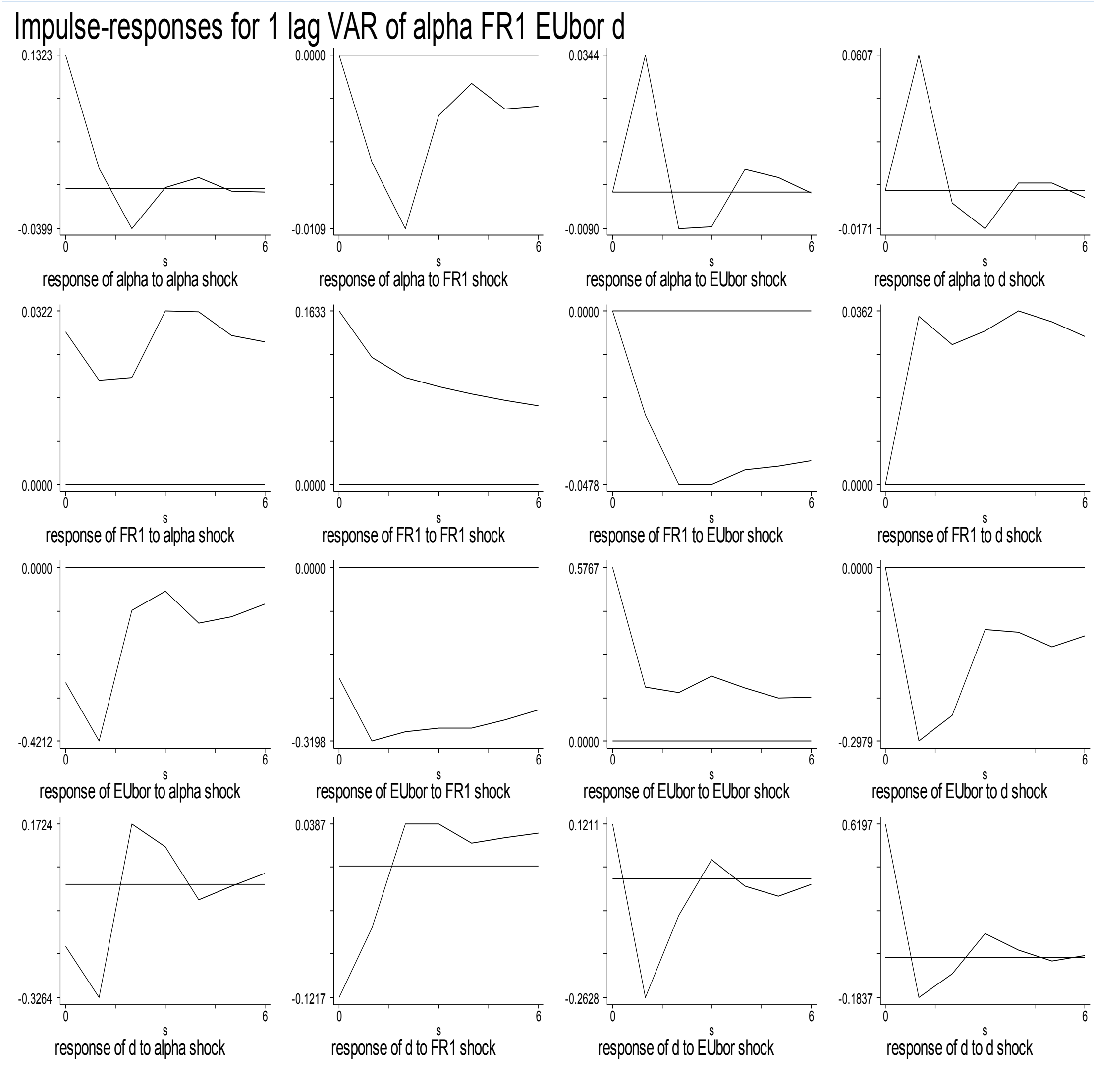
[10] Following Love and Zicchino (2006) all data are forward mean-differenced using the Helmert procedure. Standard errors of the impulse response functions are calculated and confidence intervals generated with Monte Carlo simulations.

[11] Results are available upon request.

[12] The results do not show violation of the normality. Panel Var results are available under request.

equilibrium thereafter. On the other hand, a shock in *EUbor* and *d* asserts a positive impact on *'alpha'*.

Diagram 5: Impulse Response Function (IRF) for *alphas*, *FR*, *EUbor* and *d*.



Note: *alpha* 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.

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

Table 7: Variance Decompositions (VDCs) for 1 lag of *alpha, Fiscal rules, Euribor 3M* and *Debt.*

	S	*alpha*	Fiscal Rules	Euribor 3M	Debt
alpha	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
alpha	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

Notes: s defines the periods ahead of VDCs.

During crisis banks are undercapitalised (Duffie, 2010) this leads to arbitrage opportunities. The recent credit crunch shows that illiquid markets contribute to high cost of holding sovereign bonds due to possible high haircuts (Mitchell and Pulvino, 2009). Deteriorating market liquidity would unavoidably lead to high sovereign bonds spreads and CDS. The above dynamics of the sovereign '*alphas*' as depicted by IRFs and VDCs clearly suggest that a shift towards pessimism has taken place during the crisis that could be the outcome also of liquidity constraints that the euro-zone 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'*. [13]

6. Conclusion

In the early days of the euro, the risk premiums on the euro-zone sovereign bonds were narrowed, whilst exhibiting low volatility. The market judged, back then, the probability of sovereign default was negligible. Since 2009 market's perception has been dramatically shifted towards asserting very high probabilities of default for several euro-zone member states, with Greece having at present the highest probability of default worldwide.

[13] 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 *'alphas'* dynamics. In general as risk in the inter-bank sector increases default protection becomes less valuable.

Our results provide a useful source of information for understanding the market's preferences regarding the sovereign debt in the euro-zone. 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 euro-zone member states, in particular Greece, sovereign bonds.

An increase in pessimism could be considered under certain conditions, such as periods of intense volatility, 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.

Regarding the impact of fiscal rules and institutions on market behaviour, empirical findings show that they improve market's expectations over fiscal sustainability in the euro-zone. As a result, enhancing fiscal governance could prevent sovereign debt crisis.

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Annex, TABLE A1: 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

The instruments are: a constant (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) or $J_{\hat{a}}$ and X^2(D) for the remaining J.

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

Structural break on 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 on 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 $n^{1/3}$ of the asymptotic variance.

TABLE A5: t-stat and p-values of structural break in 5 yr CDS, weekly: Italy.

Structural break on 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 on 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 $n^{1/3}$ of the asymptotic variance.