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AUTHORS	Maria Alberta Oliveira Carlos Santos

ARTICLE INFO	Maria Alberta Oliveira and Carlos Santos (2022). Unveiling trading patterns: iTraxx Europe financials from the great financial crisis to ECB monetary easing. *Banks and Bank Systems*, *17*(3), 188-200. doi:10.21511/bbs.17(3).2022.16
DOI	http://dx.doi.org/10.21511/bbs.17(3).2022.16
RELEASED ON	Thursday, 29 September 2022
RECEIVED ON	Wednesday, 24 August 2022
ACCEPTED ON	Friday, 23 September 2022
LICENSE	This work is licensed under a Creative Commons Attribution 4.0 International License
JOURNAL	"Banks and Bank Systems"
ISSN PRINT	1816-7403
ISSN ONLINE	1991-7074
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
45	2	1

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Maria Alberta Oliveira (Portugal), **Carlos Santos** (Portugal)

UNVEILING TRADING PATTERNS: ITRAXX EUROPE FINANCIALS FROM THE GREAT FINANCIAL CRISIS TO ECB MONETARY EASING

Abstract

Financial stability is a statutory concern of the European Central Bank. Spreads of bank credit default swaps (CDS) indices are a reference for financial stability, but the literature is scarce in this respect. This paper poses the novel research question of which characteristics of investors in these derivatives are implied by the volatility behavior of the returns of financial CDS indices. Daily spread returns for the 5-year maturity iTraxx Europe Financials (subordinated and senior), for the period between June 2004 and March 2015, are used to estimate a GJR-M model with Student t innovations, and two MGARCH models (one with constant and the other with dynamic conditional correlations). The results show that investors in the index referring to subordinated debt are risk averse (risk premium estimate of 0.688) and liable to leverage effects, while investors in the index for senior debt do not have such characteristics. The degrees of freedom of the Student t innovations are estimated to be 4 for both indices, implying that returns have distributions with very fat tails. Population excess kurtosis diverges to infinity. The results show that the conditional correlation between the indices is dynamic. Although correlations vary widely, most of that variation occurs before the Euro Area crisis. It is concluded that the inclusion of both indices in a portfolio would be misadvised for bear markets with distressed financial entities: the correlations are always positive, above 0.75 since 2010. Moreover, both indices prove to be sensitive to the varying surrounding conditions as investors share market sentiments.

Received on: 24th of August, 2022
Accepted on: 23rd of September, 2022
Published on: 29th of September, 2022

Maria Alberta Oliveira, Ph.D., Associate Professor, Business Sciences Department, University of Maia, Av Carlos Oliveira Campos, Portugal; Researcher at NECE (Research Centre for Business Sciences), Portugal; Researcher at UNICES – University of Maia (Research Unit in Business Sciences and Sustainability), Portugal.

Carlos Santos, Ph.D., Associate Professor with Habilitation, Business Sciences Department, University of Maia, Av Carlos Oliveira Campos, Portugal; Researcher at University of Coimbra, CeBER (Center for Business and Economics Research), Portugal; Researcher at UNICES – University of Maia (Research Unit in Business Sciences and Sustainability), Portugal. (Corresponding author)

Conflict of interest statement:
Author(s) reported no conflict of interest

Keywords CDS indices, risk aversion, leverage effects, investor behavior, bank crisis, financial stability

JEL Classification C58, E52, E58, G01, G21

INTRODUCTION

Bank credit default swaps (CDS)[1] have been at the core of the debate surrounding the Great Financial Crisis (GFC) and the Euro Area (EA) sovereign debt crisis. In the latter, the nexus between financial instability and the sovereign crisis is well established in the literature, particularly in the bank bailout period. The concern with financial stability was such that, from 2012 onwards, the European Central Bank (ECB) has changed monetary policy radically, from inflation targeting to quantitative easing. Notwithstanding, although bank CDS indices are a benchmark for financial stability, and in spite of some studies trying to focus on them to assess policy measures in highly volatile periods, the literature concerning the characteristics and motivations of the behavior of investors in these synthetic Over-The-Counter (OTC) derivatives is scarce. This paper seeks to fill that gap. Its research motif is to understand the behavior of the volatility of returns from these in-

1 Credit Default Swaps (CDS) are credit derivatives concerning a single reference entity. The protection buyer pays periodic coupons during the lifetime of the agreement, while the seller makes no payments unless a credit event occurs. Multi-name CDS (CDS indices) provide protection against credit events in any of a list of reference single-name CDS. The choice of these varies with different criteria (liquidity, business sector, geographical location, etc.).

http://dx.doi.org/10.21511/bbs.17(3).2022.16

dices, retrieving the investors' behavioral parameters from such volatility models. The aim is to achieve a better understanding of the characteristics of these investors. This is done for both subordinated and senior debt bank indices, as subordinated debt is deemed to be quite relevant in the EA. In fact, as it shall be shown, the behavior of investors differs, with respect to some fundamental reactions, between these two segments of the bank multi-name CDS market. Nonetheless, it is similar in other behavioral features, namely the roles of shared market sentiments and trading momentum.

1. LITERATURE REVIEW AND HYPOTHESES

CDS indices emerged in 2002, when J. P. Morgan launched the synthetic indices JECI and Hydi, while Morgan Stanley launched the TRACERS index (Markit, 2019). With the two firms merging in 2003, the consolidated TRAC-X indices have appeared. The TRAC-X consisted of US single names only. IHS Markit® has acquired both indices, now owning iTraxx and CDX[2], as well as other families of indices (Markit, 2019). It should be noticed that Markit® may vary the constituents of an index (e.g., iTraxx Financials)[3], every six months, depending mainly on the rating of the underlying reference entities. As in single name CDS, a spread increase in the index indicates deteriorating credit conditions (Markit, 2021).

The relevance of looking both at the CDS index for banks subordinated debt and at the index for banks senior debt should be clear, when the concern is financial stability. Both Kato and Hagendorff (2010) and Miller et al. (2015) discuss the role of subordinated debt spreads as predictors of bank default risk. In fact, the Protocol on the Statute of European System of Central Banks (ESCB) and of the European Central Bank (ECB) acknowledges that the actions of these shall be such that they contribute to the stability of the financial system (ECB, 2002). As such, one would expect a plethora of studies using the iTraxx Financials Europe for subordinated debt, referring to the EA crisis, given the riskier nature associated with the low priority of subordinated debt creditors. Such studies are missing. Notwithstanding, it has been argued by the ECB (2006) that holders of subordinated debt, as participants in the secondary market, may exercise more discipline than depositors or equity holders. The first may be covered by deposit insurance, whilst the second may benefit from the bank taking more risks under certain conditions. In fact, the third pillar of the Basel II agreement had already considered that market discipline could play a role in reducing the risk to financial stability, as argued by Gropp et al. (2006). The weight of the EU in bank subordinated debt worldwide (in 2006, EU banks represented 50% of subordinated debt issuance, well above the levels of non-EU banks, the USA & Canada, and Japan (ECB, 2006)) does, however, advise against ignoring the risk such a situation represents.

The literature is scarce on studies pertaining multi-name CDS. Most of the existing papers are focused on the connectedness between a certain CDS and other markets. The iTraxx sovereign indices have received particular attention within the context of the EA sovereign debt crisis. Multiname CDS in the corporate segment have been less studied. In short, the literature has played little attention to the financial instrument, bank CDS index, by itself, and to the CDS sub-indices associated with subordinated bank debt and with senior bank debt.

The nexus between the EA sovereign debt crisis and banks default likelihood, as well as the connectedness between bank CDS spreads and sovereign CDS spreads, are well documented in the finance literature (see, *inter alia*, Alter & Schüller, 2012). In fact, the addition of government-initiated bail-ins to the credit events list (ISDA, 2014) was the result of an attempt to solve the EA debt crisis (Oliveira & Santos, 2015). In short, the EA crisis comprised a bail outs period, in which banks were deemed too big to fail, thus ultimately being saved by governments. However, bailing out banks increased the pressure over the financially distressed EA periphery, rising sovereign CDS. Given the

2 The CDX refers to North America.

3 The iTraxx Europe Financials index includes presently 30 institutions, most of which are bank groups, although there are some insurance providers as well.

http://dx.doi.org/10.21511/bbs.17(3).2022.16

EA banks' high exposure to public debt (Covi & Eydam, 2020), there was an increased likelihood of bank defaults after a public bail out, with a new surge in banks CDS spreads. Covi and Eydam (2020) estimate the two-way effect between sovereign and bank CDS to be of a non-negligible magnitude: an increase in sovereign CDS of 10% would lead to an increase of 0.2-0.3% in bank CDS, while a rise in the spreads of banks CDS of 10% would lead to an increase in sovereign CDS spreads of 2-3%. Alter and Schüller (2012) also highlight the role, in the negative amplification cycle, of bank CDS and sovereign CDS, in the EA. Bruneau et al. (2014) argue that banks CDS were the drivers of sovereign CDS markets' sentiments. It should be noted that none of the earlier papers have studied the EA crisis using bank CDS indices.

The EA addressed the nexus between sovereign and bank spreads by attempting to move to a bail in solution. In a bank bail in, senior creditors are liable to take part in the banks' losses, protecting taxpayers. Depositors on the distressed bank would also be forced to participate in the deal, in the form of debt-to-equity conversion. From the 1st of January 2016 onwards, the European legislation has forbidden governments from bailing out banks, leaving the bail in as the only admissible solution (EU, 2014). Klimek et al. (2015) discuss the merits of each path: bail in *versus* bail out. The bail in enforcement appears not to have been totally successful. King (2019) provides examples of Italian regional banks that had recently been publicly bailed out. Other examples from different countries could be provided. The first attempt of solving a bank crisis through a bail in had already occurred in 2013, in Cyprus, before the 2014/59 directive, but this was a one-off event, not properly framed in the EU legislation (see, *inter alia*, Katsourides, 2016).

With respect to the EA debt crisis *per se*, and the role banks have played in it, there are some studies that look at bank CDS indices. Hui et al. (2013) investigate spillovers of default risk from the financial to the non-financial sector. For this purpose, they look at the correlations between the iTraxx Europe Financials and the iTraxx Europe Non-Financials. Bratis et al. (2020) look at the inter-connectedness of the volatility of bank and sovereign CDS spreads during the EA crisis, particularly between the core and periphery of the EA, but find no long-term association. The authors make no use of CDS indices. Alemany et al. (2015) also look at possible contagion between the volatility of bank CDS spreads in the EA, and those of banks outside the EA, and between banks in the core of the EA and those in the financially distressed periphery. The authors do not use bank CDS indices in their analysis. Tamakoshi and Hamori (2013) study time-varying correlations between bank CDS indices for the US, the UK and the EU. They seek to find common movements during the EA debt crisis.

Albeit not looking at bank CDS indices, Drago et al. (2017) seek an understanding of the determinants of bank CDS spreads. The difficulty of explaining credit spreads poses a major challenge to researchers, as explained in Afonso et al. (2007). Oliveira and Santos (2018) have offered a most valid approach for single-name sovereign CDS. Drago et al. (2017) focus on a sample of US and European bank CDS, and they conclude that both bank specific ratios and country specific fundamentals are of relevance.

Gubareva (2020) conducts a closer exercise to the study of multi-name CDS. She is concerned with the liquidity differences between the two markets: single-name CDS and CDS indices. The paper compares the relative liquidity for corporate CDS markets and CDS indices pertaining comparable reference entities. The indices used are the iTraxx Europe and CDX North America. This choice of variables is sufficient to distinguish hers from this paper: her concern is not the financial sector. Wang and Zhong (2022) study CDS indices alone, trying to understand the features of their OTC trade. Notwithstanding, the concern is with the role of dealer's inventories on the price and liquidity of CDS indices markets. One could argue they do investigate features of CDS indices market microstructure, but neither are they restricted to the financial sector, nor do they worry with behavioral characteristics of trade participants.

Hippert et al. (2019) provide an insightful study on CDS indices from the perspective of financial management. They explore the effect on the mean and variance of returns, resulting from adding

http://dx.doi.org/10.21511/bbs.17(3).2022.16

investment grade US and European corporate CDS indices to portfolios containing stock and sovereign bonds indices. The authors conclude that, in the long run, the risk-return features of the CDS indices are such that these are more appealing to institutional investors. Therefore, they tend to partially substitute sovereign bonds by corporate indices in their portfolios. Despite the relevance of the paper, it is not concerned with financial CDS indices.

One of the closest studies to this paper, in terms of focusing on financial CDS indices alone, is provided by Tamakoshi and Hamori (2014). The authors use daily data covering the period between January 2004 and June 2013. However, they are only interested in the insurance sector, leaving banks aside. Furthermore, differently from this paper, they are interested in the dependence structure between the US, the EU and the UK CDS indices. Their copula analysis shows particularly strong dependence between the UK and the US, suggesting simultaneous losses, in the period prior to the GFC. From 2008 onwards, the authors find low dependence between each pair, suggesting low systemic risk in the global insurance sector.

Calice (2014) investigates the connectedness between bank CDS indices and the equity returns, for a sample of systemically important financial institutions (SIFIs). He uses both the 5-year maturity investment grade iTraxx Europe and the matching CDX North America. He concludes in favor of a negative correlation between both CDS indices and the corresponding equity returns, for SIFIs. This relationship appears to be stronger in Europe. The author assumes explicitly he is not interested in behavioral parameters.

King (2019) studies the effects of bank bail outs on bank stock prices, and bank CDS spreads. He looks at the GFC, particularly at data from October 2008, referring to US banks and banks from 5 European countries. Fenech et al. (2014) also focus on the GFC, using Archimedean copulas to study the dependence between the Australian iTraxx CDS index and the price of the corresponding firms in the stock market. Fang and Lee (2011) study the GFC, using a measure of the impact of the ABX index on the CDX-US index. The authors constructed the ABX as an index of Collateralized Debt Obligations (CDO) related to asset backed securities (ABS). Choe et al. (2020) develop a tool to assess systemic risk during the EA debt crisis. The authors study the simultaneous default risk and the contagion-default risk during the crisis, by using the iTraxx Europe and the Marshall-Olkin copula.

Katsompoxakis (2022) introduces the change in the monetary policy of the ECB from 2012 onwards. The financial stability of the EA can, potentially, be conflicting with the fundamental priority of the ECB: price stability (ECB, 2002). Notwithstanding, the EA banking crisis, with a strong nexus between non-performing public debt in banks' portfolios, and the possible need for bank bail outs to avoid default and systemic risk, had assumed such proportions by 2012 that the ECB governor Mario Draghi took a strong stance, eliciting financial stability as the fundamental priority of monetary policy. In his notorious speech in London, on the 26th of June 2012, the expression "whatever it takes" was used by Draghi, to refer to what the ECB was willing to do to achieve financial stability in the EA. In practice, this has marked a turn in ECB monetary policy, from inflation targeting to extreme quantitative easing (Financial Times, 2022a). By lowering the ECB's reference interest rate to zero, and by conducting a series of unconventional monetary policy measures (namely lending money to banks in exchange of non-performing public debt titles), the ECB has lowered the likelihood of bank failures and slowed the sovereign debt crisis. Ehmer (2017) notes that government bond yields have lowered dramatically with the ECB's policy turn. He estimates the cost savings of the new policy to be of 5.3% of GDP for Spain and 6.6% for Italy.

Katsompoxakis (2022) seeks to assess the relevance of the monetary policy shift to the nexus between EA sovereign CDS spreads and bank CDS spreads. He concludes that the radical change to quantitative easing, that the ECB has adopted from 2012 onwards, has succeeded in increasing financial stability, since the nexus between sovereign and bank spreads appears to have been broken. The author also points out that bank CDS spreads do not appear to be reacting to the deteriorating government deficits[4]. However, the paper does leave the question of which would be the reaction of the bank CDS spreads to a possible reversal in the ECB monetary policy[5]. The analysis in Katsompoxakis (2022) does not make use of CDS indices (either financial or sovereign).

As it has been shown in this section, no papers provide behavioral insights into the agents acting in the market for financial CDS indices. Even the very rare studies that model indices' returns volatility are not concerned with traders' behavior as foundations for modelling, but rather with spillovers to other markets. In particular, models of indices' returns that include behavioral parameters, namely the GJR model of Glosten et al. (1993), which allows positive and negative surprises to have different impacts on conditional volatility (leverage effects), are not used in this literature. Models checking if the expected returns on CDS indices are increasing with their conditional variance, a sign of risk aversion, are also missing (GARCH variations of the ARCH-M of Engle et al. (1987)). Moreover, the insights gained from looking jointly at subordinated and senior bank CDS indices have never been studied (using, *inter alia*, MGARCH models (Bollerslev et al., 1988)).

In conclusion, the research question addressed in this paper seeks to fill such a gap in the literature, and it is clearly defined: Which characteristics of investors in these derivatives are implied by the volatility behavior of the returns of financial CDS indices?

In particular, the paper shall address this goal through the following research hypotheses:

H_1: *There exists volatility clustering in the returns of financial CDS indices, for both subordinated and senior debt.*

H_2: *The conditional volatility of both series of returns exhibits long memory.*

H_3: *Investors in financial CDS indices are risk averse. Therefore, they demand a risk premium in the returns.*

H_4: *Investors in financial CDS indices are prone to react to negative news in a way that amplifies the variance, in comparison to their reaction to positive news, which will have a smaller variance.*

H_5: *Given the heterogeneous sample period, one expects the distribution of returns to be non-normal, with fat tails.*

H_6: *The correlation between the two series of returns is time varying.*

2. METHODS

This paper uses two series of spreads: that for the 5-year maturity iTraxx for subordinated debt of European financial institutions, and that for the corresponding iTraxx for senior debt of such financial institutions. Firstly, the daily returns of each spread will be modelled independently, using a specification that allows for non-normal innovations, volatility clustering, long memory, risk aversion and leverage effects (as defined in Glosten et al., 1993). As such, for each series of returns the GARCH (1,1)_t-M model shall be estimated, with the following equations defining the mean and the conditional variance. Equation (1) refers to the returns and is known as the mean equation, and equation (2) refers to the conditional variance of the returns and is known as the conditional volatility equation:

$$r_{i,t} = \mu_i + c_i h_{i,t} + \varepsilon_{i,t}, \quad \varepsilon_{i,t} \sim t(v_i), \tag{1}$$

$$h_{i,t} = \alpha_{i,0} + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} + \gamma_i \varepsilon_{i,t-1}^2 I_{i,t-1}. \tag{2}$$

It is assumed that i = 1, 2. That is, there will be an equation for the mean and one equation for the conditional variance, for i = 1, referring to a GARCH (1,1)_*t-M* for the returns of the CDS index defined for subordinated debt of financial reference entities. There will also be a mean and a conditional variance equation for the returns of the CDS index referring to senior debt, in which case i = 2.

4 These rose in many EA countries, well above the 3% maximum for the deficit to the GDP ratio, during the pandemic years. The average EA government deficit was 7.2% in 2020 and 5.1% in 2021 (Eurostat, 2021, 2022).

5 We are beginning to observe that policy reversal (Financial Times, 2022b), as the ECB rose its interest rate by half a percentage point in June 2022.

http://dx.doi.org/10.21511/bbs.17(3).2022.16

In equations (1) and (2):

$$I_{i,t-1} = \begin{Bmatrix} 1, if\ \varepsilon_{i,t-1} > 0 \\ 0, if\ \varepsilon_{i,t-1} \leq 0 \end{Bmatrix} \quad (3)$$

and $t(v_i)$ is a Student t distribution with v_i degrees of freedom, where v_i is a parameter to be estimated. The model above is also known as the GJR-M specification with $t(v_i)$ distributed random errors. Most of the behavioral hypotheses outlined in the previous section will be answered from testing certain parameters in the specification above.

Notwithstanding, multivariate joint models for the returns and conditional volatilities of both series shall also be estimated: a multivariate GARCH with dynamic conditional correlations (MGARCH-DCC) as suggested by Engle (2002), and a multivariate GARCH with constant conditional correlations (MGARCH-CCC), suggested by Bollerslev (1990).

The MGARCH-DCC starting point is the definition of a conditional correlation matrix:

$$\rho_t = J_t Q_t J_t, \quad (4)$$

where J_t is a diagonal square matrix, of the form

$$diag\left\{\sqrt{q_{11,t}}^{-1}, \ldots\ldots, \sqrt{q_{kk,t}}^{-1}\right\}. \quad (5)$$

Q_t is a square matrix of dimensions (k x k), satisfying

$$Q_t = \left(1-\theta_1-\theta_2\right)\bar{Q} + \theta_1 \int_{t-1} \int'_{t-1} + \theta_2 Q_{t-1}, \quad (6)$$

$$\grave{o}_{j,t} = \frac{\varepsilon_{j,t}}{\sqrt{\sigma_{jj,t}}}, \quad (7)$$

where ε_t is the standardized vector of innovations with elements, $\bar{Q}$ is the unconditional covariance matrix of ε_t, and θ_1, θ_2 are nonnegative scalar parameters satisfying $0 < \theta_1 + \theta_2 < 1$. J_t is a normalization matrix to guarantee that the correlation matrix R_t exists and is properly defined.

The MGARCH-DCC is a common choice when modelling jointly two or more series of returns. Tsay (2010) discusses other alternatives. It should become clear, from the outline of the hypotheses to be tested, provided in the previous section, that the purpose of such models, in this paper, is solely to compare a time-varying correlations output with that of a model with constant correlations, such as the one developed by Bollerslev (1990), where $\rho_{21,t} = \rho_{2,1}$. In practice, only one output from the MGARCH-DCC will be relevant for this research: the plot of conditional correlations between returns of the two series. With respect to the MGARCH-CCC, the only relevant estimate is that of the correlation coefficient. As such, it makes no sense to derive the MGARCH-CCC with the detail used above for the MGARCH-DCC.

The plot of the dynamic conditional correlations shall be confronted with the constant correlation estimate obtained, so that conclusions about H_6 are drawn. The plot of the time-varying correlations shall also allow drawing conclusions for portfolios containing these indices, in different sample periods.

The next section shall be concluded by a detailed inspection of the plot of the spreads themselves, from which additional insights on traders' behavior can be gained.

The sample consists of two daily series of spreads for 5-year maturity financial CDS: the iTraxx Europe Financials Sub (for subordinated debt) and the iTraxx Europe Financials Senior (for senior debt). The data comprises the period from the 24th of June 2004 to the 20th of March 2015 (2,740 observations). Data was obtained under an academic license directly from the creators and managers of the index: Markit ®. The GJR version of the GARCH_*t-M* model for each series, as well as the MGARCH models were estimated using the Oxmetrics Professional 8 software. This software uses the BFGS algorithm to estimate the parameters of these models.

3. RESULTS

The estimation results for equations (1) and (2), for both indices, are displayed in Table 1.

The first two columns of Table 1 report the estimation results for the subordinated debt CDS index. The third refers to the p-value obtained when conducting an individual significance test on each

Table 1. Estimation results for the GJR (1,1)_t-M model of the iTraxx returns

Source: Results from Oxmetrics Professional 8.

Variable	Subordinated debt			Senior debt		
	Coefficient	Robust std. error	p-value	Coefficient	Robust std. error	p-value
$\hat{\mu}$	–0.002152	0.00038920	0.0000	-0.001919	0.00045786	0.0000
$\hat{\alpha}_0$	0.057336	0.028466	0.0441	0.043306	0.027951	0.1214
$\hat{\alpha}_1$	0.263490	0.047893	0.0000	0.202442	0.039645	0.0000
$\hat{\beta}$	0.830707	0.020964	0.0000	0.850076	0.020745	0.0000
$\hat{\gamma}$	–0.062042	0.036037	0.0853	–0.009464	0.033406	0.7770
$\hat{\nu}$	3.672684	0.30338	0.0000	3.880915	0.33579	0.0000
$\hat{c}$	0.687778	0.26108	0.0085	0.489508	0.31071	0.1153

of the equations' parameters. On the right-hand side of the table, columns 4 and 5 report estimates of the same parameters for the senior debt index. Column 6 presents the p-value obtained when conducting individual significance tests on each parameter, for the series pertaining senior debt.

To test the hypothesis H_0: $\alpha_1 = 0$, the p-value for both models is approximately 0. Hence, at a 1% significance level, the p-value is smaller than 0.01. As such, the null hypothesis is rejected, for both subordinated and senior debt. The reasoning with respect to β is very similar. A test, at a significance level of 1%, of the hypothesis H_0: $\beta = 0$, leads to rejection of the null. Table 1 indicates p-value < 0.01 for both series, with respect to this hypothesis.

For the null hypothesis H_0: $c = 0$, a p-value of 0.0085 is obtained for the model concerning subordinated debt. Hence, at a significance level of 1%, the null hypothesis is rejected. In fact, the evidence in Table 1 implies that if the conditional variance of returns increases by one, investors will want an average increase in the returns of 0.687778. However, when running the same test on the model for senior debt CDS index, the p-value is 0.1153. The hypothesis H_0: $c = 0$ cannot be rejected in this model, since, even considering a much higher significance level of 10%, 0.1 < p-value.

For the sample consisting of returns from the subordinated debt bank CDS index, a test of the hypothesis H_0: $\gamma = 0$, at a 10% significance level, rejects the null: p-value = 0.0853. When looking at the right part of table 1 (results for the senior debt sample), the hypothesis H_0: $\gamma = 0$ is not rejected. Even at a significance level of 10%, the relevant p-value is 0.777 > 0.1.

In both cases $\hat{\nu}$ is such that there is support for a $t(4)$. In fact, the hypothesis H_0: $\nu = 4$ is not rejected. For subordinated debt, the observed test statistic is

$$\frac{\hat{\nu}-4}{robust\, st\, error\, of \hat{\nu}} = -1.07. \tag{8}$$

Given that the test statistic is asymptotically normal $N(0; 1)$, the observed value is inside the non-rejection region with 90% confidence: [–1.96;1.96]. The same is true for senior debt (observed test statistic of –0.3546).

A $t(4)$ has indeed very fat tails. Although variance is defined (since $\nu > 2$), population excess kurtosis in a t distribution can only be computed for $\nu > 4$ (Johnson et al., 1995). The implication is that excess kurtosis of spread returns diverges to infinity as $\nu \to 4$, in both cases[6].

The bivariate MGARCH, both with constant conditional correlations and with dynamic conditional correlations, was estimated. As discussed in the methodology section, this paper is only interested in the constant correlation estimate obtained from the first model, and in the plot of estimated dynamic correlations obtained from the second model. There is no need to report other results. The estimate of a constant conditional correlation is 0.773506 (the sample correlation between the returns of the two indices). When confronting this constant correlation with Figure 1 (the plot of the estimated dynamic correlations), one may argue, along the lines of Tsay (2010), that the CCC as-

6 The excess kurtosis for a Student t distribution with v degrees of freedom is given by 6/(v-4). Hence, it is not defined for v < 4, and when v converges to 4, the excess kurtosis diverges to infinity (Johnson et al., 1995).

http://dx.doi.org/10.21511/bbs.17(3).2022.16

Source: Results from Oxmetrics Professional 8.

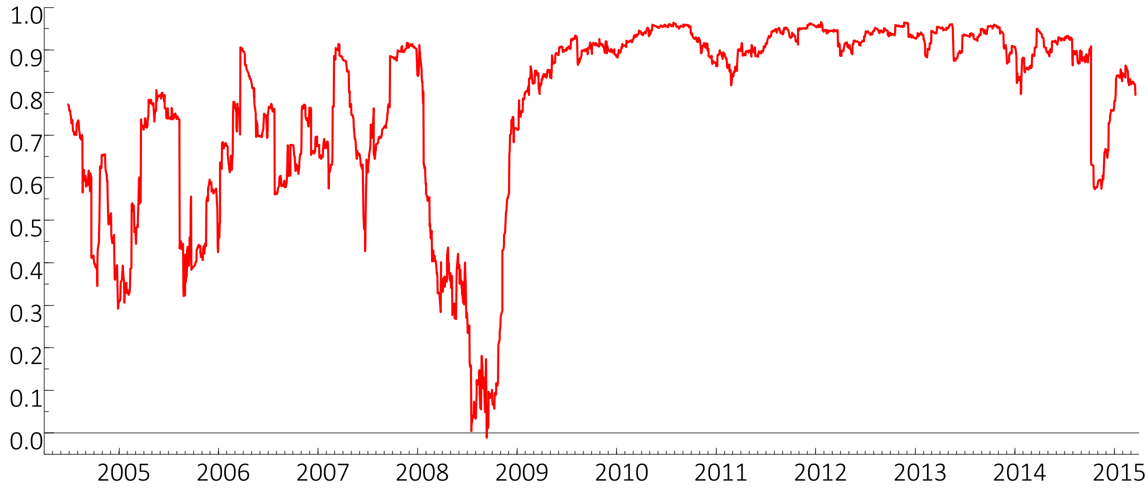

Figure 1. Dynamic conditional correlations from MGARCH-DCC

sumption would be absurd. In fact, Figure 1 shows that the correlation coefficients between returns of the two indices vary widely, taking all possible values in the interval [0,1] during the sample period[7].

An interesting fact suggested by the plot in Figure 1 is that correlations between returns of the iTraxx Europe Financials, for subordinated debt and for senior debt, vary more widely before the EA crisis. In fact, before 2008 it was possible to observe conditional correlations differing by 0.5 or 0.6, for relatively close days. Indeed, since 2010, the maximum observable difference between correlations was approximately 0.3. Moreover, the plot in Figure 1 clearly suggests the conditional correlation of returns for the two CDS indices is almost always systematically high (above 0.75) from 2010 onwards.

Albeit not resulting from any hypothesis raised in the previous section, the plot of the spreads of the two indices for the sample period is provided in Figure 2. It clearly shows common patterns in the two indices, with simultaneous, or almost simultaneous, peaks and troughs for all major events in the period. There are common surges in the indices' spreads: from July to September 2007, the year of the crash in the US housing market (on the 20th of June of 2007 the Bear Sterns investment bank bailed out two of its mortgage backed securities hedge funds; in August of 2007, the firm American Home Mortgage filed for bankruptcy; in August of 2007, the Federal Reserve lowered its discount rate due to the lack of confidence between banks, given that all were exposed to troubled subprime loans); with the Bear Stearns collapse, in March of 2008; with the Lehman Brothers bankruptcy, in September of 2008, and its aftermath, in the last quarter of the year and in 2009; with the first EA sovereign bail out in May of 2010 (Greece); with other EA countries also requiring financial aid (2010–2011: Ireland and Portugal); with the 2nd Greek bail out in March of 2012, entailing a partial debt forgiveness that implied losses for banks holding Greek sovereign bonds; with the rescue of Spanish banks in June 2012; and with the Cyprus bail in episode in March of 2013. On the other hand, the spreads of both indices share a common tendency to diminish after the Cyprus case, and as the ECB monetary easing was being implemented progressively. Figure 2 also shows that the index for subordinated debt has always had a higher spread, which was to be expected given the riskier nature of subordinated debt.

4. DISCUSSION

In this section, the findings of section 3 shall be interpreted in connection with the research hy-

7 Following again Tsay (2010), we also notice an improvement in the log-likelihood function when moving from constant to time-varying correlations.

Source: Results from Oxmetrics Professional 8.

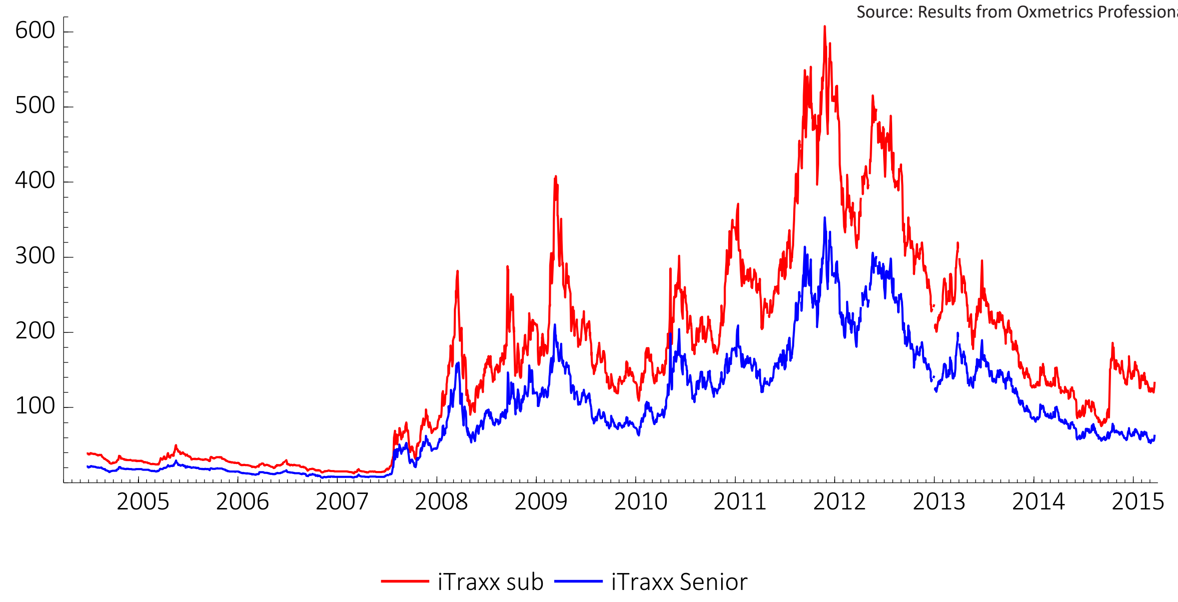

Figure 2. iTraxx Financials Europe spreads for subordinated and senior debt

potheses raised at the end of section 1, and in relation to the main research question of this paper. It shall also be argued whether such findings were to be expected. A discussion on the reasons for some more intriguing results shall also be provided. Comparisons with existing literature results will be provided when possible.

The rejection of the null H_0: $\alpha_1 = 0$, in the two cases, implying that both returns series have volatility clustering, means that research hypothesis H_1 is confirmed. This was to be expected, since volatility clustering is a stylized fact of most financial returns time series (Tsay, 2010). The same should be said of the confirmation of long memory in both series, resulting from the individual significance of the parameter β. H_2 is also confirmed.

The results obtained with respect to the risk premium, c in equation (1), are interesting. The rejection of the null hypothesis related to c implies that the buyers of iTraxx for subordinated debt of European financial institutions have significant risk aversion. In the previous section, it was also shown that in the model for the senior debt returns, the risk premium term is not significant. Contrary to buyers of iTraxx for subordinated bank debt in the EU, the buyers of iTraxx for senior debt do not demand an increase in returns when conditional volatility rises. Hence, they do not exhibit statistically significant risk aversion behavior, when buying this CDS index. Thus, H_3 cannot be validated.

If the conflicting evidence does not allow to confirm hypothesis H_3, it must be said that a market behavior has been uncovered. One possible explanation, assuming buyers of iTraxx Financials for subordinated debt, in fact, own subordinated debt from the reference financial institutions, and the same assumption holding for senior debt holders, is that the baseline exposure to risk is already higher for the first group, given the nature of subordinated debt. As such, they are more prone to demand risk premium, than investors with a lower baseline risk exposition. Notice that this explanation, assuming no short positions of index holders, is just an hypothesis.

For buyers of the index pertaining subordinated debt, the leverage effects studied by Glosten et al. (1993) are found. The fact that the estimated coefficient $\hat{\gamma}$, in equation (2), for the model of subordinated CDS returns, is negative and significant allows the claim that investment behavior in the iTraxx for subordinated debt shows leverage effects. This is a most interesting behavioral conclusion, discussed extensively in Glosten et al. (1993). It means that investors have an asymmetric response to unanticipated shocks. It is estimated that the effect of a negative shock in the previous period on conditional volatility is 0.26349, while

http://dx.doi.org/10.21511/bbs.17(3).2022.16

the estimated effect of a positive shock is $\hat{\alpha_1} + \hat{\gamma} =$ 0.26349 – 0,062042 = 0.201448. Therefore, the investors in subordinated bank CDS indices react to news differently, depending on whether they are good or bad, and bad news have a bigger effect on volatility than good news, increasing it.

In the previous section, it was noticed that, despite having the correct sign for leverage effects, $\hat{\gamma}$ = –0.009464 < 0, in the sample referring to senior debt financial CDS indices, the coefficient γ was not statistically significant. Hence, the behavior of investors in bank CDS indices referring to subordinated debt differs from that of investors in this product for senior debt. H_4 is not validated.

Despite not concluding in favor of H_4, another behavioral characteristic of market participants is uncovered. Given the relevance of CDS bank indices as a reference for financial stability, it is important to know that the subordinated segment is subject to leverage effects. Again, the fact that this market may possibly be dominated by agents who are really hedging, with an already high (as creditors) baseline exposure to risk, might be the reason for the stronger volatility reaction to negative shocks.

With respect to H_5, one should bear in mind that as the degrees of freedom of a Student t distribution lower, its kurtosis rises, with tails getting increasingly fat (Johnson et al., 1995). A sample of financial CDS index spread returns that comprises periods of tranquility (pre-2007), the GFC, the EA sovereign debt crisis in the bail outs and the post bail outs periods, and a drastic shift in ECB's monetary policy as a support to financial stability, is heterogeneous enough to support the idea behind H_5. In fact, Table 1 provides support for this intuition, as explained in section 3, since the hypothesis H_0: $v = 4$ could not be rejected, both for subordinated and for senior debt. As shown in that section, the returns from both CDS indices have very fat tails, confirming H_5.

The conclusion that the time-varying correlation model is preferred, in section 3, shows that research hypothesis H_6 is confirmed. The two regimes in the dynamic conditional correlations found in the results lead to an interesting implication for portfolio management: the DCC plot suggests that in bearish market periods, with threats to bank stability, one should not include both indices in the same portfolio, since the correlation of their returns is not only positive, but very high.

In conclusion, Figure 2 suggests that investors shared market sentiments, and that these drove the spreads for CDS indices. The highly leveraged nature of the indices (Oliveira & Santos, 2015) is likely to have facilitated some herding behavior. These conclusions are in line with those of Bruneau et al. (2014) for single name bank CDS. Chiarella et al. (2015) also conclude that trading momentum plays a fundamental role in sovereign CDS.

All the discussion in this section is original, filling a gap in the literature. No other study had looked at bank CDS indices *per se*, nor at the behavioral characteristics of market participants, namely with the division between types of debt. Notwithstanding, the study should be deepened, namely considering whether investors behavior varied at other indices maturities. Moreover, the experience of Covid lockdowns and the departure from quantitative easing by the ECB, would make it interesting, in the future, to extend the analysis until 2022.

CONCLUSION

In this paper, a novel research question was posed: Which characteristics of investors in these derivatives are implied by the volatility behavior of the returns of financial CDS indices? The GJR_t-M was used, as well as two MGARCH variations. The data used referred to the EU and included senior and subordinated debt separately. It was shown that market participants for the subordinated debt segment have a distinct behavioral profile. They are risk averse, demanding a risk premium for increases in returns' conditional volatility. This segment also exhibits leverage effects, as the impact of bad news in the previous day has the consequence of increasing conditional volatility above the level that would exist otherwise. In contrast, investors in the senior segment do not show risk aversion nor asymmetric response to good and bad news. The distribution of financial CDS returns was found to have very fat tails, with infinite population excess kurtosis. Also, the plot of dynamic conditional correlations highlights that these vary widely in the first part of the sample, stabilizing on the second, at a very high level. Implications for portfolio management were drawn. The evolution of spreads for the sample period was assessed, and shared market sentiments of traders appear to have played a role.

AUTHOR CONTRIBUTIONS

Conceptualization: Maria Alberta Oliveira, Carlos Santos.
Data curation: Maria Alberta Oliveira, Carlos Santos.
Formal analysis: Maria Alberta Oliveira, Carlos Santos.
Funding acquisition: Maria Alberta Oliveira, Carlos Santos.
Investigation: Maria Alberta Oliveira, Carlos Santos.
Methodology: Maria Alberta Oliveira, Carlos Santos.
Project administration: Maria Alberta Oliveira, Carlos Santos.
Resources: Maria Alberta Oliveira, Carlos Santos.
Software: Maria Alberta Oliveira, Carlos Santos.
Supervision: Maria Alberta Oliveira, Carlos Santos.
Validation: Maria Alberta Oliveira, Carlos Santos.
Visualization: Maria Alberta Oliveira, Carlos Santos.
Writing – original draft: Maria Alberta Oliveira, Carlos Santos.
Writing – reviewing & editing: Maria Alberta Oliveira, Carlos Santos.

ACKNOWLEDGMENT(S)

NECE's research is funded by national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., Project UIDB/04630/2020.
CEBER's research is funded by national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., Project UIDB/05037/2020.

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