Information transmission between stock and bond markets during the Eurozone debt crisis: Evidence from industry returns

Nuno Silva[*,+]

[*]University of Coimbra, Faculty of Economics
[+]CeBER - Centre for Business and Economics Research

Abstract

I analyze the Granger causality in distribution between sovereign bonds and industry indexes in the five European countries most affected by the debt crisis: Greece, Ireland, Italy, Portugal, and Spain. Prior research assessed the impact of the debt crisis on the financial firms, but its effect on other industries was broadly neglected.

My results reveal that, at the height of the crisis, delayed shocks transmission from the sovereign bond to the stock market occurred mainly in Greece. At the industry level, there is no evidence of lagged response of the financial industry to negative sovereign debt shocks, but sovereign debt leads other industries in, at least, one country. These findings are consistent with the investor inattention hypothesis, which states that investors tend to specialize in specific markets, due to their limited availability of time and resources and the cost of information gathering, and information flows slowly across markets.

1. Introduction

The European debt crisis began at the end of 2009 when the new Greek government revised upwards the budget deficit projection to 12.7% of GDP. This revision led to downgrades of the Greek sovereign debt by several rating agencies, and to a surge in bond yields that effectively barred Greece from international credit markets and culminated in a request by Greece of an initial loan of 45 billion euros from the EU and the IMF.

The Greek debt crisis quickly spread to the rest of the Eurozone, as investors become increasingly aware of the fragility of other peripheral countries. In 2010 sovereign bond yields rose sharply in Portugal and Italy, as investors began questioning the sustainability of their public debt, and in Ireland and Spain who had to rescue several banks that were plagued by a large stock of non-performing loans, after the world financial crisis.

The European debt crisis left its mark, not only in the sovereign bond market but also in other asset classes, such as stocks. Several authors studied the impact of this crisis on banking stocks, which were particularly affected by it, due to their high exposure to the sovereign credit risk. A study group established by the Committee on the Global Financial System of the Bank for International Settlements (BIS, 2011) identified four main transmission channels through which sovereign risk can affect banks:

i) Asset holdings- Banks may suffer losses due to their holdings of sovereign debt;

ii) Collateral/liquidity- Increases in sovereign credit risk reduce the value and/or eligibility of sovereign bonds as collateral in banks' funding operations;

iii) Sovereign ratings and banking ratings- Sovereign ratings usually represent a ceiling for domestic banks' ratings. Thus, a sovereign downgrade tends to be followed by downgrades in domestic banks' ratings;

iv) Government guarantees- The deterioration of the sovereign fiscal position leads to a decrease of both explicit and implicit guarantees on bank funding.

Even though banking was the most severely affected and thoroughly studied sector during the European debt crisis, its impact was felt across the whole economy. The linkages between other industries and sovereign bonds are deep and often neglected. First, they are both affected by a deterioration of investors' expectations regarding the future growth of the economy. Second, a higher sovereign yield may lead to contagion in the form of higher financing costs for firms, especially in highly leveraged industries, such as telecommunications and utilities. Third, an increase in the perceived likelihood of sovereign default increases the prospects of further fiscal consolidation, which decreases internal demand and affects, particularly, industries most exposed to the domestic market. Finally, a deterioration in firms' business conditions may generate lower profits and employment, which translates into lower tax revenues, and may compromise the sovereign debt sustainability.

The main objective of this study is to analyze if information flowed swiftly between the sovereign bond and eleven industry equity indices, during the height of the sovereign debt crisis (2010-12), in the five most affected countries (Greece, Ireland, Italy, Portugal, and Spain). To obtain a clearer picture of the information transmission in these countries during the crisis, I benchmark it against the two largest Eurozone economies. I also compare the speed of information flow during the crisis and in the period afterward (2013-19). To achieve this goal, I use the nonparametric test for Granger causality in distribution proposed by Candelon and Topkavi (2016). This method can test causality over several quantiles of the distribution and offers a more complete picture of the information transmission across markets than the traditional Granger causality in mean. Furthermore, it extends the method proposed by Hong et al. (2009) by allowing the researcher to test causality in several quantiles simultaneously, effectively making it a causality test in the distribution. My results reveal there is evidence of contagion, in both directions, for several industries, in the left and right tails of the distribution.

My contribution to the literature is twofold. First, I assess the impact of the sovereign debt crisis in other industries beyond finance, across different parts of the distributions. Second, I show that the European debt crisis had a broad impact on several industries and that new information is not incorporated in the sovereign bond and stock markets at the same time. These results are consistent with Hong et al. (2007) and Menzly and Ozbas (2010), among others, who report that industry returns exhibit positive cross-momentum because Information gathering is costly, and investors tend to specialize in specific sectors. Thus, news flows slowly across industries.

The remainder of this paper is organized as follows. Section 2 presents the main related literature. Section 3 describes the dataset. Section 4 presents the econometric methodology. Section 5 displays and analyzes my main results. Finally, section 6 presents the concluding remarks.

2. Related literature

This study is related to a vast strand of literature on the cross-asset spillover of shocks, that experienced rapid growth following the 2008 Global financial crisis and the subsequent European debt crisis.

The strong linkages between sovereign bonds and banking stocks led several authors to study the existence of contagion and spillover effects between them. Allegret et al. (2017), using a multifactor model of equity returns with a sovereign risk premium, conclude that the negative impact of the European Debt Crisis is confined to European banks. Bhanot et al. (2014) find that an increase in Greek sovereign bond yields generates negative abnormal returns in financial stocks of Greece, Portugal Italy, and Spain, and this effect is reinforced when there are negative news announcements about Greece. Tamakoshi and Hamori (2012) analyze the relation between Greek sovereign bond yields and Southern European banking stock indices and conclude that there is unidirectional causality-in-mean from banking stocks to Greek sovereign bond yields and bidirectional causality-in-variance. Using a database of 33 systemically important banking stocks and 36 sovereign bond yields, Corsi et al. (2018) develop a measure of connectedness between these markets in times of financial distress. They show that this indicator peaks at the beginning of the European, which implies that the "flight-to-quality" phenomenon was especially prevalent during this period. The credit default swap (CDS) spreads is used to test the transmission of shocks between sovereign bonds and banks by Alter and Beyer (2014), who show that the interconnectedness between banks and sovereign CDS's increased from 2010 to 2012, and De Bruyckere et al. (2013) who report evidence of increased correlation (contagion) between sovereign and bank CDS spreads during the European debt crisis, especially in the GIIPS countries. Grammatikos and Vermeulen (2012) show that an increase in Greek CDS spread causes a decrease in both financial and non-financial stock returns, not only in the fragile Southern European countries but also in the more robust Northern ones. Using a vector autoregressive model, Coronado et al. (2012) analyze the transmission of shocks between the CDS and stock markets, in several European countries, between 2007 and 2010. They find that the stock markets lead CDS markets throughout most of the period considered, but the CDS markets played a key role in shock transmission at the heyday of the debt crisis. Ballester et al. (2016) assess return spillovers between bank CDS markets in different countries. After decomposing CDS returns into systematic and idiosyncratic factors, using principal component analysis, they apply a generalized VAR model to measure contagion. The authors report that global contagion is always greater than idiosyncratic contagion, but the role of idiosyncratic risk in information transmission increased during the European debt crisis.

Another line of research focuses on the international transmission of shocks across several European countries during the debt crisis. Tola and Walti (2015), using a narrative approach, find evidence of contagion in the European sovereign debt market, and Tamakoshi and Hamori (2011) show that significant causal relationships between European stock markets disappeared during the Greek sovereign debt crisis.

The literature on cross-asset interdependence is a rich one and covers a wide range of classes. Chang and Cheng (2016) study the cross-asset contagion between REIT, stock, money, bond and currency markets in the US, Norden and Weber (2009) analyze the transmission of shocks in stocks, CDS spreads and bonds, Beirne and Gieck (2014) focuses on global bond, equity and exchange rate markets, Longstaff (2010) shows that a subprime asset-backed collateralized debt obligations index leads stocks, and corporate and treasury bonds by as much as three weeks, and Chulia and Torro (2008) test the volatility transmission between European stock and bond markets using futures contracts.

The research on contagion at the industry level is much scarcer. Bekaert et al. (2014) analyze the information transmission for 415 equity industry portfolios from 55 countries during the global financial crisis, using a three-factor model. They find that domestic contagion dominates international contagion, and it is particularly severe in countries that present poor economic fundamentals. Phylatkis and Xia (2009) also use a factor model to test for contagion across several country-industry indexes, from U.S., Latin America, Europe, and Asia, between 1990 and 2004. They conclude that the transmission of information is heterogeneous across industries: some industries are plagued with contagion, while others seem almost immune to it. Using an asymmetric dynamic conditional correlation GARCH model, Alexakis and Pappas (2018) test for international contagion at the sector level in 15 European countries, during the global financial crisis and the European sovereign debt crisis. They conclude that contagion exists in all the business sectors, and it is especially prevalent in financials and telecommunications. The information flow between 11 US industry stock indexes and their corresponding CDS spreads, is studied by Shazad et al. (2017). They report that all the stock market indexes Granger-cause the CDS markets, but there is also some evidence of bidirectional causality for some industries.

3. Data

The database consists of daily sovereign bond total return and equity indexes, covering the years 2010 to 2019, for five of the Eurozone countries most affected by the European sovereign debt crisis- Greece, Ireland, Italy, Portugal, and Spain- and their two largest economies (France and Germany), which are used as benchmarks. For each country, I extracted, from Datastream, the 10-year sovereign bond total return index, a broad equity market total return index, and eleven industry level 1 ICB[1] total return equity indexes, namely, Basic Materials (BM), Consumer Discretionary (CD), Consumer Staples (CS), Energy (En), Financials (Fin), Health Care (HC), Industrials (Ind), Real Estate (RE), Technology (Tec), Telecommunications (Tel), and Utilities (Ut). Data on the Health Care, Real Estate, Technology, Telecommunications and Utilities for Ireland, and Health Care for Portugal are not available over the entire sample period. Thus, I choose to exclude them from this study.

Table 1 presents some descriptive statistics about the continuously compounded bond and stock indexes returns. During the heyday of the debt crisis (2010-2012), Greek bonds showed the worst performance with a daily average return of -0.07% and a high standard deviation (2.60%). French and German bond markets had the highest returns and the lowest risk levels, while the remaining GIIPS[2] countries delivered slightly positive average returns and moderate standard deviations. The broad stock market indexes exhibited negative returns in all GIIPS countries, except Ireland, while France and Germany's ones had positive returns. At the industry level, Finance was the

[1] Industry Classification Benchmark
[2] Greece, Ireland, Italy, Portugal, and Spain.

most affected industry in the peripheral countries, with a negative return and a high standard deviation, and Basic Materials, Energy and Consumer Staples proved to be more resilient.

During the 2013-2019 period, the sovereign bond markets in the GIIPS countries outperformed the core Eurozone ones as yields normalized in the former countries. In most stock markets the average return turned positive except in Greece, whose economy continued to be penalized by austerity measures aiming to improve debt sustainability. Finance continued to underperform in the GIIPS countries and didn't fully recover from the losses suffered during the crisis, while Consumer Staples and Consumer Discretionary had higher returns than the broad market as the economies and consumption started growing again after the crisis. The volatilities of returns decreased in most peripheral countries, except Greece, and became similar to the ones in France and Germany.

4. Econometric methodology

In order to assess the transmission of shocks between the sovereign bond returns and industry returns, I use the test of Granger causality in distribution proposed by Candelon and Tokpavi (2016). This test is a multivariate extension of the Granger causality in risk test developed by Hong et al. (2009).

This test is based on the concept of value-at-risk (VaR), which is a measure of the maximum loss at the α%-confidence interval, for an asset or portfolio. Let X_t, Y_t represent two time series. Their VaR at the α%-confidence level is given by

$$Pr[X_t < V_t^X(\theta_X^0)|\mathcal{F}_{t-1}^X] = \alpha \quad (1)$$

$$Pr[Y_t < V_t^Y(\theta_Y^0)|\mathcal{F}_{t-1}^Y] = \alpha \quad (2)$$

, where θ_X^0, θ_Y^0 are the true unknown parameters related to the specification of the value-at-risk models for the variables X_t and Y_t, and $\mathcal{F}_{t-1}^X$, $\mathcal{F}_{t-1}^Y$ are their information sets at time t-1

$$\mathcal{F}_{t-1}^{X} = [X_l, l \leq t-1] \tag{3}$$

$$\mathcal{F}_{t-1}^{Y} = [Y_l, l \leq t-1] \tag{4}$$

Based on the previous equations, I may define a vector of VaR, at time t, for a set of risk levels $A = \{\alpha_1, \ldots, \alpha_{m+1}\}$, with $0 < \alpha_1 < \alpha_2 < \ldots \alpha_{m+1} < 1$, such that

$$V_{t,1}^{X}(\theta_X^0, \alpha_1) < \cdots < V_{t,1}^{X}(\theta_X^0, \alpha_{m+1}) \tag{5}$$

Then, I can divide the support of X_t, using indicator variables that identify the events comprised between two consecutive VaR levels

$$Z_{t,s}^{X}(\theta_X^0) = \begin{bmatrix} 1 \quad if\ V_{t,1}^{X}(\theta_X^0, \alpha_s) \leq X_t < V_{t,1}^{X}(\theta_X^0, \alpha_{s+1}) \\ 0 \quad otherwise \end{bmatrix} \tag{6}$$

For s = 1,…,m.

Now, let $H_t^X(\theta_X^0)$ be a vector formed by the m indicator variables presented above

$$H_t^X(\theta_X^0) = \left(Z_{t,1}^X(\theta_X^0), \ldots, Z_{t,m}^X(\theta_X^0)\right)^T \tag{7}$$

and, similarly for Y_t

$$H_t^Y(\theta_Y^0) = \left(Z_{t,1}^Y(\theta_Y^0), \ldots, Z_{t,m}^Y(\theta_Y^0)\right)^T \tag{8}$$

Then, Y_t does not Granger-cause X_t in distribution if the following hypothesis holds

$$\mathbb{H}_0: \mathbb{E}\left[H_t^X(\theta_X^0)|\mathcal{F}_{t-1}^{X\&Y}\right] = \mathbb{E}[H_t^X(\theta_X^0)|\mathcal{F}_{t-1}^{X}] \tag{9}$$

, that is, the information set related to the variable Y_t does not have any predictive power for $H_t^X(\theta_X^0)$ beyond the one contained in the distribution support of X_t.

To develop a testable hypothesis, I need to estimate the VaR for both X_t and Y_t, to obtain empirical counterparts of $H_t^X(\theta_X^0)$ and $H_t^Y(\theta_Y^0)$. There are many approaches to estimate the VaR such as GARCH models proposed by Engle and Ng (1993), simulation methods, Morgan's (1996) Risk Metrics, rolling historical quantiles, and Engle and Manganelli (2004) conditional autoregressive value-at-risk (CAViaR). I choose the latter method, which estimates the quantiles directly, because it has proven to be robust in the presence of typical features of financial series, such as volatility clustering and non i.i.d returns. For each series and risk level, the conditional value-at-risk is modeled using the asymmetric slope specification proposed by Engle and Manganelli (2004)

$$V_t^X(\theta_s^X) = \theta_{s0}^X + \theta_{s1}^X V_{t-1,}^X + \theta_{s2}^X X_{t-1}^+ + \theta_{s3}^X X_{t-1}^- \tag{10}$$

$$V_t^Y(\theta_s^Y) = \theta_{s0}^Y + \theta_{s1}^Y V_{t-1}^Y + \theta_{s2}^Y Y_{t-1}^+ + \theta_{s3}^Y Y_{t-1}^- \tag{11}$$

, where $X_{t-1}^+ = \max\,(X_{t-1}, 0)$. $X_{t-1}^- = -\min(X_{t-1}, 0)$, $Y_{t-1}^+ = \max\,(Y_{t-1}, 0)$. $Y_{t-1}^- = -\min(Y_{t-1}, 0)$, and s = 1,…,m indicates the risk level. As in Engle and Manganelli (2004), I estimate the parameters in equations (10) and (11) by minimizing the regression quantile loss function, and I assess the quantile adequacy using their dynamic quantile test.

Using the estimated values-at-risk, I compute $\hat{H}_t^X \equiv H_t^X\left(\hat{\theta}_1^X, \dots, \hat{\theta}_m^X\right)$ and $\hat{H}_t^Y \equiv H_t^Y\left(\hat{\theta}_1^Y, \dots, \hat{\theta}_m^Y\right)$, the empirical counterparts of $H_t^X(\theta_X^0)$ and $H_t^Y(\theta_Y^0)$. Then, I obtain the test statistic proposed in Candelon and Tokpavi (2016) by following the steps below.

1 – Compute the sample cross-correlation matrix between $\hat{H}_t^X$ and $\hat{H}_t^Y$

$$\hat{\Lambda}(j) \equiv \begin{cases} T^{-1} \displaystyle\sum_{t=1+j}^{T} \left(\hat{H}_t^X - \hat{\Pi}_X\right)\left(\hat{H}_{t-j}^Y - \hat{\Pi}_Y\right)^T & 0 \le j \le T-1 \\ T^{-1} \displaystyle\sum_{t=1-j}^{T} \left(\hat{H}_{t+j}^X - \hat{\Pi}_X\right)\left(\hat{H}_t^Y - \hat{\Pi}_Y\right)^T & 1-T \le j \le 0 \end{cases} \tag{12}$$

, where $\hat{\Pi}_X$ and $\hat{\Pi}_Y$ are the sample means of $\hat{H}_t^X$ and $\hat{H}_t^Y$, respectively.

2- Calculate the corresponding sample cross-correlation matrix

$$\hat{R}(j) = D\left(\hat{\Sigma}_X\right)^{-1/2} \hat{\Lambda}(j) D\left(\hat{\Sigma}_Y\right)^{-1/2} \tag{13}$$

, where D represents the diagonal form of a matrix, and $\hat{\Sigma}_X$ and $\hat{\Sigma}_Y$ are the sample covariance matrices of $\hat{H}_t^X$ and $\hat{H}_t^Y$, respectively.

3- Compute the quadratic form

$$\hat{\mathcal{T}} = \sum_{j=1}^{T-1} \kappa^2 \left(\frac{j}{M}\right) \hat{Q}(j) \tag{14}$$

, where κ is a kernel function (Bartlett, Daniel, and Parzen kernels are popular choices), M is a truncation parameter and $\hat{Q}(j)$ is

$$\hat{Q}(j) = T vec\left(\hat{R}(j)\right)^T \left(\hat{\Gamma}_X^{-1} \otimes \hat{\Gamma}_Y^{-1}\right) vec\left(\hat{R}(j)\right) \tag{15}$$

, where $\hat{\Gamma}_X$ and $\hat{\Gamma}_Y$ are the sample correlation matrices of $\widehat{H}_t^X$ and $\widehat{H}_t^Y$.

4- The test statistic, which is a centered and scaled version of the quadratic form $\hat{\mathcal{T}}$, follows a standard Normal distribution

$$V_{Y\to X} = \frac{\hat{\mathcal{T}} - m^2 C_T(M)}{\left(m^2 D_T(M)\right)^{1/2}} \tag{16}$$

, where $C_T(M)$ and $D_T(M)$ are

$$C_T(M) = \sum_{j=1}^{T-1} (1 - j/T)\, \kappa^2 \left(\frac{j}{M}\right) \tag{17}$$

$$D_T(M) = 2 \sum_{j=1}^{T-1} (1 - j/T)(1 - (j+1)/T)\, \kappa^4 \left(\frac{j}{M}\right) \tag{18}$$

In this study, I set M = 5 and use the Bartlett kernel. I test the sensitivity of my results to changes in the kernel (Daniell and Parzen kernels) and the truncation parameter (M = 10) and conclude that the results remain broadly unchanged.

5. Results

In this section, I report and comment on the results of the Granger causality in distribution tests. The next to last row of Table 2 shows that the number of significant causality tests in the left tail of the distributions (5% level), during the crisis period, from the bond to the stock markets, equals 19 out of 78, and there are 21 out of 78 significant tests in the reverse direction. These numbers, which are higher than what should be expected by mere chance, show that the bond-stock market integration is less than perfect, and information does not flow swiftly across markets. Greece is the country that exhibits a higher level of delayed information transmission from the bond to the stock market. In this country, all industries except Finance and Energy lag the bond market. In contrast, in France, the stock market leads the bond market in most sectors. Germany, which is considered a safe haven amongst the European economies, shows the highest level of integration between the sovereign bond and stock markets. In the remaining countries, there is modest evidence of causality running mostly from the stock to the bond market. At the industry level, the bond market leads the Finance industry in no country. The remaining industries lag the bond market in, at least, one country, the most affected one being Consumer Discretionary (3 countries). This pattern is coherent with the limited attention hypothesis, which predicts that bond-market shocks are transmitted more rapidly between markets whose interconnections are obvious but may lag in neglected industries. Several industries lead the bond markets in more than one country, such as Utilities (3) and Finance, Health Care, and Real Estate (2). The case of Ireland deserves special attention, as it shows that the shocks that affected the Finance industry, following the rescue of the Irish banking sector, were not timely incorporated in sovereign bond prices.

In the period after the crisis (2013-2019), the overall evidence of lagged information transmission between markets became slightly weaker from the bond to the stock market (14 significant tests, at the 5% level) and slightly stronger in the reverse one (24 significant tests). In

Greece, the bond to stock market causality was reversed. Most countries experienced a decrease in the number of significant tests, except Germany (sizable increase in stock-bond causality) and Italy. At the industry level, news flowed mainly from the bond to the stock market in Energy, Real Estate and Technology, and in the opposite direction in Basic Materials, Consumer Discretionary, Consumer Staples, Finance, Industrials, and Utilities.

Table 3 displays the p-values of the Granger causality tests for the middle part of the distributions. During the crisis period, the evidence of delayed information flow across markets in the middle of the distribution is weaker than in the left tail (12 significant tests in the bond-stock direction, and 5 in the reverse one). Greece exhibits the highest number of lagged responses in both directions, while information is timely transmitted between markets in the core European economies. At the industry level, the stock market dominates the bond market for Energy, and the reverse pattern is observed for Financials, Health Care, Industrials, and Technology. The period after the crisis also presents modest evidence of lagged news flows, with a slight dominance of the bond market over the stock market (13 significant tests in the bond-stock direction, and 10 in the stock-bond direction).

During the heyday of the crisis, markets also showed a lack of integration following good news. There are 22 significant causality tests from the bond to the stock markets, in the right tail of the distribution, and 28 from the stock to the bond markets (Table 4). Curiously, the core European markets, together with Spain, show the highest number of failures in the timely information transmission across markets. At the industry level, the industries which present clearer evidence of lead over the bond market are Finance, Telecommunications, and Utilities, while Consumer Discretionary lags the bond market in most countries. In the period after the crisis, the bond markets saw an increase in their ability to incorporate and transmit good news (28 significant tests), but, in Greece, the stock market became dominant over the bond market in the speed of information transmission. In Basic Materials, Health Care, Industrials, Real Estate, Telecommunications, and Utilities news ran mainly from the bond to the stock market, but in Finance it continued to flow in the other direction.

6. Concluding Remarks

In this study, I show that the transmission of shocks between sovereign bonds and stock markets depends upon the industry and the zone of the distributions considered. Contagion is especially prevalent at the left and right tails of the distribution, and it is almost absent at the center. Stock markets exhibit a slight dominance in information incorporation following bad news, while the bond market prevails after good news.

Greece, the country where the European debt crisis began, shows a curious pattern of information flows across different sections of the distributions: the bond market clearly dominates the stock market following negative shocks, but there is evidence of bidirectional causality in the middle and right tails of the distribution. This pattern, which was revealed by my choice of a causality test in distribution, has not been reported in previous studies that rely on standard Granger causality in mean tests. In the remaining GIIPS countries, neither the stock nor the bond markets present a clear dominance during the most severe period of the crisis.

I also find that the finance industry led the sovereign bond market during the Irish banking crisis. That is, sovereign bond prices failed to reflect, promptly, both good and bad news coming from banks.

Overall, Finance seems to be the industry that can incorporate bond market shocks the fastest. This result is not surprising given that banks were drawn to the center of the debt crisis by their strong interconnectedness with sovereign bond yields, through the asset holding, collateral, ratings, and government guarantee channels.

In other industries, there is evidence that prices do not fully reflect news from the bond market in a timely manner, particularly in the left and right tails of the distributions. Conversely, I also find that stock market shocks are not immediately reflected in sovereign bond prices. Surprisingly, this pattern is not specific to the peripheral GIIPS country, whose financial markets are less evolved but can also be observed in the core European countries, even the post-crisis period. These results provide support to the limited attention hypothesis, according to which investors lack the time and resources to follow all the markets and tend to specialize in a particular one. Thus, market integration is less than perfect, which explains the lead-lag pattern observed across markets.

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Table 1- Descriptive statistics

This table exhibits the average (Ave) and standard deviation (St. Dev.) values, in percentage points, of the continuously compounded returns for the sovereign bond (Bond), the broad equity market index (Mkt.) and eleven industry indexes in France(FR), Germany (GE), Greece (GR), Ireland (IR), Italy (IT), Portugal (PT), and Spain (SP). The industry indexes are Basic Materials (BM), Consumer Discretionary (CD), Consumer Staples (CS), Energy (En), Financials (Fin), Health Care (HC) Industrials (Ind.), Real Estate (RE), Technology (Tec.), Telecommunications (Tel.), and Utilities (Ut.). The top part of the table corresponds to the first subsample, comprising the years 2010-2012, and the bottom part corresponds to the second one (years 2013-2019).

	Bond	Mkt.	BM	CD	CS	En	Fin	HC	Ind.	RE	Tec.	Tel.	Ut.
FR Ave.	0.03	0.01	0.04	0.04	0.06	0.03	0.04	0.03	0.05	0.04	0.06	0.05	0.02
St. Dev.	0.38	1.36	1.50	1.34	1.31	1.43	2.10	1.22	1.46	1.15	1.46	1.48	1.56
GE Ave.	0.04	0.03	0.05	0.07	0.08	-0.18	0.01	0.05	0.04	0.05	0.07	0.01	-0.06
St. Dev.	0.39	1.26	1.45	1.51	1.57	2.02	1.50	0.92	1.38	1.02	1.34	1.38	1.40
GR Ave.	-0.07	-0.10	-0.01	-0.06	0.00	0.02	-0.28	-0.11	-0.03	-0.07	-0.09	-0.08	-0.05
St. Dev.	2.60	2.17	2.53	1.92	2.16	2.16	4.13	4.25	1.94	2.16	7.5	3.46	2.84
IR Ave.	0.02	0.03	0.09	0.07	0.08	0.05	-0.22	-	0.04	-	-	-	-
St. Dev.	0.94	1.30	5.12	1.27	1.04	2.25	3.76	-	1.95	-	-	-	-
IT Ave.	0.02	-0.02	0.01	0.03	0.06	0.02	-0.08	0.03	-0.02	-0.07	-0.04	-0.03	-0.01
St. Dev.	0.72	1.59	2.08	1.54	1.52	1.59	2.41	1.25	1.63	2.00	1.31	1.96	1.36
PT Ave.	0.01	-0.03	0.01	-0.07	-0.06	0.00	-0.15	-	-0.09	-0.13	-0.12	-0.02	-0.01
St. Dev.	1.36	1.30	1.39	1.54	2.11	2.00	2.54	-	1.60	10.22	2.24	1.84	1.57
SP Ave.	0.01	-0.01	-0.05	0.09	0.02	0.00	-0.05	0.05	0.00	-0.14	-0.06	-0.05	-0.01
St. Dev.	0.72	1.63	1.45	1.56	0.86	2.03	2.19	1.35	1.47	3.26	1.78	1.73	1.64
FR Ave.	0.02	0.05	0.03	0.06	0.06	0.03	0.04	0.03	0.05	0.040	0.06	0.05	0.02
St. Dev.	0.32	0.94	1.10	1.04	1.03	1.31	1.19	1.11	0.98	.78	1.12	1.46	1.21
GE Ave.	0.01	0.03	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.06	0.05	0.04	0.01
St. Dev.	0.32	0.91	1.12	1.06	1.13	1.92	0.91	1.04	0.97	0.84	1.17	1.18	1.15
GR Ave.	0.07	-0.04	0.03	0.06	0.05	0.04	-0.19	0.01	0.02	0.06	-0.01	0.06	0.01
St. Dev	1.82	2.13	1.92	1.51	1.76	2.03	3.78	3.13	1.72	1.74	2.77	2.42	2.43
IR Ave.	0.03	0.04	-0.16	0.05	0.05	-0.13	0.02	-	0.09	-	-	-	-
St. Dev.	0.29	0.99	4.61	1.45	0.98	5.16	1.94	-	1.51	-	-	-	-
IT Ave.	0.03	0.04	-0.01	0.06	0.06	0.00	0.03	0.09	0.04	0.03	0.09	0.01	0.06
St. Dev.	0.50	1.19	1.77	1.18	1.13	1.40	1.71	1.14	1.12	1.38	1.18	1.93	1.22
PT Ave.	0.04	0.02	0.07	0.05	0.04	0.03	-0.06	-	-0.01	0.03	0.02	-0.06	0.05
St. Dev.	0.56	1.06	1.43	1.22	2.37	1.57	2.38	-	1.27	2.71	1.55	2.01	1.29
SP Ave.	0.04	0.03	0.05	0.03	0.03	0.03	0.01	0.05	0.06	0.04	0.04	0.01	0.07
St. Dev.	0.41	1.08	1.32	1.28	0.90	1.48	1.63	1.23	0.92	0.92	1.60	1.33	1.00

Table 2 – Results of the causality tests in the left tail of the distribution

The numbers in each cell represent the p-value of the bond-stock causality test (left), and the stock-bond causality test (right) for the years 2010-2012 (1), and 2013-2109 (2). The two bottom rows display the number of significant tests, at 5%, for each country. The rightmost column shows the number of significant tests, at 5%, for each industry.

		FR	GE	GR	IR	IT	PT	SP	
Mkt	1	81.3/**4.73**	40.0/66.1	**0.00**/88.4	55.1/**0.01**	22.1/**4.30**	14.3/**0.35**	36.9/53.3	1/4
	2	66.0/29.7	52.7/**0.00**	6.64/**0.00**	72.4/7.42	94.7/27.3	36.3/**3.13**	90.0/19.9	0/3
BM	1	86.2/**2.37**	79.5/80.4	**0.00**/91.6	48.3/15.1	59.9/18.1	**1.03**/75.3	33.3/76.8	2/1
	2	52.8/**0.01**	52.0/59.0	**0.00**/5.70	54.9/34.3	92.2/88.2	94.9/19.5	54.4/**4.84**	1/2
CD	1	85.8/**0.92**	58.6/91.5	**0.00**/85.3	**4.21**/81.1	46.7/52.0	**0.00**/81.7	29.6/80.1	3/1
	2	25.4/61.6	78.7/**0.00**	**0.00/0.02**	78.4/**0.00**	49.4/86.6	11.9/31.5	74.2/17.7	1/3
CS	1	79.5/**1.67**	19.3/96.2	**0.00**/79.9	56.6/34.2	46.0/19.6	98.0/51.2	**0.94**/61.1	2/1
	2	9.23/**0.36**	68.0/**0.19**	**0.00**/55.9	93.3/90.4	82/93.7	50.5/79.3	93.8/72.8	1/2
En	1	**3.10/1.32**	**2.29**/62.3	5.36/77.6	92.9/37.4	86.9/64.4	6.54/24.8	27.8/21.9	2/0
	2	82.7/76.5	37.0/73.3	7.08/23.5	38.6/70.6	**1.96**/72.8	**2.05**/88.5	90.8/15.7	2/0
Fin	1	9.02/**0.81**	76.0/22.2	14.7/89.1	82.9/**1.03**	52.1/21.1	27.7/86.4	72.3/73.1	0/2
	2	96.5/13.3	14.2/**2.8**	88.0/**0.00**	84.5/8.84	88.9/**0.16**	93.0/34.1	74.3/44.5	0/3
HC	1	77.5/25.3	82.2/16.4	**0.00**/64.3	-	90.1/63.8	-	**0.41**/95.2	2/0
	2	88.4/**0.47**	47.4/67.6	51.6/59.0	-	**2.95**/23.1	-	48.5/75.4	1/1
Ind	1	85/**0.00**	26.7/81.8	**0.00**/78.6	28.2/**0.05**	65.5/13.9	14.8/67.9	81.2/95.3	1/2
	2	87.4/**3.02**	58.0/**1.43**	**0.00/4.72**	21.7/68.3	73.2/48.0	73.3/92.9	85.1/**1.73**	1/4
RE	1	94.0/**0.00**	78.6/45.1	**1.56**/68.9	-	**1.12/2.75**	86.9/97.9	44.7/89.5	2/2
	2	90.9/39.2	**0.00**/31.1	19.2/**0.01**	-	**1.35**/67.2	25.0/73.8	61.1/24.3	2/1
Tec	1	83.2/**0.05**	29.8/80.8	**0.00**/6.50	-	26.4/14.0	9.09/97.4	91.9/75.5	1/1
	2	90.3/59.3	32.6/38.8	**3.93**/93.0	-	69.4/90.6	39.0/86.3	64.3/57.4	1/0
Tel	1	62.0/32.9	96.0/17.1	**1.85**/52.9	-	43.5/**0.00**	35.9/**1.70**	97.0/33.6	1/2
	2	31.5/**0.02**	79.1/43.3	**0.01**/42.8	-	72.4/55.7	28.0/78.3	87.8/85.6	1/1
Ut	1	49.9/**0.01**	81.2/87.1	**0.00**/87.5	-	24.8/62.0	**1.16/4.00**	93.8/**0.70**	2/3
	2	22.3/**0.00**	**0.06/0.00**	**0.00/0.00**	-	84.1/**1.30**	**0.01**/10.9	55.8/12.3	2/4
	1	1/10	1/0	10/0	1/3	1/4	3/3	2/1	
	2	0/6	2/6	7/6	0/1	3/2	2/1	0/2	

Table 3 – Results of the causality tests in the middle of the distribution

The numbers in each cell represent the p-value of the bond-stock causality test (left), and the stock-bond causality test (right) for the years 2010-2012 (1), and 2013-2109 (2). The two bottom rows display the number of significant tests, at 5%, for each country. The rightmost column shows the number of significant tests, at 5%, for each industry.

		FR	GE	GR	IR	IT	PT	SP	
Mkt	1	61.0/7.83	**2.62**/35.1	**0.93**/65.2	**2.21**/46.1	85.2/62.4	86.4/5.90	60.0/45.1	3/0
	2	13.2/**2.42**	**2.69**/30.3	50.8/9.70	21.0/45.1	26.3/60.3	71.3/78.8	**1.66**/41.5	2/1
BM	1	68.1/62.3	52.3/95.1	16.8/39.6	85.9/81.0	32.7/87.4	5.37/**0.27**	**3.65**/32.3	1/1
	2	21.1/55.0	77.8/26.9	52.9/**0.00**	31.0/38.8	35.5/99.7	62.6/32.5	35.4/5.64	0/1
CD	1	8.57/42.6	46.0/56.0	55.6/90.9	92.7/86.7	57.1/25.4	25.6/55.0	24.6/35.5	0/0
	2	14.4/32.2	10.7/12.1	90.6/82.9	97.1/93.4	13.1/**2.40**	22.6/3.75	9.78/7.94	0/1
CS	1	29.3/62.9	27.2/7.71	40.6/89.6	23.7/94.8	35.2/78.9	24.2/92.2	75.0/73.9	0/0
	2	**1.63**/65.3	74.1/10.4	69.6/**1.33**	42.0/79.3	17.4/13.4	**0.05**/60.1	18.4/58.7	2/1
En	1	29.5/70.9	77.8/15.6	28.9/**0.16**	19.2/77.1	19.0/86.5	54.9/33.2	32.6/87.7	0/1
	2	83.4/76.4	4.33/97.9	97.1/88.8	41.9/16	**2.85**/51.5	16.0/3.57	63.1/76.7	1/0
Fin	1	43.4/30.8	18.0/53.5	61.6/42.3	**4.02/0.05**	92.9/9.37	**0.87**/22.3	70.1/48.0	2/1
	2	36.4/83.1	55.3/45.2	54.9/86.8	34.3/26.7	55.1/62.0	17.1/72.1	7.63/0.03	0/0
HC	1	51.8/78.1	32.2/76.9	**0.01/3.66**	-	**3.98**/84.1	-	78.0/6.97	2/1
	2	92.8/76.0	56.8/73.8	16.9/83.4	-	**0.33**/14.9	-	**2.87**/16.9	2/0
Ind	1	83.3/20.8	61.8/93.9	82.4/77.7	60.3/11.2	21.2/83.1	75.5/52.1	**3.66**/76.6	1/0
	2	88.9/59.4	75.3/**0.02**	**4.46**/59.4	63.0/**1.60**	90.5/64.3	86.7/36.2	54.4/5.24	1/2
RE	1	79.1/72.2	23.3/80.8	84.9/52.8	-	20.0/86.5	**0.00/0.00**	60.9/60.3	1/1
	2	19.8/21.9	24.2/**0.51**	85.2/11.8	-	**1.59**/42.1	**0.00**/30.4	7.26/67.5	2/1
Tec	1	42.9/15.0	29.8/77.1	**0.00**/14.6	-	**0.19**/35.6	95.0/21.8	49.5/4.99	2/0
	2	24.4/35.1	16.1/48.8	40.5/61.1	-	5.68/41.3	19.8/84.9	41.2/**0.27**	0/1
Tel	1	96.2/55.6	81.8/94.3	8.44/29.7	-	12.3/84.6	22.4/62.8	38.0/74.1	0/0
	2	20.8/55.9	64.3/60.6	38.7/44.0	-	37.6/36.3	**0.05**/40.8	66.6/56.5	1/0
Ut	1	80.2/34.3	21.1/75.9	53.3/69.7	-	98.9/80.3	79.0/48.3	69.6/34.4	0/0
	2	**0.42/4.06**	**0.07**/7.03	51.1/27.1	-	62.9/42.6	66.0/58.7	45.9/**4.16**	2/2
	1	0/0	1/0	3/2	2/1	2/0	2/2	2/0	
	2	2/2	2/2	1/2	0/1	3/1	3/0	2/2	

Table 4 – Results of the causality tests in the right tail of the distribution

The numbers in each cell represent the p-value of the bond-stock causality test (left), and the stock-bond causality test (right) for the years 2010-2012 (1), and 2013-2109 (2). The two bottom rows display the number of significant tests, at 5%, for each country. The rightmost column shows the number of significant tests, at 5%, for each industry.

		FR	GE	GR	IR	IT	PT	SP	
Mkt	1	6.88/**3.83**	**0.16**/63.5	29.4/18.0	92.6/86.0	**3.61**/**0.00**	20.3/52.7	65.4/**0.56**	2/3
	2	15.4/**1.25**	**3.22**/71.7	21.1/**0.00**	49.6/31.1	56.0/6.71	**0.00**/31.9	45.4/54.8	2/2
BM	1	82.4/**0.02**	**0.04**/41.1	10.4/**0.59**	**3.84**/73.9	**1.32**/36.5	24.3/**0.06**	29.9/84.0	3/3
	2	**0.00**/55.9	**0.14**/55.6	71.1/19.6	94.5/12.0	95.3/93.2	**2.20**/15.4	**2.37**/98.3	4/0
CD	1	70.1/**2.58**	**0.32**/12.1	**1.32**/38.8	75.4/72.4	87.6/96.9	**0.01**/67.5	**1.63**/49.1	4/1
	2	69.7/5.42	10.1/95.1	35.7/**0.03**	31.8/34.4	**2.24**/73.0	16.2/46.2	40.8/48.6	1/1
CS	1	52.1/14.9	20.5/11.0	88.7/14.6	88.7/96.9	81.9/97.9	86.7/20.9	66.9/4.52	0/0
	2	56.2/62.5	18.0/93.0	16.0/**1.81**	**2.41**/**1.90**	**0.78**/71.0	8.08/**0.13**	**0.05**/19.7	3/3
En	1	**0.15**/**0.50**	7.67/**0.30**	**0.77**/50.3	71.9/80.3	64.6/**0.00**	17.4/53.2	41.3/67.2	2/3
	2	85.8/38.1	13.4/81.2	30.4/28.7	37.6/32.2	96.6/52.5	81.5/34.4	65.9/39.1	0/0
Fin	1	75.2/85.5	60.0/4.78	8.22/**3.08**	79.4/**0.09**	16.5/50.0	**0.00**/**0.00**	18.5/**1.69**	1/4
	2	95.6/59.3	**2.6**/71.7	82.7/**0.00**	7.75/79.2	11.2/97.9	59.6/90.9	65.3/**0.04**	1/2
HC	1	21.9/**0.13**	54.0/69.2	**1.94**/50.1	-	72.3/59.4	-	**1.32**/**0.02**	2/2
	2	**0.24**/80.2	**0.00**/50.8	73.8/88.5	-	82.2/30.6	-	**0.01**/91.9	3/0
Ind	1	34.0/**0.00**	**1.03**/40.7	**3.07**/39.2	32.1/74.3	**0.08**/85.8	31.9/67.0	55.4/**0.23**	3/2
	2	**0.00**/21.0	67.5/76.9	29.9/**0.02**	39.1/61.5	27.7/96.2	**0.00**/19.4	16.6/94.1	2/1
RE	1	75.0/65.9	62.6/28.6	65.9/**4.75**	-	22.0/92.4	91.8/79.1	82.2/58.0	0/1
	2	35.1/76.3	**0.00**/22.6	**0.24**/47.3	-	**0.06**/44.0	**0.00**/2.20	56.2/**0.81**	4/1
Tec	1	**0.29**/**0.76**	45.9/54.2	23.1/25.8	-	**0.00**/85.0	16.5/91.1	54.7/**2.50**	2/2
	2	**0.35**/83.9	6.55/89.5	**0.00**/**0.61**	-	6.47/**2.60**	74.3/48.1	15.5/90.5	2/2
Tel	1	48.1/**0.57**	**0.64**/**3.10**	80.5/63.8	-	42.3/**0.21**	**0.82**/34.6	84.3/**0.00**	2/4
	2	**2.76**/12.9	7.96/43.1	**0.00**/**2.09**	-	**2.04**/77.0	**0.00**/46.2	91.4/**3.40**	4/2
Ut	1	10.2/40.0	**0.64**/**3.10**	47.9/70.9	-	90.1/**0.00**	80.8/58.4	62.6/**0.41**	1/3
	2	5.20/90.0	7.96/43.1	**3.01**/**0.02**	-	**0.02**/91.3	37.4/13.2	86.1/55.2	2/1
	1	2/8	6/3	4/3	1/1	4/4	3/2	2/7	
	2	5/1	5/0	4/8	1/1	5/1	5/1	3/3	