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Conditional Return Asymmetries in the Sovereign-Bank Nexus

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Abstract

We estimate the time-varying skewness of European banks' stock and sovereign bond returns using quantile methods. We obtain a negative relationship between sovereigns' and banks' return asymmetries, which we relate to the safe haven features of sovereign debt. However, this feature reverses for peripheral European countries (GIIPS). Furthermore, although better capitalized and less risky banks tend to offer less negatively skewed stock returns, these benefits do not reach similarly strong GIIPS-headquartered banks. Finally, we identify a risk premium related to sovereign negative skewness for both large financial and non-financial European firms, which is stronger for firms headquartered in GIIPS.

JEL Codes: G12, G15, G21.

Keywords: Banks, sovereign bonds, conditional asymmetry, negative risk premium.

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1 Introduction

The European financial and sovereign debt crises have generated interest in the tight relationship between financial sector and sovereign credit risk, or the so-called sovereign-bank nexus. In some countries, the risk originated in the financial sector, which then spilled over to the sovereigns, and returned to the financial sector through their balance sheets. Meanwhile, in other countries, sovereign debt was the source of fragility, which was then transmitted to the financial sector. Regardless of the source, however, the twin crises have emphasised the linkages that exist between banks and sovereigns.

While several papers have focused on studying the transmission of risk between sovereign bond and bank returns (see e.g., Acharya and Steffen (2015), Brutti and Sauré (2015), and Kallestrup et al. (2016)), almost all of them focus on studying the effects of these risk spillovers on the conditional mean/volatility of the distributions of bank and bond returns. Yet the twin crises have emphasised the role of asymmetries in bank and bond distributions, respectively. Indeed, the more popular risk measures devised in response to the crises have focused on the tails of the conditional distribution of returns (see e.g., Adrian and Brunnermeier (2016), Giglio et al. (2016), Brownlees and Engle (2016), and Acharya et al. (2017)), where extremely negative events occur. Moreover, a long tradition in asset pricing has studied the impact of return skewness on investors' decision-making (see e.g., Harvey and Siddique (2000) and Ghysels et al. (2016)). To the extent that financial and non-financial firms' values are negatively affected by sovereign market stress events, it is reasonable to surmise that these firms pay a premium to attract investors. Unfortunately, there has been little work on the nature and consequences of return asymmetries in the sovereign-bank nexus.

This paper fills the gap in the literature by providing a comprehensive empirical study of bank stock and sovereign bond return asymmetries. We utilise a simple measure of conditional skewness that is robust to outliers, and more importantly, captures time variations in the conditional distribution of bank equity and sovereign bond returns. The measure is based on the relative difference between the 75th (and 25th) conditional quantile and the conditional median of bank and bond returns, respectively. The intuition behind the conditional asymmetry measure is simple: if at period t, the interquartile range is not centered at the median, then the return distribution is asymmetric. This measure, which traces its origins to Bowley (1920), has been used to characterise the distribution of stock returns (see, e.g., Kim and White (2004) and more recently, by Ghysels et al. (2016)). To compute asymmetries, we estimate a flexible quantile model that takes into account the linkages between bank equity and sovereign bond returns uncovered by previous work. By doing so, our measures capture the information processed by investors, thus we call them *conditional* asymmetries. We document that conditional bank equity return and sovereign bond return asymmetries exhibit substantial time variation. Remarkably, we find that conditional skewness was highly negative in turbulent periods, such as the Dot-com bubble, the onset of the financial crisis, and the height of the European sovereign debt crisis. We take these estimates as the starting point of the rest of our empirical analysis. In this light, we make the following three contributions.

First, we investigate the dynamics and co-movements of the estimated conditional asymmetry measures via two time series regressions that are motivated by the wide literature that studies linkages between sovereign bond and bank stock returns (e.g., Acharya and Steffen (2015) and Kallestrup et al. (2016)). In the first regression, we study whether the contemporaneous variation in conditional bank asymmetries is related to conditional sovereign bond asymmetries. We find a negative correlation between bank stock and sovereign bond asymmetries, which is related to the role of sovereign bonds as "safe haven" investments. We analyse in the second regression whether non-peripheral banks are exposed to the conditional asymmetries of the peripheral sovereign bond returns and the German bund, which is widely thought of as a safe asset. We show that indeed, non-peripheral bank stock return asymmetries are positively correlated with the conditional asymmetries of peripheral sovereign bonds. This suggests the presence of a contagion effect from peripheral sovereigns to non-peripheral banks' stock returns.

Second, we examine the extent to which these asymmetries can be explained by macroeconomic and financial fundamentals. In this regard, we consider a set of bank balance sheet variables (see e.g., Altunbas et al. (2017) and Gandhi and Lustig (2015)) and macroeconomic variables (see e.g., Hilscher and Nosbusch (2010) and Dieckmann and Plank (2012)) that are known to explain bank stock returns and sovereign bond returns, respectively. We find that variables related to capital adequacy (such as the Tier 1 capital ratio) are relevant determinants of bank conditional stock return asymmetry. More importantly, we show that sovereign conditional asymmetry is a highly significant determinant of bank conditional stock return asymmetry. In particular, there is a negative relationship between sovereign bond skewness and future bank equity skewness. There is also a positive relationship between peripheral sovereign skewness and future bank stock return skewness, which further underscores the sovereign-bond nexus. We also find that variables that are related to leverage (such as the reserves-to-GDP ratio) help predict future sovereign bond asymmetry.

Third, we study the economic implications of conditional asymmetries in an asset pricing setting. In particular, we assess whether financial and non-financial firms in the Eurostoxx 600 pay an equity premium for negative sovereign conditional asymmetry. To do so, we implement cross-sectional asset pricing tests via two-pass regressions (see Cochrane (2009) for an exposition). The first-pass (time series regression) results indicate a clear, negative relationship between conditional sovereign bond asymmetries and firm stock returns. The second-pass (cross-sectional regression) results suggest the existence of a sovereign skewness risk premium in the stock market. More importantly, our results also suggest that firms headquartered in countries with a weak sovereign have to pay an additional premium to investors. These results further emphasise the existence of two nexuses: that between sovereigns and financial firms, and that between non-financial firms and sovereigns.

Related Literature. The sovereign-bank nexus has been at the forefront of the academic and policy debate. In particular, the theoretical literature has focused on modelling the link between banks and the sovereign. Gennaioli et al. (2014) focus on modelling the Greek-style crisis, i.e., a crisis which originates from the inability of the government to finance public debt, which then is transmitted to the financial sector. Meanwhile, Bolton and Jeanne (2011) study how sovereign crises are spread throughout the banking sector through an integrated banking system. Finally, Acharya et al. (2014) model the two-way feedback loop between sovereigns and banks. Our paper is related to this literature to the extent that one can think that the linkages captured by our flexible quantile model are a reduced-form representation of the models shown here, without taking a precise stand on the mechanisms involved. Moreover, to the extent that our sovereign and bank conditional asymmetry measures capture the tail risk events during the crisis, our empirical results can be thought of as a quantification of the transmission of risk between sovereigns and bonds at the tails of their return distributions.

This paper is also related to a wide empirical literature that aims to understand the linkages between sovereigns and banks. Several of these papers use sovereign and bank credit default swap (CDS) data (e.g., Kallestrup et al. (2016)) or bank balance sheet information (e.g., Acharya and Steffen (2015), Altavilla et al. (2017) and Gennaioli et al. (2018)) to quantify the transmission of risk from sovereigns to banks (and vice-versa). A common conclusion of these papers is that exposures to sovereign debt, both of own country and foreign, are a major determinant of bank risk. Our results, which use bank equity and sovereign bond return data, are consistent with these papers, and extend them by showing that direct and indirect exposures result in changes to the conditional asymmetries of bank equity and bond return distributions. More importantly, we show that financial firms' stock prices reflect sovereign conditional asymmetry. The analysis in this paper is also linked to empirical work that studies the transmission of risk from sovereigns to non-financial firms (e.g., Augustin et al. (2018) and Bedendo and Colla (2015)). Compared to these papers, we also show that non-financial firms pay a premium for negative sovereign conditional asymmetry.

Two closely related papers to ours are those of Andrade and Chhaochharia (2018) and Mäkinen et al. (2018). Andrade and Chhaochharia (2018) show that the returns of non-financial firms' stock prices that are vulnerable to financial disruption, or those that are more exposed to the government, are more sensitive to changes in credit spreads. Mäkinen et al. (2018), meanwhile, use bank asset returns from 15 countries to uncover a risk premium that is related to implicit sovereign guarantees, which is intimately tied to sovereign risk. While these papers also look at sovereign risk, like we do, our paper differs from these in the following two aspects. First, we find that even if the prospect of a sovereign default is small, financial and non-financial firms have to pay a premium to attract investors in situations when the sovereign bond prices are less stable; that is, when the distribution of sovereign bond returns are negatively skewed. Second, the empirical analysis we pursue shows that this effect is more intense for GIIPS firms, and more insensitive to the actual level of sovereign bond return skewness.

Finally, our paper is related to work that has aimed to understand the implications of conditional asymmetries for asset pricing and portfolio choice decisions (see e.g., Harvey and Siddique (2000), Mencía and Sentana (2009), Conrad et al. (2013), and Ghysels et al. (2016)). Compared to these papers, we focus on the role of asymmetries in the sovereign-bank nexus, which, to the best of our knowledge, has not been explored.

In what follows, bank equity returns and bank returns will refer to the same variable, and asymmetry and skewness will be used as interchangeable concepts. Additional information can be found in the Supplemental Material.

2 Data and descriptive statistics

2.1 Data sources

We construct a dataset with information obtained from Datastream and Bloomberg to compute bank equity returns and sovereign bond returns. The information covers the period from January 3, 2001 to November 6, 2013, which includes both tranquil and crisis periods. The data comprises the 27 major cross-border listed banks in Europe, a list of which is provided in section S1 of the Supplemental Material. Out of the banks in the sample, ten are headquartered in peripheral countries, while 17 are headquartered outside. There are 14 countries represented; ten are in the Eurozone[1], while the remaining countries are Denmark, Sweden, Switzerland, and the United Kingdom.

We compute weekly bank equity returns y_{t,B_i} from publicly available equity prices

[1]The Euro area countries included in the sample are the GIIPS countries, Austria, Belgium, France, Germany, and the Netherlands.

in Datastream.[2] Meanwhile, we construct euro-denominated sovereign bond returns for the countries in the dataset by a first-order approximation[3]. More formally, denoting duration by Dur_{t,S_j} and the yield on the ten-year sovereign bond of country j by Z_{t,S_j}, we calculate sovereign bond returns by the following two steps:

1. Compute the modified duration of the bond, $ModD_{t,S_j}$ through the following equation:
$$ModD_{t,S_j} = \frac{Dur_{t,S_j}}{\left(1 + Z_{t,S_j}/100\right)}.$$
2. Calculate weekly sovereign bond returns, y_{t,S_j} from the following formula:
$$y_{t,S_j} = -ModD_{t-1,S_j} \cdot \left(Z_{t,S_j} - Z_{t-1,S_j}\right)$$

We calculate the euro-denominated returns of non-Euro area banks and sovereign bonds by converting the relevant variables into euros using spot exchange rate data obtained from the Pacific Exchange Rate database. Finally, we obtain economic and financial variables for the analyses in sections 4 and 5 from Datastream, SNL Financial, and Eurostat. We describe the specific variables that we use in the respective sections.

2.2 Descriptive statistics

Table 1 provides the descriptive statistics for the returns of the GIIPS and the German sovereign bonds.[4] Panel A shows mean weekly bond returns during the entire sample period. We find that Greece and Portugal exhibit negative returns and the highest variances, followed by Ireland. German bond returns, on the other hand, exhibit positive weekly returns with small variances.

[Table 1 about here.]

Panel B (Panel C) reports bond return correlations between 2001 and 2006 (2007 to 2013). As can be observed, bond returns were positively correlated prior to the sovereign

[2] We compute weekly returns as some equity prices were illiquid during certain periods.

[3] See Fabozzi (2005) for a textbook exposition.

[4] Table S7 and S8 of the Supplementary Material present summary statistics of bank returns before and after the crisis. Prior to the crisis, the vast majority of European banks exhibited positive returns with small variances. During the crisis, however, the returns of the majority of the banks became negative with large variances.

debt crisis; this suggests that investors perceived these bonds as similar despite major economic differences. As the crisis unfolded, however, the bond return correlations between the different GIIPS countries declined, while for some countries, this return correlation became negative. This result highlights the divergence within the eurozone, and the so-called flight-to-quality effects.[5]

3 Distributional linkages between sovereign bond and bank equity returns

We are interested in studying the dependence over time and in quantifying the asymmetry of the conditional distributions of bank and bond returns in Europe. Our approach to study these is through quantile regressions, which provide the advantage of being robust to distributional assumptions and potential outliers (see Koenker (2005) for a monograph). Furthermore, the flexibility of our modelling approach allows us to capture interactions between different bank and bond returns over time. We discuss the quantile vector autoregressive (quantile VAR) model that we estimate in the first subsection. In the second subsection, we describe the robust measures of conditional asymmetry which we recover from the estimated quantile VAR. We then present the results of the quantile VAR and the estimates of conditional asymmetry in the third subsection. Finally, we investigate the dynamics and co-movements of the conditional asymmetry measures.

3.1 Model specification and estimation

We consider the following system of equations that belongs to the family of quantile VAR models studied by White et al. (2015) to characterise the conditional distribution of bank and sovereign bond returns:

$$\mathbf{q}_{t,B}(\theta) = \mathbf{c}_B(\theta) + \nu_1(\theta)\mathbf{y}_{t-1,B} + \mathbf{A}_{bs}(\theta)\mathbf{y}_{t,S} + \nu_2(\theta)\mathbf{q}_{t-1,B}(\theta) + \mathbf{B}_{bs}(\theta)\mathbf{q}_{t-1,S}(\theta), \quad (1)$$

$$\begin{aligned}\mathbf{q}_{t,S}(\theta) &= \mathbf{c}_S(\theta) + \phi_1(\theta)\mathbf{y}_{t-1,S} + \mathbf{A}_{sb}(\theta)\mathbf{y}_{t,B} + \mathbf{A}_{ss}(\theta)\mathbf{y}_{t,S} \\ &\quad + \phi_2(\theta)\mathbf{q}_{t-1,S}(\theta) + \mathbf{B}_{sb}(\theta)\mathbf{q}_{t-1,B}(\theta) + \mathbf{B}_{ss}(\theta)\mathbf{q}_{t-1,S}(\theta). \quad (2)\end{aligned}$$

[5] This divergence also holds for other non-peripheral sovereign bonds, which are in Tables S5 and S6 of the Supplemental Material.

In this model, $\mathbf{q}_{t,B}(\theta)$ ($\mathbf{q}_{t,S}(\theta)$) is the vector of θ-th quantiles of banks (sovereign bond) returns and $\theta \in (0,1)$. The matrices $\mathbf{A}_{bs}(\theta)$, $\mathbf{A}_{sb}(\theta)$ and $\mathbf{A}_{ss}(\theta)$ measure contemporaneous dependence between between $\mathbf{y}_{t,B}$ and $\mathbf{y}_{t,S}$. Meanwhile, the matrices $\mathbf{B}_{bs}(\theta)$, $\mathbf{B}_{sb}(\theta)$ and $\mathbf{B}_{ss}(\theta)$ capture autoregressive dynamics. Controlling for the lagged quantiles enables us to take into account the entire past history of the variables in the regressions, which makes it preferable over a quantile model with a large number of lags. Moreover, the model allows us to capture time-varying features of the return distributions, such as conditional asymmetries. Hence, (1) and (2) permit an analysis of the evolution of the conditional quantile functions, and in turn, the conditional distribution, over time.[6]

We parametrise the matrices that capture contemporaneous dependence and autoregressive dynamics as sparse to highlight the relevant linkages emphasised in the academic literature.[7] In addition, we employ a panel structure, by which each effect has a common coefficient across the cross-section of banks and bonds, respectively. The dimensions of $\mathbf{A}_{bs}(\theta)$, $\mathbf{A}_{sb}(\theta)$ and $\mathbf{A}_{ss}(\theta)$ (and similarly, $\mathbf{B}_{bs}(\theta)$, $\mathbf{B}_{sb}(\theta)$ and $\mathbf{B}_{ss}(\theta)$) are $n \times m$, $m \times n$, and $m \times m$, as there are n banks and m bonds in the sample.[8] We consider different coefficients depending on whether the countries are members of the GIIPS or not. In addition, we allow German sovereign bonds and banks to have an additional impact on all other banks and countries. The developments in the German market have been widely perceived as a relevant fear gauge during the crisis, as noted by Acharya and Steffen (2015) and Angeloni and Wolff (2012), among others. For instance, flight-to-quality movements out of crisis-hit markets and into German assets have been common at the points when the crisis aggravated.

To focus the discussion, we describe the parameters that are in the contemporaneous matrices, as those that capture autoregressive dynamics are parametrised in the same manner. First, we outline the effects that enter $\mathbf{A}_{bs}(\theta)$:

[6] Notice that while very flexible, this model follows a multivariate GARCH(1,1)-like process, as explained in White et al. (2015).

[7] While the restrictions that we impose in this paper do not emanate from a particular structural model of the sovereign-bank feedback loop, they are compatible with several models of the feedback loop, such as those by Acharya et al. (2014) and Gennaioli et al. (2013). Alternatively, one can consider our approach as a way of estimating predictive distributions.

[8] In this notation, the subscripts refer to the rows and columns of the partitioned matrices. For example, $\mathbf{A}_{bs}(\theta)$, b stands for banks in the rows, and s stands for bonds in the columns.

- GIIPS bond returns to non-GIIPS bank returns: α.
- German bond returns to non-German bank returns: β.
- Own bond effect to banks headquartered in the country: γ on the cells of non-GIIPS banks and τ for GIIPS banks' returns.

Second, the effects captured in $\mathbf{A}_{sb}(\theta)$ are summarised as:

- GIIPS banks to non-GIIPS bond returns: η.
- German banks to non-German bond returns: ω.
- Effect of banks headquartered in a country to their own sovereign bond: κ on the cells of non-GIIPS bonds and π for GIIPS bonds.

Third, $\mathbf{A}_{ss}(\theta)$ only contains the contemporaneous effect of GIIPS bonds on non-GIIPS bonds (ψ). Figure 1 illustrates graphically the effects that we investigate.[9]

[Figure 1 about here.]

To provide a simple example, consider a version of quantile models (1) and (2) with only three countries, each having one bank. The countries are a non-GIIPS country, Germany, and a GIIPS country, ordered in this way in the matrices. Then,

$$\mathbf{A}_{bs}(\theta) = \begin{bmatrix} \gamma & \beta & \alpha \\ 0 & \gamma & \alpha \\ 0 & \beta & \tau \end{bmatrix}, \mathbf{A}_{sb}(\theta) = \begin{bmatrix} \kappa & \omega & \eta \\ 0 & \kappa & \eta \\ 0 & \omega & \pi \end{bmatrix}, \mathbf{A}_{ss}(\theta) = \begin{bmatrix} 0 & 0 & \psi \\ 0 & 0 & \psi \\ 0 & 0 & 0 \end{bmatrix}.$$

Typically, one can estimate the parameters of quantile models (1) and (2) via minimising the usual "check" function of quantile regression:

$$\min_{\boldsymbol{\alpha}} S_T(\boldsymbol{\alpha}) := T^{-1} \sum_{t=1}^{T} \left\{ \sum_{i=1}^{n} \rho_{\theta_{i,t}} (y_{it} - q_{i,t}(\boldsymbol{\alpha})) \right\} \tag{3}$$

There are two main challenges involved in estimating the parameters of the quantile models we specified, though. First, the quantile process must be stationary given the

[9] Notice that in the restrictions we impose, we do not allow for bank-to-bank linkages. While this might be potentially important, there is empirical work (e.g., Brutti and Sauré (2015)) that shows that these linkages do not matter for the transmission of sovereign risk. We estimated a model that allows for bank-to-bank linkages, and we find the same results as Brutti and Sauré (2015). Estimation results are available upon request.

autoregressive nature of the model. Second, the recursive nature of the specification makes estimating the model via the usual simplex algorithm (see Koenker (2005) for an exposition) less tractable. In this regard, we estimate a smoothed version of the "check" function for quantile regression, and impose a stationarity condition, which we outline in section S3 of the Supplemental Material. We estimate the parameters of interest from $\theta = 0.05$ to $\theta = 0.95$, which allows us to characterise the conditional distributions of bank and bond returns, respectively.

3.2 A robust measure of conditional asymmetry

A particular statistic we are interested in is the asymmetry of the conditional distributions of bank and bond returns. There are several reasons why one might be interested in measuring the degree of return asymmetries. For example, in the aftermath of the Great Recession, several measures of systemic risk were proposed (such as CoVaR by Adrian and Brunnermeier (2016) and Marginal Expected Shortfall by Acharya et al. (2017)) that focused on the tails of the conditional distributions of bank returns. Furthermore, there is a large tradition in empirical asset pricing that looks at the importance of skewness in explaining not only the cross-section of stock returns (see e.g., Harvey and Siddique (2000) and Conrad et al. (2013)), but also the portfolio allocation of investors (see e.g., Mencía and Sentana (2009) and references therein).

The most popular measure of asymmetry is skewness, which is calculated as the sample analogue of the normalised third moment of returns: $S(y_{t,k}) = E(y_{t,k} - \mu)^3/\sigma^3$, where $k \in \{B_i, S_j\}$. However, it is well-known that estimates based on sample averages are sensitive to outliers. This has prompted researchers to look for alternative measures of skewness that are not based on sample estimates of the third conditional moment.

One such quantity is the Bowley (1920) measure of skewness, which, when modified in the context of calculating conditional measures, we define as the following[10]:

$$\widehat{CA}_{t,k} = \frac{q_{t,k}(0.25) + q_{t,k}(0.75) - 2q_{t,k}(0.5)}{q_{t,k}(0.75) - q_{t,k}(0.25)} \tag{4}$$

[10] Kim and White (2004) modify the Bowley (1920) measure of skewness to study asymmetry of stock returns. Meanwhile, Ghysels et al. (2016) utilise the same measure to study portfolio allocation in international stock markets.

As can be observed, the conditional asymmetry measure (4) captures skewness in the interquartile range with respect to the median. It is robust to outliers, as the quantiles are not affected by them. Moreover, this measure is unit independent (due to the normalisation), and assures that the values are between -1 and 1. Recovering $\widehat{CA}_{t,k}$ is straightforward after running the quantile regressions in (1) and (2), as we can calculate it simply by computing the predicted conditional quantiles implied by these regressions.

From now on, we will define conditional asymmetry in terms of $\widehat{CA}_{t,B_i}$ and $\widehat{CA}_{t,S_j}$. We will calculate conditional asymmetry in this section, and study its properties in the subsequent sections.

3.3 Results

3.3.1 Quantile autoregressive model results

Table 2 presents the results for the bank quantile model, equation (1), for selected quantiles of the distribution. We find that there is contemporaneous dependence between bond and bank returns. In particular, there is a positive and significant exposure to the peripheral sovereign bonds across the distribution of non-GIIPS bank returns (α). In contrast, non-German banks have a negative and statistically significant exposure to the German bond return (β). In both cases, the coefficients remain relatively constant across quantiles. The results that we obtain here are consistent with those obtained by Acharya and Steffen (2015) and Kallestrup et al. (2016), among other papers, but substantially extend them by showing that the transmission of risk from sovereigns to banks is propagated throughout the entire distribution of returns.[11] Turning to own sovereign bond effects, we find that there is no contemporaneous dependence from non-peripheral sovereign bonds to their corresponding bank returns (γ), except at the extreme left tail. The opposite is true, however, for peripheral sovereign bonds (τ), which have a positive and significant dependence throughout the entire conditional distribution.

[Table 2 about here.]

[11] Moreover, in a related paper, Brutti and Sauré (2015) show that financial sector linkages are a major factor in the transmission of sovereign credit risk.

We now turn to the coefficients associated to the lagged quantiles, which are at the bottom panel of the table. The estimation results suggest that the GIIPS bond effect is positive, significant and persistent at the extreme tails of the conditional distribution of bank returns. While the contemporaneous effect is flat across quantiles, these more persistent effects remain relevant only at the tails. Meanwhile, the German bond effect continues to be negative and significant over time, as can be observed from the parameter estimates. Turning to the own bond effects for all quantiles, we interestingly find that this effect for non-GIIPS countries is negative and significant at the two tails. The analogous effect for peripheral countries, however, turns out to be statistically insignificant, though it carries the same positive sign as the contemporaneous effect. These results suggest that dependence between bond and bank returns for peripheral countries is mainly contemporaneous, while the same effect is only introduced to non-peripheral countries through lags.

Finally, Table S9 of the Supplementary Material shows empirical results for the bond quantile model, equation (2). As can be observed, the transmission of risk from bank to bond returns is not as strong.

3.3.2 Estimates of conditional asymmetry and its properties

As is clear from the skewness measure defined in (4), to compute the conditional asymmetry measures, we need estimates of the 25th, 50th and 75th quantiles. To do so, we recover them from the estimated conditional quantile models (1) and (2), and plug the estimates into the formula.

[Figure 2 about here.]

Figure 2 plots the kernel densities of the conditional asymmetry estimates of bank equity returns and sovereign bond returns. First, we discuss the results for Figure 2a, the kernel densities for bank asymmetries. We plot the kernel densities for peripheral and non-peripheral banks. As can be observed from the figure, we find that the kernel density for non-GIIPS banks is less dispersed than that for GIIPS banks. Moreover, we find that the kernel density for the non-GIIPS banks has thinner tails, consistent with the idea that extremely negative events occur more frequently for banks that are headquartered in countries with weak sovereigns. The second panel, meanwhile, Figure 2b, plots the kernel densities for bond asymmetries. In the figure, the difference between peripheral and non-peripheral bonds is more obvious. In particular, we find that, in general, conditional skewness is lower for GIIPS than for non-GIIPS.

[Figure 3 about here.]

The kernel densities do not portray the evolution of the conditional asymmetry measures over time, though. Figure 3 plots the quarterly conditional asymmetry estimates for average GIIPS and non-GIIPS banks and bonds throughout the sample periods. Looking at Figure 3a, we find that the conditional asymmetry measures for banks co-move together, though the magnitudes differ for non-GIIPS and GIIPS banks. We also observe that bank conditional asymmetries are negative during periods of financial turmoil, such as the Dot-com bubble in 2003, the financial crisis in 2008, and the height of the European sovereign crisis in 2011. The second panel, Figure 3b, shows that in general, peripheral and non-peripheral sovereign bonds do not co-move together; rather, they tend to move in opposite directions. Lastly, Figure 3c plots the conditional asymmetry measures between banks and own country sovereign bonds, which in this case, are the non-GIIPS bank and bond in the previous figures. As can be observed from the figure, there is a clear divergence between bank and bond conditional asymmetries for non-GIIPS.

3.3.3 Co-movements in conditional asymmetries of bond and bank returns

It is natural to ask the degree to which the time variation in the conditional asymmetry in the distribution of bank returns is due to fluctuations in sovereign bond returns. In other words, can we trace these fluctuations to a sovereign factor? As we have seen in the previous section, the distributions of bank returns are affected by different factors that can be country-specific (such as their own sovereign bond returns), or because of risks that come from other sovereigns.

In this regard, we first estimate the following model:

$$\widehat{CA}_{t,B_i} = \alpha + \beta\widehat{CA}_{t,S_j} + \varepsilon_{t,B_i} \quad (5)$$

where $\widehat{CA}_{t,B_i}$ and $\widehat{CA}_{t,S_j}$ are the estimated conditional asymmetries of bank return i and sovereign return j where the bank is headquartered, at the quarterly frequency.[12] Apart from providing a simple procedure that shows the co-movements between bond and bank returns, an alternative interpretation of the model is that of a single factor model where the source of asymmetries in the distribution of bank returns is that of country-specific factors. We estimate this regression with quarterly instead of weekly measures to be consistent with subsequent regressions where we will link them with macroeconomic or financial variables.

Table 3 presents the results of this regression. Looking at the first column, there is a negative and significant relationship between the conditional asymmetry of banks and the sovereign in the country in which they are headquartered in; that is, banks have a negative and signficant exposure to their own sovereign bond. This is not surprising, as this relationship reflects the role played by sovereign bonds as "safe havens". Thus, positive (negative) skewness in the sovereign market tends to be observed when the equity market is generating more negative (positive) skewness as a result of investors leaving (returning to) the equity market. We then analyse whether the relationship changes for banks headquartered in peripheral countries by introducing an interaction between a GIIPS indicator and the conditional asymmetry measure. As the results in the second column of Table 3 indicate, there is indeed a significantly less negative exposure of the peripheral banks to the peripheral bonds. This is a first indication that no safe haven effect is observed for sovereign bonds from GIIPS countries, as these bonds were not perceived as sufficiently safe by investors during the European sovereign crisis. Moreover, the negative and significant coefficient on the GIIPS dummy points to a fixed penalty for banks headquartered in the GIIPS countries.

[Table 3 about here.]

[12] To do so, we take the last observation of $\widehat{CA}_{t,B_i}$ and $\widehat{CA}_{t,S_j}$ of every quarter for each bank i and sovereign bond j.

We then study the presence of spillovers from peripheral sovereign bonds to banks that are not in peripheral countries. To do this, we augment specification (5) and project the conditional asymmetry measures of each of the peripheral sovereign bonds interacted with a dummy equal to one if the bank is not headquartered in the peripheral country considered. That is, we estimate the following model:

$$\widehat{CA}_{t,B_i} = \alpha + \beta\widehat{CA}_{t,S_j} + \gamma\widehat{CA}_{t,S_k}\mathbf{1}(j \notin GIIPS) + \delta\widehat{CA}_{t,S_{DE}}\mathbf{1}(j \notin DE) + \varepsilon_{t,B_i} \qquad (6)$$

where $k \in \{GR, IE, IT, PT, ES\}$. Note that we also include as a regressor the conditional asymmetry measure for the German sovereign bond, interacted with a dummy that is equal to one if the bank is not headquartered in Germany. This allows us to test the hypothesis that German sovereign bonds were seen as "safe haven" assets, in particular during the sovereign debt crisis.

[Table 4 about here.]

Table 4 presents the results of this estimation. Looking at the first to the fifth column, each of the peripheral sovereign bonds (with the exception of Portuguese bonds) has a positive and significant co-movement with the conditional asymmetry of bank returns, consistent with the evidence from Acharya and Steffen (2015) for the mean return, among others. We go beyond previous results by showing that not only does the mean of the returns co-move together, but that the conditional asymmetries also co-move together. The German bond conditional asymmetry measure is highly negative and significant as well, which is consistent with the presence of flight-to-quality effects during the European sovereign debt crisis (Beber et al. (2009)).[13]

We study what happens when all bonds are considered jointly, which is in column 6 of the table. We find that almost all of the peripheral bond asymmetries have a positive and significant relationship, except for the Portuguese sovereign bond, which has a negative and significant coefficient. The coefficient on German sovereign bond asymmetry is negative and significant. Importantly, we find that own sovereign bond asymmetry regains

[13]Notice that the own-country conditional asymmetry measures become insignificant in these regressions. However, in the next column, we find that once we consider all bonds jointly, the own sovereign bond asymmetry retains its significance.

its significance, albeit at a 10 percent level. Because there is a high degree of collinearity among the peripheral sovereign bonds, we conduct another regression wherein we first conduct a principal component analysis of the GIIPS sovereign bond return asymmetries, and extract the first principal component to use it as a regressor. As the results in column 7 of the table indicate, we find a positive and significant relationship between the first principal component and bank conditional asymmetry, suggesting that indeed, there are spillovers from the peripheral sovereign bond returns to bank returns, particularly at the tails of the distribution. The own sovereign bond and the German sovereign bond asymmetry measures remain to be negative and significant in this estimation.

Finally, it might be of interest to consider the relationship between conditional asymmetry and the volatility of bank equity returns, which is in Table S10 of the Supplementary Material. As the results indicate, there is a negative relationship between conditional asymmetry and volatility.[14]

4 Economic determinants of conditional asymmetries

In the previous section, we related the conditional asymmetry of banks to bonds and to fluctuations to volatility. While these results allow us to understand the time series and co-movement properties of our conditional asymmetry measures, they do not provide much insight on the economic determinants. That is, can we trace the co-movements in bank and bond asymmetries to fluctuations in economic and financial fundamentals?

We investigate in this section whether $\widehat{CA}_{t,B_i}$ and $\widehat{CA}_{t,S_j}$ can be explained by a set of predetermined state variables. The selection of economic and financial state variables are mainly motivated by results in previous empirical studies which investigate the predictors of the conditional mean of bank and bond returns, respectively (e.g., Gandhi and Lustig (2015) for bank returns and Hilscher and Nosbusch (2010) for sovereign bond returns). As most of these predictive variables are observed at a quarterly frequency, our approach in this paper is to study whether variables observed in quarter $t-1$ can predict conditional

[14]Related to this point, we estimated regressions 5 and 6, but with conditional the interquartile range. The estimates show a positive relationship between bank and sovereign conditional IQRs of the peripheral countries. Results are available upon request.

asymmetry in quarter t.

We proceed by estimating the following panel regression:

$$\widehat{CA}_{t,k} = \alpha + \mathbf{X}'_{t-1,k}\beta + e_{t,k} \tag{7}$$

where $k \in \{B_i, S_j\}$ and $\mathbf{X}_{t-1,k}$ is a vector of lagged state variables. We consider different state variables depending on whether the left-hand side variable is $\widehat{CA}_{t,B_i}$ or $\widehat{CA}_{t,S_j}$. We run the pooled regression across banks (or countries) and across time, using the quarterly estimates of the conditional asymmetry measure, which is estimated from the quantile model in section 3. Additional information about the estimations we perform are provided in each subsection. We provide the definitions of the variables used in the estimation, and the corresponding sources, in the Supplemental Material.

4.1 Determinants of bank conditional asymmetry

We consider bank-level variables related to capital structure, asset structure, and bank performance, plus the estimated sovereign conditional asymmetry measures, as determinants of bank skewness $\widehat{CA}_{t,B_i}$.

We consider the Tier 1 capital ratio as a measure of capital structure. There are two opposite potential effects on the relationship between capital and bank risk. On the one hand, the higher the capital reserves of a bank, the greater capacity it has to withstand losses. Higher capital levels can also result in banks becoming more prudent in screening potential borrowers, which leads to less bank risk taking behavior (e.g., Mehran and Thakor (2011)). On the other hand, higher capital requirements can lead to excessive risk-taking. As underscored in the corporate finance literature, agency problems between shareholders and managers can lead to excessive risk-taking by managerial risk-seeking. These papers conclude that increasing leverage (by reducing capital requirements) mitigates this problem, as informed debt holders might force the bank managers to become more prudent (e.g., Diamond and Rajan (2001)).

Bank size can be an important determinant of bank risk and systemic importance, as shown by Gandhi and Lustig (2015)[15] and Altunbas et al. (2017) recently. Large

[15] Gandhi and Lustig (2015) show that the bank returns of the largest US banks ranked by size are

banks may face different incentives to take on risk than small banks because of the "too-big-to-fail" problem, or due to wider possibilities for portfolio diversification. In the estimations, asset size is measured by the logarithm of the total assets of the banks in the data. Another asset structure variable is the loans-to-assets ratio, which summarises how much of the activity of the bank is invested in traditional roles.

As a measure of bank profitability, we consider return on equity, which we calculate as the quarterly ratio of total net income of the bank and shareholder equity. Finally, we consider the non-performing-loans to total bank loans ratio as a measure of bank incurred credit losses. As highlighted in the global financial crisis, non-performing loans can be seen as a measure of a bank's level of default on its asset side, and can be thought of as a measure of a subsequent banking crisis' severity, when aggregated to the whole banking system. This is because a rising share of non-performing loans in a bank's loan portfolio reflects losses from previously granted loans that might affect the liquidity and profitability of banks.

To compute the aforementioned variables, we use information from SNL Financial that spans the first quarter of 2008 to the last quarter of 2013. We introduce bank and quarter fixed effects to control for unobserved bank and time variation. The standard errors in our regressions are clustered by bank and quarter.

[Table 5 about here.]

Table 5 presents the regression results. We first focus on the results in the first column, the baseline specification. We find that larger asset size in $t-1$ results in more negative bank return conditional asymmetry in period t. Our findings extend the results of Gandhi and Lustig (2015) by showing that not only do larger banks (in terms of size) have lower returns, but also that their return distributions change shape (i.e., become more negatively skewed). Meanwhile, the coefficient on the Tier 1 ratio is positive and significant. This result is consistent with the first of the two views discussed earlier; that is, the higher capital reserves the bank has, the less likely it engages in risk taking

smaller than small and medium bank stocks. They argue that these results are consistent with a size factor that is a measure of bank-specific tail risk.

behaviour. The non-performing loans ratio turns out to be negative and significant as well, supporting the view that this is an indicator of banks' loan portfolio risk profiles. Looking at the conditional asymmetry measures, we find that the results are quite similar to the regressions in section 3.3.3 of the paper. That is, there is a negative relationship between own sovereign skewness (and German bond skewness for non-German countries) and future bank skewness. In contrast, higher skewness of GIIPS bond returns yields higher bank skewness at time $t + 1$ for non-GIIPS countries. Again, this reflects how the peripheral sovereign bonds lost their status as a safe investment during the crisis. In addition, it shows that tensions in the GIIPS affect banks in both GIIPS and non-GIIPS countries.

We then study whether there is an additional effect for banks headquartered in GIIPS countries. To do so, we augment the specification by interacting the bank-level variables with an indicator for GIIPS-headquartered banks. As the second column of Table 5 indicates, the main determinant of bank conditional asymmetry is the Tier 1 ratio. Specifically, there is a positive and significant relationship between the Tier 1 ratio and bank conditional asymmetry. However, this effect disappears for banks headquartered in peripheral countries, as the negative coefficient in the interaction of the Tier 1 ratio and the indicator for GIIPS-headquartered banks cancels the effect of the general coefficient on the Tier 1 ratio. The conditional asymmetry measures still retain similar coefficients in terms of size and magnitude, although with less power for the own sovereign skewness measure. These imply that bond conditional asymmetry measures are strong predictors of future conditional asymmetries of banks, which underscores the sovereign-bank nexus.

In sum, the regressions in this subsection indicate that sovereign skewness is a significant predictor of future bank skewness. Moreover, variables that are related to banks' capital adequacy (such as the Tier 1 ratio) are relevant indicators of future bank risk. However, banks from GIIPS countries with stronger Tier 1 ratios do not seem to enjoy the positive effects observed for banks from core countries on their skewness. This is already a sign of potential stigma for GIIPS banks due to the sovereign-bank nexus.

4.2 Determinants of bond conditional asymmetry

We now discuss the determinants of model (7) for sovereign bonds, $\widehat{CA}_{t,S_j}$. In particular, we introduce variables that describe leverage and volatility, as these have been shown to be relevant determinants of sovereign credit risk (Ericsson et al. (2009)).

To compute measures of a country's indebtedness, we follow Hilscher and Nosbusch (2010) and Dieckmann and Plank (2012) by utilising the country's debt-to-GDP ratio and reserves-to-GDP ratio.[16] The rationale for including the reserves-to-GDP ratio is due to its interpretation as a measure of a country's ability to pay its foreign debt. We provide two variables that measure volatility. The first variable, local stock market volatility, is defined as the 18-month rolling standard deviation of the stock market return of each country in the sample. With respect to the second measure, we follow Hilscher and Nosbusch (2010) and compute an 18-month rolling standard deviation of the terms of trade of each country in the sample. Finally, to further impose discipline, and to include variables that describe local market conditions, we consider aggregate bank skewness, calculated as the average of the conditional asymmetry measures of the banks headquartered in country j, weighted by each bank's size, and the changes in a country's terms-of-trade, which is defined as the percentage change of the country's export-to-imports ratio over the past five years, following Hilscher and Nosbusch (2010).[17] We introduce country and quarter fixed effects to control for unobserved country and time variation. We cluster standard errors by country and quarter.

[Table 6 about here.]

Table 6 shows the corresponding regression results. We find that a higher reserves-to-GDP ratio results in higher sovereign skewness. This result is consistent with the idea of the country being able to better pay off its sovereign debt (Dieckmann and Plank

[16] We ran augmented Dickey-Fuller tests to determine whether the time series are highly persistent. The results indicate that indeed, they are not.

[17] In regressions not shown here, we also included other measures that describe local market conditions, such as the effective exchange rate of the Euro, the European industrial production index, and the European Fama-French factors, following Longstaff et al. (2011) and Acharya and Steffen (2015). As these variables are collinear with the quarter fixed effects, we do not include them in the final specification. The results that we obtain are quite similar, even when removing quarter fixed effects.

(2012)). The change in the terms of trade variable is also positive and significant, which suggests that the better is the country's performance in trade markets (suggested by higher exports), the better is the country's economic health. In contrast to Hilscher and Nosbusch (2010), we do not find that the volatility in the country's terms of trade is stastistically significant. However, the sign associated to the coefficient is negative, which is in line with their findings that terms of trade volatility is a significant factor in determining sovereign risk. Finally, we find that aggregate bank skewness has a negative and significant relationship with sovereign bond skewness.

To determine whether there is an additional effect for peripheral sovereign bonds, we augment the specification by interacting the country variables with an indicator for whether a sovereign is from a peripheral country or not. As the second column of Table 6 indicates, it appears that the reserves-to-GDP ratio continues to be a determinant of conditional bond asymmetry. Meanwhile, the changes in the terms of trade becomes more relevant for GIIPS countries than it is for non-GIIPS countries. We also find, however, that stock market volatility becomes negative and significant, in line with economic intuition. This relationship turns out to be positive for peripheral sovereign countries, however. Finally, aggregate bank skewness appears to be negative and significant, but only for peripheral countries. Overall, these results indicate that variables related to leverage are highly significant predictors of sovereign credit risk.

5 Do investors pay a premium for positive sovereign skewness?

The previous sections showed that bank and sovereign bond returns not only display time-varying skewness, but that there is also a negative relationship between those of banks and sovereign bonds. As stressed earlier, this suggests that in periods of financial market stress, investors leave the equity markets to invest in sovereign debt, which may be perceived to be safer. However, such a negative relationship does not seem to hold for countries undergoing a sovereign crisis. This strong interconnectedness between bank and sovereign risk is known as the sovereign-bank nexus. Many authors argue that this nexus is due to the domestic sovereign holdings in banks balance sheets (Altavilla et al. (2017)).

The results from the previous sections document that this nexus indeed exists at the tails of bank equity and sovereign bond return distributions. However, our findings so far do not shed light on the extent to which it is actually driven by banks domestic sovereign exposures or to other factors. Specifically, the sovereign-bank nexus may go well beyond banks domestic sovereign holdings. Banks are also exposed to sovereign tensions through their linkages to the real economy, since eventually those tensions usually reflect problems on the whole economy. In this sense, some recent papers have also found that there is a transmission of risk from sovereigns to non-financial firms (see e.g., Augustin et al. (2018) and Bedendo and Colla (2015)). If this is the case, it would be a confirmation that the sovereign-bank nexus is also driven by common exposure to the real economy, since the sovereign debt holdings by non-financial firms are negligible.

We explore this possibility by assessing whether both financial and non-financial firms need to pay a sovereign skewness premium to attract equity investors, and whether this premium is more intense for GIIPS. In particular, we conduct cross-sectional asset pricing tests. Instead of forming portfolios, we resort to examining individual stocks. As emphasised in recent work by Ang et al. (2017) and Chordia et al. (2015), the use of individual stocks as opposed to forming portfolios improves the statistical efficiency of the estimation of pricing models. We outline the methodology we pursue below.

5.1 Methodology

As is well known, under no arbitrage, excess returns $rx_{t,j}$ satisfy the Euler equation $\mathbb{E}(m_{t+1}rx_{t+1,j}) = 0$, where m_{t+1} is the stochastic discount factor (SDF). If the SDF is linear in the factors, the equation implies a beta pricing model. In particular,

$$\mathbb{E}(rx_{t+1,j}) = \boldsymbol{\lambda}'\boldsymbol{\beta}_j \tag{8}$$

in which the $\boldsymbol{\lambda}$'s are the factor risk prices and the $\boldsymbol{\beta}_j$'s are the factor loadings. We estimate these quantities via a two-pass regression procedure, as the factor of interest (i.e., sovereign skewness) is not tradeable (Cochrane (2009)).

The first pass regression is a time series regression of each stock's excess return on a vector of risk factors:

$$rx_{t,j} = \alpha_j + \mathbf{f}_t' \boldsymbol{\beta}_j + \varepsilon_{t,j}, \qquad \text{for } t = 1, \ldots, T, j = 1, \ldots, J \tag{9}$$

where $\mathbf{f}_t$ is the vector of risk factors, α_j is the risk-adjusted return on the stock, and $\boldsymbol{\beta}_j$ is the vector of exposures to the risk factors. In the second pass, we take the time series average of the excess returns $\overline{rx}_j = \frac{1}{T}\sum_{t=1}^{T} rx_{t,j}$, and perform the following cross-sectional regression of the average returns on the estimated beta's:

$$\overline{rx}_j = \widehat{\boldsymbol{\beta}}_{\boldsymbol{j}}{}' \boldsymbol{\lambda} + a_j, \qquad \text{for } j = 1, \ldots, J \tag{10}$$

where a_j is the cross-sectional pricing error associated with each stock j.

In this section, we study whether financial and non-financial firms that are constituents of the Eurostoxx 600 pay a premium for negative sovereign conditional asymmetry, and whether it is stronger for GIIPS-headquartered firms. We identify 94 financial firms and 392 non-financial firms that are headquartered in the countries that are part of our sample, and calculate, for each of them, the excess return on the corresponding equity prices, where the reference risk-free rate is the overnight interest rate spread. We then perform the two-pass regression procedure on each group separately.

We consider three sets of estimations. In the first set, we consider a four-factor SDF that represents widely used risk factors for pricing the cross section of stock and bond returns (Fama and French (1993)).[18] The first factor is the market factor, which is defined as the difference between the return on the Eurostoxx 600 and the overnight interest rate spread. The second and the third factors are the bond market and the credit spreads. The bond market spread is defined as the difference between the ten-year and the two-year Treasury rates of each country in the sample. Meanwhile, the credit spread is the difference between ten-year A rated Eurozone corporate bond yields and the 10-year German sovereign bond yield. The term spread can be thought of as a measure of business cycle risk; meanwhile, the credit spread can be thought of as a measure of corporate default risk. Moreover, as Mäkinen et al. (2018) notes, both of

[18] We describe in more detail the variable definitions, and the corresponding sources, in the Supplemental Material.

these variables can be thought of as measures of bank profitability and risk. The fourth factor is the TED spread, which is the difference between the three-month Euribor and the three-month Euro overnight interest rate swap. One interpretation of the TED spread is that of a measure of stress in the interbank market, which then is related to funding and over-all market liquidity. In the second set, we introduce a fifth factor, which is the estimated sovereign conditional asymmetry measure $\widehat{CA}_{t,s_j}$ of the country the firm is headquartered in. Finally, in the third set of estimations, we consider not only these factors, but also their interaction with a dummy variable for whether the firm is headquartered in a peripheral country or not. The rationale behind this is to understand whether indeed, there is an additional penalisation for being headquartered in a GIIPS country.

5.2 Results

Before presenting the results of the second-pass regression, we first present the results of a panel regression that mimics the first-pass regression (9). In particular, we estimate the following model:

$$rx_{t,j} = \alpha + \mathbf{f}_t' \boldsymbol{\beta}_j + \delta_j + \lambda_t + \varepsilon_{t,j} \tag{11}$$

with firm and quarter fixed effects to control for unobserved variation across firms and time. We compute standard errors that are clustered by firm and quarter.

[Table 7 about here.]

Table 7 shows the estimation results. We first focus on the first three columns, which describe the results for financial firms. Looking at the first column, we find that financial firms load positively only on the market factor. Once we introduce sovereign skewness, we find that financial firms load positively on the term spread and the TED spread, albeit with weakly significant coefficients. More importantly, though, we find that financial firms load negatively on sovereign conditional asymmetry, which is consistent with the flight-to-quality interpretation that we have argued earlier. Once we introduce the interaction with the GIIPS dummy, we find that own sovereign skewness retains its negative and significant loading. We also find that the interaction between the term and credit spreads, and the GIIPS dummy, respectively, are positive and significant. This suggests that the term and credit spreads are more important for the peripheral countries than for the non-peripheral countries.

We next describe the results for non-financial firms, which are on the fourth to sixth columns of the table. Again, we find that non-financial firms load positively on the market, term and the TED spread and negatively on the credit spread. The fifth column shows that non-financial firms also have a negative loading on sovereign conditional asymmetry, while the rest of the factors retain their loadings. The interaction terms, which are in column six, show that sovereign conditional asymmetry matters for all countries, regardless of whether they are peripheral or not. We also find, though, that the factor loading on the market of peripheral countries are smaller than those of non-peripheral countries.

[Table 8 about here.]

We now look at the results of the second-pass regression (10), which are outlined in Table 8. We first discuss the result of the second-pass regression for financial firms, which are on the first three columns. We find that in the model with only the usual risk factors, only the market factor is priced. However, once we introduce sovereign skewness in column 2, we find that its risk price is negative and statistically significant at the one percent level, suggesting that indeed, skewness is priced by financial firms. Moreover, the negative coefficient, coupled with the loading on the sovereign skewness coefficient, suggests that financial firms need to pay a sovereign risk-related premium to investors holding their equity. Looking at the third column, we observe that the coefficient related to the GIIPS indicator is positive and significant; the fact that this coefficient is constant suggests that financial firms have to pay a premium to investors just for being headquartered in a country that has a weak sovereign.

Finally, we look at the last three columns, which present the results for non-financial firms. We find that, similar to financial firms, non-financial firms have a negative risk price associated with sovereign conditional asymmetry, which is reflected in the price of risk for these firms. Remarkably, even non-financial firms that are headquartered in GIIPS countries are penalised, as can be seen from the positive coefficient on the GIIPS indicator in column 6. Though we do not directly look at the real channel of the sovereign-bank nexus, this result suggests that the nexus also exists for non-financial firms.[19] Our approach does not allow us to empirically disentangle whether this nexus for non-financial firms is due to spillovers from financial to non-financial firms or to common exposures to sovereign risk through the real economy. However, as constituents of the Eurostoxx 600, the non-financial companies in our sample are generally large firms, which normally have direct access to the international markets. Hence, the results we obtain appeal to the second hypothesis (i.e. the nexus with sovereign risk operating through the real economy). Looking at the other factors, we find that both the market and the term spread are consistently priced across all specifications.

In Tables S11 and S12 of the Supplemental Material, we consider the Europe-wide market, size, value and momentum factors as an alternative pricing model, given the high integration of the European stock markets. As we show, the results for the sovereign skewness parameter remain insensitive to this alternative pricing model.

6 Conclusions

While there are several papers that study the sovereign-bank nexus, empirical research that aims to understand the distributional linkages between sovereign bond and bank stock returns has been relatively scarce. We contribute to the literature by studying the evolution of the conditional distributions of bank and bond returns over time. In particular, we focus on conditional asymmetries of bank equity and sovereign bond returns, given their particular importance during the recent financial crisis.

Using a large panel of European bank equity and sovereign bond returns, we estimate measures of conditional asymmmetry via an approach that is robust to outliers and distributional assumptions. We find significant dynamics over time, a negative correlation between sovereign bond and bank return asymmetries, and a positive correlation between asymmetries of peripheral sovereign bond returns and bank stock returns of

[19] Acharya et al. (2018) directly look at the real channel of the sovereign-bank nexus by studying access to credit using a syndicated loan database.

non-peripheral countries. These findings have significant implications for asset pricing, some of which are explored in this paper. Specifically, we study if known economic and financial variables can predict conditional skewness of bank equity and bond returns. Our estimation results indicate that variables that relate to bank's financial health are relevant indicators of future bank market risk; likewise, macroeconomic variables that relate to a country's ability to pay debt are relevant indicators of future sovereign market risk. More importantly, we find that sovereign skewness is a significant predictor of bank skewness. Armed with these results, we finally show that both financial and non-financial firms pay a premium for negative sovereign conditional asymmetry. Peripheral firms pay a higher premium, which appears to remain when the level of sovereign asymmetry decreases.

The empirical results of our paper suggest that both financial and non-financial firms are penalised because of their links with the sovereign. From this perspective, the main policy question is whether there are mechanisms that can break the "diabolical" loop between sovereign debt and the financial conditions faced by domestic firms. This is a particularly relevant question for a monetary union without a fiscal union, such as the Euro area. Given that both financial and non-financial firms are affected by this loop, solutions addressing only the financial system might be less effective than more comprehensive ones. Specifically, the goal could be to try to weaken the link between sovereign debt and domestic firms in the Euro area to the same extent as the situation in which US firms are unlinked from the state they are headquartered in. Currently, there are different proposals, but some of them face substantial challenges unless more decisive steps toward European integration are taken.

However, a recent proposal that has gained traction in both academic and policy circles is the creation of a European synthetic benchmark bond (Brunnermeier et al. (2017)), which can potentially substitute national sovereign debt as a reference for pricing assets. Should such a proposal be successful, and with appropriate regulation (ESRB (2018), EC (2018)), it might help facilitate financial stability by replacing national sovereign debt as the reference for pricing national assets, which would enhance diversification in the asset allocations of financial institutions, while at the same time, imposing prudent fiscal policy.

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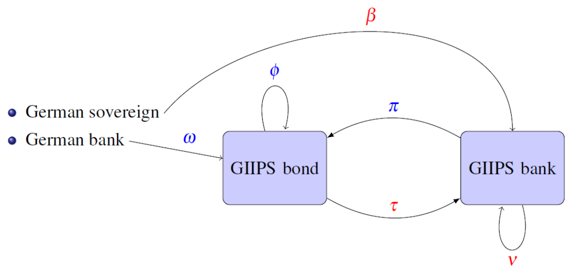
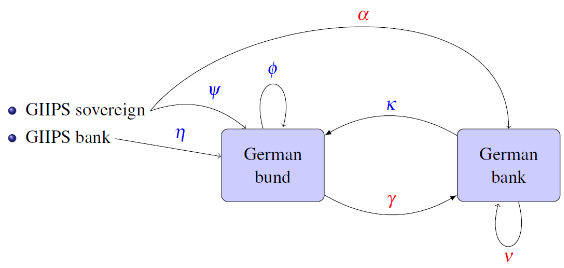
Figures

Figure 1: Distributional linkages between bond and bank returns

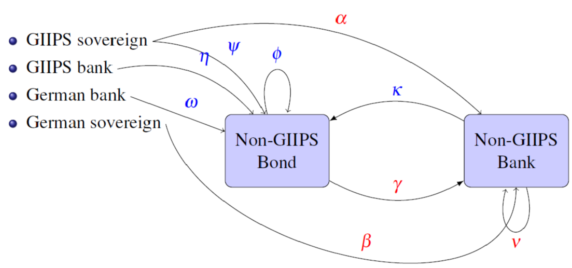
(a) GIIPS banks and sovereigns



(b) German banks and sovereigns



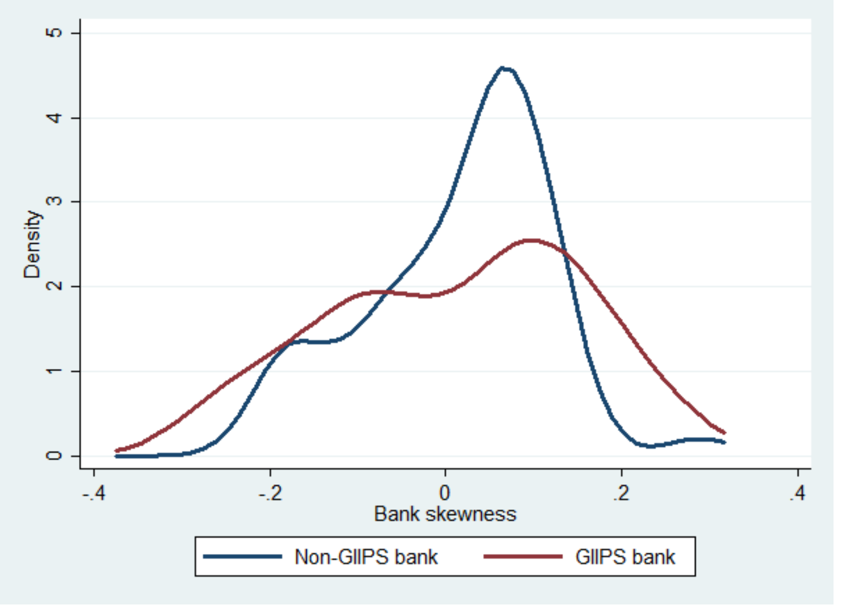
(c) Non-GIIPS, non-German banks and sovereigns



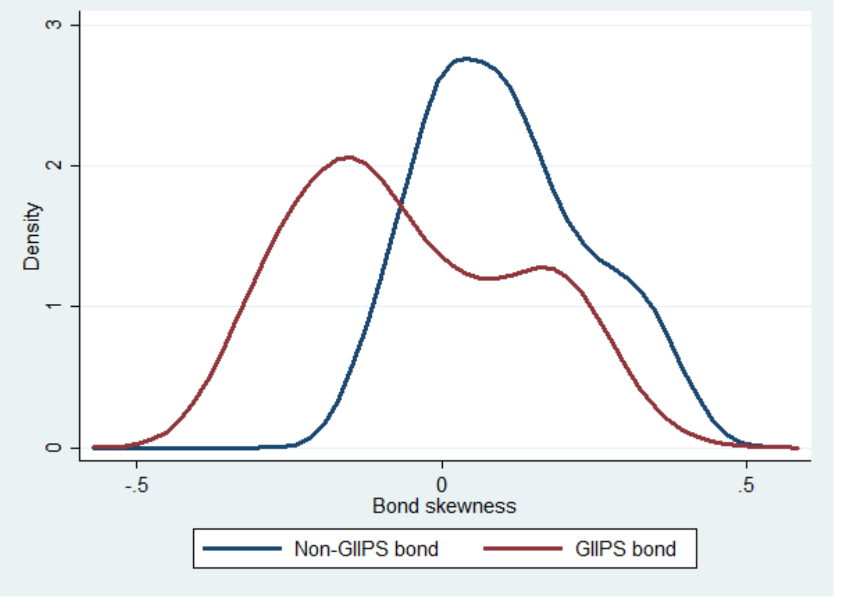
Note: This figure illustrates the linkages between bond and bank returns that are of interest, which we use to parameterise the quantile functions estimated in the paper. Each subfigure illustrates the linkages relevant to the group of banks and sovereigns labelled below it. The red parameters correspond to those of the bank equation (1) blue parameters correspond to the parameters of the bond equation (2).

Figure 2: Densities of conditional asymmetry estimates, Q12001-Q32013

(a) Bank stock returns



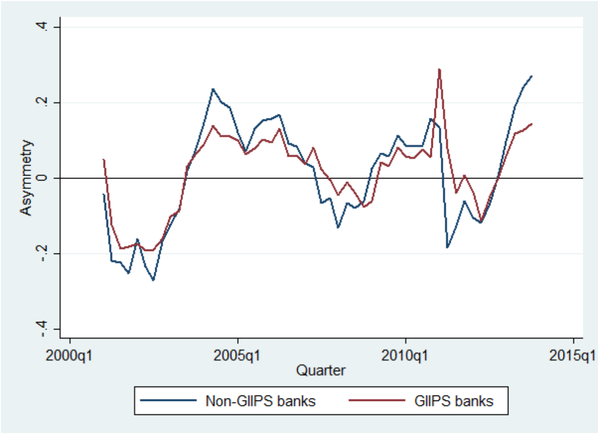
(b) Sovereign bond returns



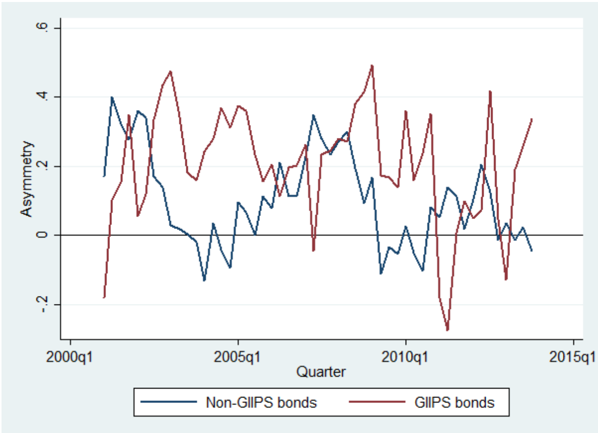
Note: The first panel plots the densities of the conditional asymmetry estimates $\widehat{CA}_{t,B_i}$ for Non-GIIPS and GIIPS banks, respectively. The second panel plots the densities of the conditional asymmetry estimates $\widehat{CA}_{t,S_j}$ for Non-GIIPS and GIIPS bonds, respectively. These are estimated from the conditional quantile model (1) and (2).

Figure 3: Conditional asymmetry estimates, quarterly frequency, Q12001-Q32013

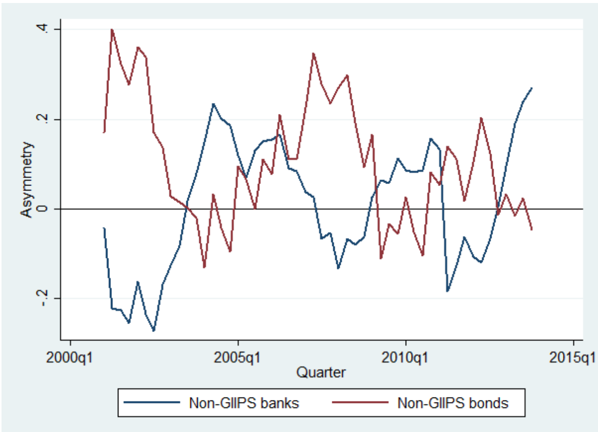
(a) Bank stock returns



(b) Sovereign bond returns



(c) Co-movements between bank stock returns and sovereign bond returns



Note: The first panel plots the conditional asymmetry estimates $\widehat{CA}_{t,B_i}$ for the average Non-GIIPS and GIIPS bank, respectively. The second panel plots the conditional asymmetry estimates $\widehat{CA}_{t,S_j}$ for the average Non-GIIPS and GIIPS bond, respectively. The third panel plots the conditional asymmetry measures of a bank and the associated sovereign bond of the country where the bank is headquartered. These are estimated from the conditional quantile model (1) and (2).

Tables

Table 1: Descriptive statistics, sovereign bond returns

Panel A: Descriptive statistics of sovereign bond returns					
	Mean	Std. Dev.	Minimum	Median	Maximum
Greece	-0.003	1.697	-8.685	0.008	38.569
Ireland	0.002	0.326	-2.274	0.019	2.349
Italy	0.003	0.209	-1.009	0.007	1.625
Portugal	-0.002	0.404	-2.783	0.005	2.235
Spain	0.001	0.238	-1.032	0.01	1.95
Germany	0.008	0.171	-0.551	0.018	0.584

Panel B: Sovereign bond return correlations (2001-2006)						
	Greece	Ireland	Italy	Portugal	Spain	Germany
Greece	1					
Ireland	0.967	1				
Italy	0.960	0.939	1			
Portugal	0.970	0.953	0.953	1		
Spain	0.977	0.949	0.959	0.978	1	
Germany	0.981	0.964	0.971	0.974	0.981	1

Panel C: Sovereign bond return correlations (2007-2013)						
	Greece	Ireland	Italy	Portugal	Spain	Germany
Greece	1					
Ireland	0.133	1				
Italy	0.166	0.431	1			
Portugal	0.182	0.334	0.516	1		
Spain	0.088	0.774	0.397	0.319	1	
Germany	-0.194	0.068	0.039	-0.053	0.103	1

Note: Panel A of the table provides summary statistics for weekly GIIPS and German sovereign bond returns. Panel B of the table shows the correlations between the sovereign bond returns from 2001 to 2006. Panel B of the table shows the correlations between the sovereign bond returns from 2007 to 2013.

Table 2: Quantile autoregressive model estimates, bank model

	Quantile				
	5	25	50	75	95
	Contemporaneous Parameters				
GIIPS bonds to	0.078**	0.087***	0.090***	0.090***	0.082***
non-GIIPS banks (α_1)	(0.031)	(0.01)	(0.014)	(0.011)	(0.011)
German bond	-2.763***	-2.345***	-2.108***	-2.323***	-2.315***
to non-German banks (β_1)	(0.292)	(0.256)	(0.223)	(0.232)	(0.242)
Own bond effect	1.206***	0.118	0.042	-0.200	0.068
for non-GIIPS (γ_1)	(0.232)	(0.201)	(0.172)	(0.189)	(0.177)
Own bond effect	0.232	1.133***	1.077***	1.144***	0.877***
for GIIPS (τ_1)	(0.244)	(0.223)	(0.169)	(0.148)	(0.136)
autoregressive term (ν_1)	-0.016	-0.027**	-0.048***	-0.065***	-0.035**
	(0.011)	(0.011)	(0.007)	(0.016)	(0.014)
	Autoregressive Parameters				
GIIPS bonds to	3.666***	0.476**	0.473	0.539**	1.535***
non-GIIPS banks (α_2)	(0.684)	(0.146)	(0.405)	(0.165)	(0.194)
German bond	-4.685***	-3.088***	-1.892***	-2.486***	-3.643***
to non-German banks (β_2)	(0.632)	(0.886)	(1.637)	(0.796)	(0.568)
Own bond effect	-3.776***	-2.311***	-0.553	-1.401***	-3.876***
for non-GIIPS (γ_2)	(0.480)	(0.458)	(0.892)	(0.218)	(0.414)
Own bond effect	0.302	0.866	0.792	0.706	0.540
for GIIPS (τ_2)	(2.584)	(0.586)	(2.579)	(0.668)	(0.716)
Constant	-2.349***	-0.466***	0.054	0.952***	2.070***
	(0.200)	(0.111)	(0.032)	(0.099)	(0.182)

Note: The table provides regression results for the bank equation (1), the quantile vector autoregressive model. The dependent variables in these regressions are bank returns. The first column corresponds to the effect of interest. The second to the last columns correspond to a particular quantile. All regressions were under the time period from January 3, 2001-November 6, 2013, except for Greece, Ireland and Portugal. Standard errors are in parentheses, and are computed by using a sandwich formula as outlined in White et al. (2015). Significance levels are indicated by the following: *** - 1%,** - 5%, * - 10%.

Table 3: Relationship between bank stock and sovereign bond return asymmetries

Dependent Variable: Conditional bank asymmetry	(1) Baseline	(2) GIIPS
$\widehat{CA}_{t,S_j}$	-0.1029***	-0.5234***
	(0.0154)	(.0304)
$1(GIIPS)$		-0.2536***
		(.0327)
$\widehat{CA}_{t,S_j} \cdot 1(GIIPS)$		0.7417***
		(0.0496)
Constant	-0.0308***	-0.0214***
	(0.0079)	(0.0070)
R^2	0.0727	0.2999
Observations	1,404	1,404

Note: This table presents the results of a regression of the conditional asymmetry of bank returns ($\widehat{CA}_{t,B_i}$) on the conditional of sovereign bond returns of the country where the bank is headquartered ($\widehat{CA}_{t,S_j}$) and a constant. The first column (*Baseline*) corresponds to the regression in equation (5). The second column (*GIIPS*) corresponds to an augmented regression that includes an interaction between sovereign skewness and an indicator for whether the bank is in a GIIPS country. Newey-West standard errors (4 lags) in parentheses. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 4: Conditional bank stock return asymmetry and the peripheral sovereign bonds

Dependent Variable: Conditional bank asymmetry	(1) Greece	(2) Ireland	(3) Italy	(4) Portugal	(5) Spain	(6) All GIIPS	(7) PCA
$\widehat{CA}_{t,S_j}$	-0.0146	0.0195	0.0024	-0.0600***	-0.0050	-0.0400*	-0.0773***
	(0.0148)	(0.0164)	(0.0169)	(0.0206)	(0.0176)	(0.0213)	(0.0079)
$\widehat{CA}_{t,S_{GR}}$	0.0974***					0.0472**	
	(0.0167)					(0.0239)	
$\widehat{CA}_{t,S_{IE}}$		0.1095***				0.1974***	
		(0.0165)				(0.0409)	
$\widehat{CA}_{t,S_{IT}}$			0.0892***			0.4532***	
			(0.0167)			(0.0744)	
$\widehat{CA}_{t,S_{PT}}$				0.0208		-0.7834***	
				(0.0194)		(0.0567)	
$\widehat{CA}_{t,S_{ES}}$					0.0814***	0.2070**	
					(0.0173)	(0.1049)	
$\widehat{PCA}_t$							0.0240***
							(0.0028)
$\widehat{CA}_{t,S_{DE}}$	-0.6207***	-0.6249***	-0.6279***	-0.6279***	-0.6298***	-0.5102***	-0.5526***
	(0.0189)	(0.0176)	(0.0176)	(0.0167)	(0.0176)	(0.0165)	(0.0165)
Constant	-0.1190***	-0.1479***	-0.1335***	-0.0788***	-0.1273***	-0.0857***	-0.0587***
	(0.0121)	(0.0139)	(0.0142)	(0.0176)	(0.0148)	(0.0186)	(0.0045)
R^2	0.506	0.502	0.496	0.482	0.491	0.605	0.544
Obs.	1,404	1,404	1,404	1,404	1,404	1,404	1,404

Note: This table presents the results of a regression of the conditional asymmetry of bank returns ($\widehat{CA}_{t,B_i}$) on the conditional asymmetry of sovereign bond returns of the country where the bank is headquartered ($\widehat{CA}_{t,S_j}$), the conditional asymmetry of peripheral sovereign bond returns interacted with a dummy variable for a bank not being a member of that country ($k \in \{GR, IE, IT, PT, ES\}$), German sovereign bond asymmetry interacted with a dummy variable for a bank not being headquartered in Germany ($\widehat{CA}_{t,S_{DE}}$), and a constant. The first five columns correspond to each of an individual peripheral countries. The sixth column corresponds to all countries, and the seventh column corresponds to a regression where instead of including all asymmetries, we introduce the first principal component of the sovereign bond return asymmetries of the peripheral countries. Newey-West standard errors (4 lags) in parentheses. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 5: Determinants of conditional bank stock return asymmetry

Dependent Variable: Conditional bank asymmetry	(1) Baseline	(2) GIIPS
$Size$	-0.0654*	-0.1161
	(0.0350)	(0.0716)
$Size \times \cdot 1(GIIPS)$		0.0935
		(0.0964)
$Tier1$	0.0079***	0.0178***
	(0.0019)	(0.0035)
$Tier1 \times \cdot 1(GIIPS)$		-0.0143***
		(0.0042)
NPL	-0.1289**	-0.8416
	(0.0619)	(1.1906)
$NPL \times 1(GIIPS)$		0.7228
		(1.1889)
ROE	0.0001	-0.1148
	(0.0013)	(0.2743)
$ROE \times 1(GIIPS)$		0.1141
		(0.2743)
LOA	0.0279	0.0015
	(0.0640)	(0.1481)
$LOA \times 1(GIIPS)$		-0.0275
		(0.1537)
$\widehat{CA}_{t-1,S_j}$	-0.1618***	-0.1148*
	(0.0564)	(0.0626)
$\widehat{PCA}_{t-1,GIIPS}$	0.0185***	0.0236***
	(0.0028)	(0.0034)
$\widehat{CA}_{t-1,S_{DE}}$	-0.3739***	-0.3682***
	(0.0391)	(0.0363)
Bank fixed effects	Y	Y
Quarter fixed effects	Y	Y
Observations	621	621
R^2	0.3103	0.3265

Note: This table presents the results of a regression of the conditional asymmetry of bank returns at time t ($\widehat{CA}_{t,B_i}$) on bank-level variables and sovereign conditional asymmetry variables that are observed in time $t-1$. The baseline (*Baseline*) results are in the first column. The bank-level variables are asset size (*Size*), which is the logartihm of bank assets, the Tier 1 ratio (*Tier1*), the non-performing loans ratio (*NPL*), the return to equity ratio (*ROE*), and the loans-to-assets ratio (*LOA*). We also introduce the conditional asymmetry measures for own country sovereign, the first principal component for GIIPS sovereign bonds (for non peripheral countries), and the German bond skewness (for non-German countries). The second column (*GIIPS*) corresponds to an augmented regression that includes an interaction between bank-level variables and whether the bank is in a GIIPS country. Standard errors are clustered by bank and quarter. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 6: Determinants of conditional sovereign bond asymmetry

Dependent Variable: Conditional sovereign bond asymmetry	(1) Baseline	(2) GIIPS
$Debt/GDP$	-0.0002	-0.0237
	(0.0025)	(0.0159)
$Debt/GDP \times 1(GIIPS)$		0.0202
		(0.0159)
$Reserves/GDP$	0.0707*	0.0913***
	(0.0372)	(0.0142)
$Reserves/GDP \times 1(GIIPS)$		-0.2151
		(1.4614)
ΔToT	0.0073***	-0.0041
	(0.0023)	(0.0060)
$\Delta ToT \times 1(GIIPS)$		0.0130*
		(0.0070)
σ_{ToT}	-0.0171	-0.0168
	(0.0196)	(0.0330)
$\sigma_{ToT} \times 1(GIIPS)$		-0.0138
		(0.0365)
σ_{Stock}	0.4609	-0.9925***
	(0.5842)	(0.1570)
$\sigma_{Stock} \times 1(GIIPS)$		3.3543***
		(0.5808)
$\widehat{CA}_{t-1,j}$	-0.2155***	-0.1363
	(0.0626)	(0.0780)
$\widehat{CA}_{t-1,j} \times 1(GIIPS)$		-0.3790*
		(0.1777)
Country fixed effects	Y	Y
Quarter fixed effects	Y	Y
Observations	392	392
R^2	0.3769	0.5076

Note: This table presents the results of a regression of the conditional asymmetry of bond returns at time t ($\widehat{CA}_{t,S_j}$) on country-level variables observed in time $t-1$. The baseline results are in the first column (*Baseline*). The country-level variables are the debt-to-GDP ratio (*Debt/GDP*), the reserves-to-GDP ratio (*Reserves/GDP*), the change in a country's terms of trade (ΔToT), the volatility of a country's terms of trade (σ_{ToT}), stock market volatility (σ_{Stock}), and aggregate bank skewness for country j ($\widehat{CA}_{t-1,j}$). The second column (*GIIPS*) corresponds to an augmented regression that includes an interaction between country-level variables and whether the bank is in a GIIPS country. Standard errors are clustered by bank and quarter. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 7: Panel estimates that mimic the first-pass equity regressions for Eurostoxx 600 firms

Dependent Variable:	Financial firms			Non-financial firms		
Excess stock returns	Four factor	Skewness	GIIPS	Four factor	Skewness	GIIPS
Market	1.2694***	1.2386***	1.2431***	0.9627***	0.9382***	0.9578***
	(0.0569)	(0.0586)	(0.0700)	(0.0291)	(0.0293)	(0.0323)
Term spread	0.0108	0.0123*	-0.0061	0.0115***	0.0117***	0.0109***
	(0.0073)	(0.0074)	(0.0058)	(0.0025)	(0.0025)	(0.0026)
Credit spread	-0.0247	-0.0184	0.0291	-0.0181*	-0.0133	-0.0105
	(0.0208)	(0.0208)	(0.0202)	(0.0095)	(0.0097)	(0.0103)
TED spread	0.0562	0.0618*	0.0274	0.0427***	0.0466***	0.0498***
	(0.0347)	(0.0343)	(0.0362)	(0.0164)	(0.0162)	(0.0173)
Sovereign skewness		-0.0488***	-0.0956***		-0.0367***	-0.0336**
		(0.0169)	(0.0311)		(0.0106)	(0.0137)
Market x GIIPS			-0.1154			-0.1495*
			(0.1542)			(0.0765)
Term spread x GIIPS			0.0621***			-0.0008
			(0.0142)			(0.0087)
Credit spread x GIIPS			-0.1516***			-0.0196
			(0.0322)			(0.0266)
TED spread x GIIPS			0.1624**			-0.0470
			(0.0715)			(0.0476)
Sovereign skewness x GIIPS			0.0493			0.0090
			(0.0414)			(0.0276)
Constant	0.0193	0.0154	0.0033	0.0388***	0.0358***	0.0359***
	(0.0124)	(0.0123)	(0.0115)	(0.0068)	(0.0068)	(0.0067)
Firm fixed effects	Y	Y	Y	Y	Y	Y
Quarter fixed effects	Y	Y	Y	Y	Y	Y
Observations	3,564	3,564	3,564	15,474	15,474	15,474
R^2	0.3667	0.3678	0.3723	0.2636	0.2642	0.2650

Note: This table presents the results of a panel regression that is similar to the first-pass regression (9). The dependent variable is the excess return on the stocks of financial and non-financial firms in the Eurostoxx 600. The factors we consider are the market, the bond market (Term) spread, the credit market (credit) spread, the TED spread, a measure of interbank liquidity, and the estimated conditional sovereign asymmetry measure, $\widehat{CA}_{t,S_j}$. The first three columns correspond to results for financial firms, while the last three columns correspond to results for non-financial firms. For each set of firms, we estimate a four-factor model (*Four factor*), a model that augments the four factor model with the sovereign skewness measure (*Skewness*), and a model that interacts the factors with an indicator for GIIP (*GIIPS*). Standard errors are clustered by bank and quarter. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 8: Second-pass equity regressions for Eurostoxx 600 firms

Dependent Variable:	Financial firms			Non-financial firms		
Excess stock returns	Four factor	Skewness	GIIPS	Four factor	Skewness	GIIPS
Market	0.0179***	0.0141***	0.0230***	0.0419***	0.0414***	0.0420***
	(0.0037)	(0.0038)	(0.0038)	(0.0021)	(0.0022)	(0.0022)
Term spread	0.0633	0.0751*	0.0734	0.0838***	0.0658***	0.0733***
	(0.0433)	(0.0445)	(0.0449)	(0.0180)	(0.0169)	(0.0168)
Credit spread	0.0567	0.0552	-0.0422	-0.0340	-0.0230	-0.0267
	(0.0377)	(0.0392)	(0.0505)	(0.0229)	(0.0237)	(0.0243)
TED spread	0.0019	0.0232	0.0032	-0.0096	0.0039	0.0046
	(0.0233)	(0.0201)	(0.0284)	(0.0149)	(0.0156)	(0.0160)
Sovereign skewness		-0.0201***	-0.0656***		-0.0311***	-0.0336***
		(0.0039)	(0.0169)		(0.0078)	(0.0079)
GIIPS indicator			0.0318*			0.0807***
			(0.0185)			(0.0176)
Market x GIIPS			-0.0314			-0.0770***
			(0.0248)			(0.0182)
Term spread x GIIPS			0.0363			-0.1063
			(0.1624)			(0.1480)
Credit spread x GIIPS			0.3602***			0.2436**
			(0.1028)			(0.1124)
TED spread x GIIPS			0.0090			0.0324
			(0.0699)			(0.0623)
Sovereign skewness x GIIPS			0.0486**			0.0668
			(0.0206)			(0.0590)
Observations	94	94	94	398	398	398
R^2	0.3366	0.3746	0.5698	0.5128	0.5164	0.5425

Note: This table presents the results of the second-pass regression (10). The dependent variable is the excess return on the stocks of financial and non-financial firms in the Eurostoxx 600. The factors we consider are the market, the bond market (Term) spread, the credit market (credit) spread, the TED spread, a measure of interbank liquidity, and the estimated conditional sovereign asymmetry measure, $\widehat{CA}_{t,S_j}$. The first three columns correspond to results for financial firms, while the last three columns correspond to results for non-financial firms. For each set of firms, we estimate a four-factor model (*Four factor*), a model that augments the four factor model with the sovereign skewness measure (*Skewness*), and a model that interacts the factors with an indicator for GIIP (*GIIPS*). Standard errors are corrected for potential correlation across firms. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Supplemental Material to "Conditional asymmetries in the sovereign-bank nexus" (for online publication)

The Supplementary Material consists of four sections. In Section S1, we describe the variables and the data sources for the paper. Section S2 provides additional summary statistics. We provide full details of the estimation procedure in section S3 of the Supplementary Material. Section S4 provides additional results of the paper.

S1 Variables and data sources

Table S1 provides a list of banks that are included in the dataset. The banks are classified according to the country of its headquarters. We also include the identifier in Datastream for each of the banks in the sample. Table S2, meanwhile, provides a short description of the variables used in sections and of the paper, along with their corresponding sources.

Table S1: List of Banks

Bank	**Identifier**	**Country**
Erste Group Bank A.G.	ERS	Austria
KBC Group N.V.	KB	Belgium
Danske Bank	DAB	Denmark
BNP Paribas	BNP	France
Societe Generale	SGE	France
Deustche Bank A.G.	DBK	Germany
Commerzbank A.G.	CBK	Germany
National Bank of Greece	ETE	Greece
Alpha Bank	PIST	Greece
Piraeus Bank Group	PEIR	Greece
Allied Irish Banks plc	ALBK	Ireland
Bank of Ireland	BKIR	Ireland
Intesa Sanpaolo S.p.A	ISP	Italy
Unicredit S.p.A	UCG	Italy
ING Bank N.V.	ING	Netherlands
Banco Comercial Portugues, S.A.	BCG	Portugal
Banco Santander S.A.	SCH	Spain
Banco Bilbao Vizcaya Argentaria S.A.	BBVA	Spain
Nordea Bank A.B.	NDA	Sweden
Skandinaviska Enskilda Banken A.B.	SEA	Sweden
Svenska Handelsbanken A.B.	SVK	Sweden
Swedbank A.B.	SWED	Sweden
Credit Suisse Group A.G.	CS	Switzerland
UBS A.G.	UBS	Switzerland
Royal Bank of Scotland Group plc	RBS	United Kingdom
HSBC Holdings plc	HSBC	United Kingdom
Barclays plc	BARC	United Kingdom

Table S2: Macroeconomic and financial variables

Variable	Definition	Source
A. Financial variables		
Size	Logarithm of bank's total assets	SNL
Tier 1 ratio	ratio of Tier 1 assets to total assets	SNL
Non-performing loans ratio	ratio of non-performing loans to total loans outstanding	SNL
Loans-to-assets ratio	ratio of total loans to total assets	SNL
Return on equity	ratio of net income to total shareholder's equity	SNL
B. Macroeconomic variables		
Debt-to-GDP ratio	ratio of total government debt to GDP	Eurostat
Terms of trade	ratio of total exports over total imports	OECD
Percentage change in terms of trade	5 year percentage change in terms of trade	
Standard deviation of terms of trade	18 month rolling window standard deviation of the percentage change in terms of trade	
Reserves-to-GDP ratio	ratio of Euro-denominated exchange rate reserves to GDP	OECD
Stock market volatility	18 month rolling window standard deviation of the volatility of the national stock exchange index	Datastream
C. Factors		
Market	difference between the Eurostoxx and the overnight interest rate	Datastream
Term spread	difference between the 10-year and 2-year Treasury rates of each country	Datastream
Credit spread	difference between 10-year A rated Eurozone corporate bonds and the 10-year German sovereign bond yields	Datastream
TED spread	difference between the 3-month Euribor and the 3-month Euro overnight interest rate swap	Datastream

S2 Additional summary statistics

The following tables in this section provide additional summary statistics for the variables used in the empirical analysis of the paper.

The first two tables, Tables S3 and S4, provide the summary statistics of the sovereign bond returns of all of the countries represented in the sample, divided into the pre-crisis period and the post-crisis period. The next two tables, Tables S5 and S6, present the correlations of sovereign bond returns for both periods. As can be observed, while there was a high correlation between the sovereign bond returns in the sample prior to the crisis, these correlations went down, especially for the peripheral sovereign bonds. Tables S7 and S8 present the summary statistics of bank returns in the sample, which are identified via their Datastream codes.

Table S3: Summary statistics of sovereign bond returns, 2001-2006

	Mean	Std. Dev.	Minimum	25th	50th	75th	Maximum
Austria	0.0042	0.1419	-0.5566	-0.0803	0.0217	0.1030	0.3138
Belgium	0.0049	0.1386	-0.5352	-0.0802	0.0221	0.0999	0.3272
Denmark	0.0043	0.1381	-0.5138	-0.0881	0.0145	0.1019	0.3198
France	0.0035	0.1391	-0.4775	-0.0821	0.0169	0.1013	0.2945
Germany	0.0032	0.1364	-0.4820	-0.0792	0.0163	0.1009	0.2996
Netherlands	0.0034	0.1371	-0.5181	-0.0762	0.0194	0.0982	0.3000
Sweden	0.0017	0.1452	-0.4487	-0.0976	0.0234	0.1073	0.3208
Switzerland	0.0052	0.1357	-0.6906	-0.0584	0.0091	0.0876	0.4297
UK	-0.0014	0.1475	-0.5490	-0.0996	0.0103	0.0955	0.3584
Greece	0.0063	0.1328	-0.4871	-0.0760	0.0200	0.0938	0.3377
Ireland	0.0040	0.1387	-0.5026	-0.0774	0.0193	0.1046	0.2858
Italy	0.0045	0.1317	-0.4960	-0.0831	0.0203	0.0947	0.3186
Portugal	0.0033	0.1392	-0.5098	-0.0869	0.0162	0.1026	0.3081
Spain	0.0049	0.1364	-0.4973	-0.0783	0.0198	0.1039	0.3002

Table S4: Summary statistics of sovereign bond returns, 2007-2013

	Mean	Std. Dev.	Minimum	25th	50th	75th	Maximum
Austria	0.0103	0.2060	-0.8398	-0.1054	0.0098	0.1260	0.9269
Belgium	0.0065	0.2436	-1.6332	-0.0944	0.0087	0.1171	1.8651
Denmark	0.0123	0.1963	-0.5587	-0.1047	0.0196	0.1328	0.5986
France	0.0073	0.1972	-0.7768	-0.1133	0.0051	0.1183	0.7932
Germany	0.0121	0.1960	-0.5512	-0.1202	0.0206	0.1375	0.5836
Netherlands	0.0100	0.1914	-0.6318	-0.1112	0.0159	0.1301	0.6242
Sweden	0.0093	0.1938	-0.5798	-0.1111	-0.0016	0.1224	0.6422
Switzerland	0.0076	0.1417	-0.5091	-0.0755	0.0084	0.0828	0.5808
UK	0.0123	0.2065	-0.8043	-0.1162	0.0164	0.1533	0.8841
Greece	-0.0119	2.3216	-8.6846	-0.3409	-0.0204	0.2322	38.5690
Ireland	0.0009	0.4274	-2.2738	-0.1522	0.0173	0.1796	2.3490
Italy	0.0012	0.2589	-1.0094	-0.1257	-0.0051	0.1201	1.6253
Portugal	-0.0068	0.5383	-2.7832	-0.2178	-0.0100	0.1509	2.2350
Spain	-0.0019	0.3003	-1.0322	-0.1550	-0.0017	0.1333	1.9500

Table S5: Correlation matrix, sovereign bond returns, 2001-2006

	AT	BE	DK	FR	DE	NL	SW	CH	UK	GR	IE	IT	PT	ES
AT	1.00													
BE	0.98	1.00												
DK	0.86	0.87	1.00											
FR	0.98	0.99	0.87	1.00										
DE	0.98	0.99	0.88	0.99	1.00									
NL	0.98	0.99	0.87	0.99	0.99	1.00								
SW	0.89	0.90	0.85	0.90	0.90	0.89	1.00							
CH	0.69	0.70	0.70	0.70	0.71	0.70	0.68	1.00						
UK	0.86	0.86	0.76	0.87	0.87	0.87	0.80	0.67	1.00					
GR	0.97	0.98	0.87	0.98	0.98	0.98	0.88	0.70	0.85	1.00				
IE	0.96	0.98	0.84	0.98	0.97	0.97	0.90	0.68	0.86	0.96	1.00			
IT	0.95	0.96	0.88	0.96	0.96	0.96	0.86	0.69	0.82	0.97	0.94	1.00		
PT	0.98	0.98	0.86	0.98	0.97	0.98	0.88	0.69	0.85	0.97	0.95	0.95	1.00	
ES	0.98	0.98	0.86	0.98	0.98	0.98	0.89	0.71	0.87	0.98	0.96	0.95	0.98	1.00

Table S6: Correlations between sovereign bond returns, 2007-2013

	AT	BE	DK	FR	DE	NL	SW	CH	UK	GR	IE	IT	PT	ES
AT	1.00													
BE	0.79	1.00												
DK	0.65	0.45	1.00											
FR	0.89	0.78	0.66	1.00										
DE	0.77	0.53	0.84	0.76	1.00									
NL	0.84	0.65	0.81	0.84	0.91	1.00								
SW	0.62	0.40	0.74	0.63	0.83	0.77	1.00							
CH	0.56	0.37	0.62	0.57	0.68	0.67	0.67	1.00						
UK	0.62	0.43	0.69	0.63	0.81	0.77	0.73	0.62	1.00					
GR	-0.03	0.09	-0.17	-0.03	-0.18	-0.15	-0.20	-0.17	-0.17	1.00				
IE	0.24	0.38	0.03	0.22	0.07	0.15	0.01	0.09	0.08	0.17	1.00			
IT	0.41	0.60	0.04	0.46	0.11	0.23	0.08	0.12	0.14	0.13	0.44	1.00		
PT	0.10	0.15	-0.05	0.09	-0.03	0.03	-0.02	0.05	0.02	0.18	0.52	0.34	1.00	
ES	0.39	0.51	0.09	0.38	0.14	0.22	0.09	0.13	0.18	0.09	0.41	0.78	0.33	1.00

Table S7: Summary statistics of bank returns, 2001-2006

	Mean	Std. Dev.	Minimum	25th	50th	75th	Maximum
ERS	0.053	1.285	-13.313	-0.351	0.106	0.549	7.44
KBS	0.02	0.949	-6.027	-0.397	-0.001	0.46	6.429
DAB	0.023	0.843	-6.472	-0.283	0.097	0.408	4.053
BNP	0.019	1.124	-7.668	-0.45	-0.002	0.512	5.428
SGE	0.031	1.131	-5.562	-0.495	-0.001	0.521	7.149
DBK	-0.004	1.084	-3.878	-0.54	-0.001	0.548	5.987
CBK	-0.021	1.463	-7.186	-0.636	-0.009	0.662	7.228
ING	-0.025	1.299	-7.356	-0.546	0.1	0.625	4.89
NDA	0.002	0.864	-3.221	-0.416	0.016	0.522	3.414
SEA	0.031	0.953	-4.755	-0.352	0.054	0.513	3.582
SVK	0.013	0.718	-3.162	-0.349	0.055	0.376	3.432
SWED	0.01	0.74	-4.47	-0.344	0.065	0.428	2.395
UBS	0.043	1.132	-7.534	-0.378	0.053	0.461	4.172
CS	-0.035	1.397	-6.832	-0.62	0.046	0.612	4.835
RBS	0.027	1.052	-7.011	-0.385	0.032	0.474	5.662
HSBC	0.02	0.854	-4.053	-0.352	0.021	0.396	5.001
BARC	0.058	1.122	-3.952	-0.482	0.035	0.539	9.834
ETE	-0.055	1.385	-14.929	-0.618	-0.006	0.721	3.26
PIST	-0.038	1.876	-25.937	-0.58	-0.002	0.615	12.135
PEIR	0.002	1.278	-9.19	-0.415	0.084	0.491	3.4
ALBK	0.02	0.953	-6.822	-0.307	-0.001	0.417	4.194
BKIR	0.034	0.858	-5.607	-0.349	0.079	0.512	3.272
ISP	-0.041	1.12	-5.633	-0.506	-0.002	0.512	3.783
UCG	0.015	1.416	-13.911	-0.341	0	0.391	15.034
BCP	-0.057	0.908	-4.772	-0.425	-0.002	0.335	6.342
SCH	0.001	1.2	-7.64	-0.4	-0.001	0.491	7.648
BBVA	0.002	1.052	-4.787	-0.349	-0.001	0.497	6.027

Table S8: Summary statistics of bank returns, 2007-2013

	Mean	Std. Dev.	Minimum	25th	50th	75th	Maximum
ERS	-0.111	1.752	-10.356	-0.828	-0.011	0.777	5.554
KBS	-0.157	2.421	-23.506	-0.909	-0.052	0.871	11.992
DAB	-0.06	1.284	-6.626	-0.535	-0.005	0.595	5.63
BNP	-0.075	1.353	-6.001	-0.748	-0.013	0.713	3.794
SGE	-0.117	1.701	-6.388	-0.945	-0.042	0.764	5.382
DBK	-0.087	1.644	-11.299	-0.706	-0.038	0.626	9.478
CBK	-0.203	2.058	-9.326	-1.038	-0.049	0.714	18.349
ING	-0.149	1.917	-10.74	-0.982	-0.022	0.796	9.607
NDA	-0.029	1.082	-6.141	-0.517	0.01	0.551	4.011
SEA	-0.063	1.452	-8.315	-0.595	-0.006	0.625	6.742
SVK	-0.02	0.89	-3.962	-0.447	0.032	0.461	3.786
SWED	-0.05	1.415	-7.579	-0.676	0.011	0.676	5.8
UBS	-0.167	1.697	-6.828	-0.893	-0.145	0.644	7.868
CS	-0.15	1.68	-12.336	-0.961	-0.032	0.639	6.912
RBS	-0.223	3.401	-42.241	-1.098	-0.052	0.773	15.391
HSBC	-0.011	1.079	-5.36	-0.483	-0.012	0.514	7.069
BARC	-0.134	2.039	-15.848	-0.936	-0.021	0.879	7.965
ETE	-0.257	3.125	-22.542	-1.397	-0.067	0.797	31.668
PIST	-0.058	3.539	-7.947	-1.414	-0.145	0.916	46.829
PEIR	-0.253	3.418	-20.702	-1.614	-0.182	0.769	37.769
ALBK	-0.445	4.105	-37.333	-1.783	-0.369	0.845	26.36
BKIR	-0.354	3.61	-26.571	-1.63	-0.212	0.958	20.381
ISP	-0.109	1.785	-14.313	-0.763	-0.027	0.702	13.147
UCG	-0.148	1.584	-6.259	-0.947	-0.026	0.738	5.151
BCP	-0.134	1.68	-6.649	-0.93	-0.04	0.719	11.628
SCH	-0.06	1.214	-6.643	-0.698	-0.003	0.633	3.514
BBVA	-0.071	1.254	-6.34	-0.749	-0.008	0.623	3.596

S3 Estimation of the quantile vector autoregressive model

To simplify the discussion, we focus on the contemporaneous matrices, as the autoregressive matrices have a similar parametrisation. We can write the matrices in (1) and (2) as $\mathbf{A_{bb}} = \nu \mathbf{I_n}$, $\mathbf{A_{bs}} = \alpha \mathbf{A_{11}} + \beta \mathbf{A_{21}} + \gamma \mathbf{A_{31}} + \tau \mathbf{A_{41}}$, $\mathbf{A_{sb}} = \kappa \mathbf{A_{12}} + \pi \mathbf{A_{22}} + \eta \mathbf{A_{32}} + \omega \mathbf{A_{42}}$, and $\mathbf{A_{ss}} = \phi \mathbf{I_m} + \psi \mathbf{A_{52}}$. These expressions are based on auxiliary matrices, which are defined as follows:

1. GIIPS sovereign bond effect on non-GIIPS banks' returns: $\mathbf{A_{11}}$ is an $n \times m$ matrix such that $\mathbf{A_{11}}(i, j) = 1$ if country (bank i) $\notin$ GIIPS but country $j \in$ GIIPS, and zero otherwise.

2. German sovereign bond effect on non-German banks' returns: $\mathbf{A_{21}}$ is an $n \times m$ matrix such that $\mathbf{A_{21}}(i, j) = 1$ if country (bank i) $\notin$ DE but country $j =$ DE, and zero otherwise.

3. Own country effect on banks' returns for non-GIIPS countries: $\mathbf{A_{31}}$ is an $n \times m$ matrix such that $\mathbf{A_{31}}(i, j) = 1$ if country (bank i) = country j, and country $j \notin$ GIIPS, and zero otherwise.

4. Own country effect on banks' returns for GIIPS countries: $\mathbf{A_{41}}$ is an $n \times m$ matrix such that $\mathbf{A_{41}}(i, j) = 1$ if country (bank i) = country j, and country $j \in$ GIIPS, and zero otherwise.

5. Own bank effect on sovereign bond returns for non-GIIPS countries: $\mathbf{A_{12}}$ is an $m \times n$ matrix such that $\mathbf{A_{12}}(i, j) = 1$ if country i = country (bank j), and country $j \notin$ GIIPS, and zero otherwise.

6. Own bank effect on sovereign bond returns for GIIPS countries: $\mathbf{A_{22}}$ is an $m \times n$ matrix such that $\mathbf{A_{22}}(i, j) = 1$ if country i = country (bank j), and country $j \in$ GIIPS, and zero otherwise.

7. GIIPS banks effect on non-GIIPS sovereign bond returns: $\mathbf{A_{32}}$ is an $m \times n$ matrix

such that $\mathbf{A_{32}}(i,j) = 1$ if country $i \notin$ GIIPS, but country (bank j) $\in$ GIIPS, and zero otherwise.

8. German bank effect on non-German sovereign bond returns: $\mathbf{A_{42}}$ is an $m \times n$ matrix such that $\mathbf{A_{42}}(i,j) = 1$ if country $i \notin$ GIIPS, but country (bank j) = DE, and zero otherwise.

9. GIIPS sovereign effect on non-GIIPS sovereign bond returns: $\mathbf{A_{52}}$ is an $m \times m$ matrix such that $\mathbf{A_{52}}(i,j) = 1$ if country $i \notin$ GIIPS, but country $j \in$ GIIPS, and zero otherwise.

Hence, we can rewrite (1) and (2), respectively, as:

$$\begin{aligned}\mathbf{q_{bt}}(\theta) = \mathbf{c_b} + \nu\mathbf{y_{bt-1}} + \alpha_1\mathbf{A_{11}}\mathbf{y_{st}} + \beta_1\mathbf{A_{21}}\mathbf{y_{st}} + \gamma_1\mathbf{A_{31}}\mathbf{y_{st}} + \tau_1\mathbf{A_{41}}\mathbf{y_{st}} + \\ +\alpha_2\mathbf{A_{11}}\mathbf{q_{st-1}}(\theta) + \beta_2\mathbf{A_{21}}\mathbf{q_{st-1}}(\theta) + \gamma_2\mathbf{A_{31}}\mathbf{q_{st-1}}(\theta) + \tau_2\mathbf{A_{41}}\mathbf{q_{st-1}}(\theta),\end{aligned} \tag{S1}$$

and

$$\begin{aligned}\mathbf{q_{st}}(\theta) = \mathbf{c_s} + \phi\mathbf{y_{st-1}} + \kappa_1\mathbf{A_{12}}\mathbf{y_{bt}} + \pi_2\mathbf{A_{22}}\mathbf{y_{bt}} + \eta_1\mathbf{A_{32}}\mathbf{y_{bt}} + \omega_1\mathbf{A_{42}}\mathbf{y_{bt}} + \psi_1\mathbf{A_{52}}\mathbf{y_{st}} + \\ \kappa_2\mathbf{A_{12}}\mathbf{q_{bt-1}} + \pi_2\mathbf{A_{22}}\mathbf{q_{bt-1}} + \eta_2\mathbf{A_{32}}\mathbf{q_{bt-1}} + \omega_2\mathbf{A_{42}}\mathbf{q_{bt-1}} + \psi_2\mathbf{A_{52}}\mathbf{q_{bt-1}}.\end{aligned} \tag{S2}$$

Stationarity condition. Notice that in this model, the presence of the autoregressive terms requires that we impose a condition to insure stationarity of the conditional distributions implied by the quantile regression. To show how to do this, let us rewrite the conditional quantile model:

$$\mathbf{q_t}(\theta) = \mathbf{c}(\theta) + \mathbf{A}(\theta)\mathbf{y_t} + \mathbf{B}(\theta)\mathbf{q_{t-1}}(\theta) \tag{S3}$$

It is easy to notice that we can rewrite equation (S3) as:

$$(1 - \mathbf{B}(\theta)L)\mathbf{q_t}(\theta) = \mathbf{c}(\theta) + \mathbf{A}(\theta)\mathbf{y_t} \tag{S4}$$

where L is the lagged operator. An implication of this is that we need to impose restrictions as to the parameter values that $\mathbf{B}(\theta)$ could take in order for $q_t(\theta)$ not to become explosive. Hence, we impose the following condition: $\max(|\mathbf{eig}(\mathbf{B}(\theta))|) < 1$.

Estimation. As in most quantile regression procedures, we solve the following optimisation problem:

$$\min_{\boldsymbol{\alpha}} S_T(\boldsymbol{\alpha}) := T^{-1}\sum_{t=1}^{T}\left\{\sum_{i=1}^{n}\rho_{\theta_{i,t}}(y_{it} - q_{i,t}(\boldsymbol{\alpha}))\right\} \tag{S5}$$

where $\boldsymbol{\alpha}$ is the vector of parameters we are estimating, $\rho_\theta(e) = e\psi_\theta(e)$ is the standard check function, defined through the quantile step function, $\psi_\theta(e) = \theta - 1_{[e\leq 0]}$. Under suitable regularity assumptions, White et al. (2015) shows that the solution to this problem is consistent and asymptotically normal. White et al. (2015) minimise (S5) from 40 different initial parameter values using a search method based on the simplex algorithm. However, due to the dimensions of the problem we are estimating, the simplex method may yield local minima. Moreover, as Koenker (2005) notes, in large sample sizes interior-point methods are more appropriate and more efficient to find the optimal parameter estimates. In this regard, we perform the following two-step algorithm:

1. In the first step, using an initial guess, we minimise optimisation problem (S5) with a smoothed approximation to the step function, $\psi_\theta(e)$:

$$H(x) = \theta - \left(\frac{1}{2} + \frac{1}{2}\tanh(kx)\right), \tag{S6}$$

   where k is a smoothing parameter, which we set as $k = 1000$. Another paper that used smoothed approximations to the quantile objective function is Gosling et al. (2000), who works with a smoothed linear absolute deviations estimator proposed by Horowitz (1998).

2. In the second step, we use the parameter estimates obtained in the previous step as an initial guess, and solve the optimisation problem (S5) using the non-smoothed step function $\psi_\theta(e)$.

We then take as the optimal parameter estimate the vector of parameters that yielded the smallest objective function value.

S4 Additional results

In this section, we provide some additional results.

S4.1 Bond quantile model

The first result we show is the estimation result of the bond equation of the conditional quantile model, equation (2), Table S9. As can be seen, our estimation results show that the transmission of risk from banks to bonds was not as strong. This highlights the fact that the transmission of risk mainly comes from the deterioration of sovereign bond returns.

S4.2 Asymmetry and volatility

In this subsection, we investigate the relationship between conditional bank return asymmetry and volatility. That is, is it the case that there is more negative skewness in periods of high volatility? In this regard, we estimate:

$$\widehat{CA}_{t,B_i} = \alpha_i + \beta \widehat{Vol}_{t,B_i} + \varepsilon_{t,B_i} \tag{S7}$$

where $\widehat{Vol}_{t,B_i}$ is constructed using the interquartile range, which is defined as the difference between the 25th and the 75th conditional quantile functions of the estimated model (1) for bank returns.[1] Though there are several measures of conditional volatility that are extant in the literature, we prefer to utilise a measure that contains the same information set as those of the conditional asymmetry of bank returns.

Table S10 presents the results of the regression. The results in the first column indicate that there is a negative relationship between skewness and volatility, which is consistent with the leverage effect results from the asymmetric GARCH literature. To determine if there are differences between banks headquartered in GIIPS countries, we augment the empirical model with an interaction between whether a bank is headquartered in a GIIPS country, and the corresponding conditional volatility measure. Overall, the relationship between $\widehat{CA}_{t,B_i}$ and $\widehat{Vol}_{t,B_i}$ remains negative and significant. However, the combined impact of the GIIPS dummy and the coefficient on $\widehat{Vol}_{t,B_i}$ for GIIPS shows that banks from the countries more affected by the European sovereign crisis generate equity returns with more negative asymmetry, similar to the penalisation found in Table 3 of the main text.

[1] We have estimated the same regression with alternative estimates of volatility computed from an estimated GARCH(1,1) model for each of the banks in the sample. The results are similar to what we show here. Results are available upon request.

S4.3 Alternative pricing factors

In Tables S11 and S12, we consider the Europe-wide Fama-French factors as an alternative pricing model for the two-pass regressions we estimate in section 5 of the paper. In particular, we consider the market, size, value and momentum factors, which we download from Ken French's website. This is because of the high integration between the European stock markets, as Andrade and Chhaochharia (2018) note. As these factors are U.S. dollar denominated, we use dollar-euro exchange rate data from the Pacific Exchange Rate Database to express the factor returns in euros.

We begin with looking at the results of the first-pass regressions in Table S11. The results of the estimations show that both financial and non-financial firms load positively on the excess market return and on the value factor, while they load negatively on the momentum factor. We also observe that both financial and non-financial firms load negatively on conditional sovereign skewness, confirming the results that are in section 5 of the paper. The second-pass regressions, which are in Table S12, indicate that indeed, negative sovereign conditional asymmetry is priced.

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Table S9: Quantile autoregressive model estimates, bond model

	Quantile				
	5	25	50	75	95
	Contemporaneous Parameters				
GIIPS on other	0.001	0.001	0.003	-0.002	0.001
sovereigns	(0.006)	(0.009)	(0.013)	(0.012)	(0.013)
Own bank effect	-0.002	-0.002	-0.011	-0.002	0.001
for non-GIIPS	(0.004)	(0.006)	(0.007)	(0.007)	(0.008)
Own bank effect	0.000	0.000	0.000	0.000	0.000
for GIIPS	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)
German bank on	0.002	0.001	-0.008	-0.005	-0.005
non-German bond	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)
GIIPS bank on	0.000	0.000	0.000	0.000	0.000
non-GIIPS bond	(0.001)	(0.001)	(0.001)	(0)	(0.001)
autoregressive term	-0.016	-0.027	-0.048	-0.065	-0.035
	(0.011)	(0.011)	(0.007)	(0.016)	(0.014)
	Autoregressive Parameters				
GIIPS on other	-0.054	0.004	0.056	-0.028	-0.021
sovereigns	(0.22)	(0.071)	(0.185)	(0.081)	(0.102)
Own bank effect	0.001	0.001	-0.014	0.008	0.000
for non-GIIPS	(0.009)	(0.016)	(0.027)	(0.026)	(0.011)
Own bank effect	-0.001	0.002	-0.006	0.005	0.000
for GIIPS	(0.028)	(0.026)	(0.046)	(0.021)	(0.02)
German bank on	0.001	0.002	0.006	0.006	0.001
non-German bond	(0.01)	(0.029)	(0.072)	(0.022)	(0.01)
GIIPS bank on	0.001	-0.001	0.001	0.002	0.001
non-GIIPS bond	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
constant	0.000	0.001	0.009	-0.011	0.002
	(0.083)	(0.098)	(0.033)	(0.058)	(0.076)

Note: The table provides regression results for the bond equation (2) in the quantile vector autoregressive model. The dependent variables in these regressions are bond returns. The first column corresponds to the effect of interest. The second to the last columns correspond to a particular quantile. All regressions were under the time period from January 3, 2001-November 6, 2013, except for Greece, Ireland and Portugal. Standard errors are in parentheses, and are computed by using a sandwich formula as outlined in White et al. (2015). Significance levels are indicated by the following: *** - 1%,** - 5%, * - 10%.

Table S10: Conditional asymmetry and volatility of bank stock returns

Dependent Variable:	(1)	(2)
Conditional bank asymmetry	Baseline	GIIPS
$\widehat{Vol}_{t,B_i}$	-0.0675***	-0.0768***
	(0.0040)	(0.0033)
$1(GIIPS)$		-0.2001***
		(0.0446)
$\widehat{Vol}_{t,B_i} \cdot 1(GIIPS)$		0.0288***
		(0.0081)
Constant	0.3066***	0.3718***
	(0.0215)	(0.0172)
R^2	0.507	0.545
Observations	1,404	1,404

Note: This table presents the results of a regression of the conditional asymmetry of bank returns ($\widehat{CA}_{t,B_i}$) on volatility of the bank ($\widehat{Vol}_{t,B_i}$), computed as the difference between the conditional 75th ($\widehat{q}_{t,B_i}(0.75)$) and 25th quantiles ($\widehat{q}_{t,B_i}(0.25)$) of the bank's return. The first column presents the baseline results (*Baseline*). The second column (*GIIPS*) corresponds to an augmented regression that includes an interaction between bank conditional volatility and whether the bank is in a GIIPS country. Newey-West standard errors (4 lags) in parentheses. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table S11: Panel estimates that mimic first-pass equity regressions for Eurostoxx 600 firms, European Fama-French factors

Dependent Variable:	Financial firms			Non-financial firms		
Excess stock returns	Four factor	Skewness	GIIPS	Four factor	Skewness	GIIPS
Market	1.1782***	1.1311***	1.1144***	0.9999***	0.9781***	0.9979***
	(0.0444)	(0.0478)	(0.0586)	(0.0276)	(0.0283)	(0.0312)
SMB	0.0514**	0.0535**	0.0692**	0.0076**	0.0082***	0.0107***
	(0.0253)	(0.0251)	(0.0303)	(0.0031)	(0.0031)	(0.0032)
HML	0.0516**	0.0476*	0.0329	0.0063	0.0041	0.0071
	(0.0253)	(0.0249)	(0.0285)	(0.0042)	(0.0043)	(0.0044)
Momentum	-0.1494***	-0.1555***	-0.1557***	0.0143***	0.0139***	0.0143***
	(0.0175)	(0.0174)	(0.0185)	(0.0031)	(0.0030)	(0.0033)
Sovereign skewness		-0.0585***	-0.0882***		-0.0263***	-0.0201*
		(0.0148)	(0.0208)		(0.0094)	(0.0112)
Market x GIIPS			-0.0121			-0.1488**
			(0.1082)			(0.0740)
SMB x GIIPS			-0.0910**			-0.0252***
			(0.0413)			(0.0096)
HML x GIIPS			0.0673			-0.0265
			(0.0524)			(0.0165)
Momentum x GIIPS			-0.0062			-0.0035
			(0.0515)			(0.0079)
Sovereign skewness x GIIPS			0.0757***			-0.0082
			(0.0258)			(0.0211)
Constant	0.0385***	0.0499***	0.0508***	0.0373***	0.0411***	0.0405***
	(0.0047)	(0.0056)	(0.0060)	(0.0020)	(0.0024)	(0.0024)
Observations	4,469	4,469	4,469	19,299	19,299	19,299
R-squared	0.4061	0.4082	0.4095	0.2774	0.2778	0.2786

Note: This table presents the results of a panel regression that is similar to the first-pass regression (9). The dependent variable is the excess return on the stocks of financial and non-financial firms in the Eurostoxx 600. The factors we consider are the Europe-wide market, size, value and momentum factors, and the estimated conditional sovereign asymmetry measure, $\widehat{CA}_{t,S_j}$. The first three columns correspond to results for financial firms, while the last three columns correspond to results for non-financial firms. For each set of firms, we estimate a four-factor model (*Four factor*), a model that augments the four factor model with the sovereign skewness measure (*Skewness*), and a model that interacts the factors with an indicator for GIIP (*GIIPS*). Standard errors are clustered by bank and quarter. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table S12: Second pass equity regressions for Eurostoxx 600 firms, European Fama-French factors

Dependent Variable:	Financial firms			Non-financial firms		
Excess stock returns	Four factor	Skewness	GIIPS	Four factor	Skewness	GIIPS
Market	0.0239***	0.0176***	0.0216***	0.0393***	0.0379***	0.0375***
	(0.0044)	(0.0039)	(0.0042)	(0.0023)	(0.0024)	(0.0024)
SMB	-0.0227	0.0823	0.0231	-0.0059	-0.0020	0.0040
	(0.0741)	(0.0622)	(0.0846)	(0.0062)	(0.0069)	(0.0070)
HML	-0.0511	-0.0192	0.0014	-0.0074	-0.0023	-0.0042
	(0.0661)	(0.0541)	(0.0609)	(0.0086)	(0.0089)	(0.0092)
Momentum	-0.1765***	0.0327	-0.0314	-0.0153	-0.0173	-0.0258**
	(0.0601)	(0.0592)	(0.0972)	(0.0111)	(0.0115)	(0.0117)
Sovereign skewness		-0.0847***	-0.1087***		-0.0393***	-0.0382***
		(0.0119)	(0.0215)		(0.0094)	(0.0097)
GIIPS			0.0382			0.0422**
			(0.0394)			(0.0199)
Market x GIIPS			-0.0592			-0.0371*
			(0.0371)			(0.0221)
SMB x GIIPS			-0.1329			-0.0334
			(0.2157)			(0.0474)
HML x GIIPS			0.1518			-0.0316
			(0.1756)			(0.0399)
Momentum x GIIPS			0.0362			0.0624
			(0.1599)			(0.0548)
Sovereign skewness x GIIPS			0.0467			0.0044
			(0.0306)			(0.0405)
Observations	94	94	94	398	398	398
R-squared	0.3364	0.5185	0.5729	0.5106	0.5163	0.5210

Note: This table presents the results of the second-pass regression (10). The dependent variable is the excess return on the stocks of financial and non-financial firms in the Eurostoxx 600. The factors we consider are the Europe-wide market, size, value and momentum factors, and the estimated conditional sovereign asymmetry measure, $\widehat{CA}_{t,S_j}$. The first three columns correspond to results for financial firms, while the last three columns correspond to results for non-financial firms. For each set of firms, we estimate a four-factor model (*Four factor*), a model that augments the four factor model with the sovereign skewness measure (*Skewness*), and a model that interacts the factors with an indicator for GIIP (*GIIPS*). Standard errors are corrected for potential correlation across firms. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.