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Karan Bhanot
College of Business
University of Texas at San Antonio

Natasha Burns
College of Business
University of Texas at San Antonio

Delroy Hunter
College of Business
University of South Florida

Michael Williams
College of Business
University of Texas at San Antonio

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News Spillovers from the Greek Debt Crisis: Impact on the Eurozone Financial Sector*

by

Karan Bhanot[1], Natasha Burns[1], Delroy Hunter[2], and Michael Williams[1]

Abstract

We analyze the relationship between sovereign yield spreads of Greece and "abnormal" returns on financial sector stocks of Portugal, Italy, Greece, and Spain during the Greek debt crisis. We find evidence of spillovers—i.e., news announcements (rating downgrades and other news) about Greece lead to negative and significant abnormal returns on financial stocks of Portugal, Italy, and Spain. We do not find evidence of spillovers for financial firms from other European countries: Austria, Belgium, France, and the Netherlands. The spillover effect is magnified for those countries with higher yield spreads. Collectively, our results point to the role of information (news announcements) as a transmission channel in the crisis period.

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* [1]One UTSA Circle, College of Business, The University of Texas at San Antonio, 78249. Emails: karan.bhanot@utsa.edu, natasha.burns@utsa.edu and michael.williams@utsa.edu, Ph: 210-458-6315. [2] Department of Finance, College of Business, University of South Florida, Tampa, FL. Email: dhunter2@usf.edu, Tel: 813-974-6319. We thank Warren Bailey, Paul Irvine, Andrew Karolyi, and seminar participants at FMA 2011 and European FMA 2012 for helpful comments.

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Abstract

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News Spillovers from the Greek Debt Crisis: Impact on the Eurozone Financial Sector

1. Introduction

The financial press provided extensive coverage about the increase in yield spreads of Greek sovereign bonds relative to German sovereign bonds during the latter part of 2009 (Figure 1). This chain of events was dubbed "the Greek debt crisis". The crisis started when the Greek government announced that its debt service relative to receipts was much larger than previously acknowledged. Eurozone policymakers and multilateral organizations raised concerns that the Greek debt crisis could spread and impact Portugal, Italy, and Spain, countries viewed by many to have similar underlying weaknesses as Greece.[1] The crisis also focused attention of the rating agencies who responded by adjusting their credit ratings for Greece and other countries, while multilateral organizations, such as the International Monetary Fund, urged Eurozone member nations to take collective action. The link between the outcome in Greece and the possible impairment of the assets of Europe's largest banks due to their investment in Greek sovereign bonds was at the fore in many discussions.[2] This link between Greek bond yield spreads (relative to Germany) and financial sector returns is the focus of our paper.

In this article we investigate whether positive changes in the yield spreads of sovereign Greek bonds relative to sovereign German bond yields led to negative excess returns in banks and other financial firms (herein after, financial firms) of Portugal, Italy, Greece, and Spain in the period after the start of the Greek debt crisis in November 2009. In particular, we focus on the impact of yield spread changes around news announcements and their spillover to financial stocks in the Eurozone. As these news announcements occur frequently during this time period we can assess their impact on cross-market linkages.

Even though the Greek economy is a small component of the Eurozone (less than 3% of total GDP), news about the ability of Greece to service its debt impacts domestic financial firms and those of other countries in the Eurozone for a number of reasons. First, if financial firms

[1] See, for example, "Who's Next? Spain? Italy?", Wall Street Journal, Feb 4, 2010 by Neil Shah. However, the Managing Director of the International Monetary Fund contended that contagion from Greece to Portugal or Spain was unlikely (see, "Greek Woes 'Unlikely to Spread'," BBC News March 08, 2010).

[2] See, for instance, "Greek contagion fears spread to other EU banks," Financial Times June 15, 2011 by M. Murphy, K. Hope, J. Thompson, and J. Wilson (http://www.ft.com/intl/cms/s/0/ac918946-975a-11e0-9c9d-00144feab49a.html#axzz1TR8tvAUu). See also "Containing Contagion", Bloomberg Magazine, September 2011 and "Greece: time for a haircut", Financial Times, July 15, 2011.

hold Greek bonds as part of their portfolio of assets, then negative news that leads investors to re-assess the probability of default should immediately impair these assets and thus reduce the value of the assets. The index of financial stocks responds by correspondingly lowering the prices of the equity claims of such firms that hold Greek debt. Second, investors possibly use the news to infer higher default probabilities of their own sovereign bonds as well as sovereign bonds in other Eurozone countries with high debt to GDP ratios. This also impacts the assets of the financial sector. Kaminsky and Schmukler (1999) refer to this as the "wake-up call hypothesis" in which the initial crisis leads the market to reassess the risks faced by countries with similar characteristics. Hence, news about Greece may impact other sovereign bond prices and reduce financial firm values even if these firms do not hold Greek sovereign bonds, but hold the bonds of their home governments.

The literature offers different approaches to find evidence on spillovers, and there is ongoing controversy as to whether the approach influences the inference about the existence of spillovers.[3] Bearing this in mind we take an approach that specifically addresses the main concern, that inferences about linkages are likely to be overstated if we do not account for the increased volatility associated with crises. We estimate a model that relates the excess returns on the financial firms' index of Portugal, Italy, Greece, and Spain to changes in Greek yield spreads. In our model we allow lagged changes in Greek yield spreads to affect the conditional means of the financial firms' excess returns prior to and during the crisis. The variance of the error term is modeled using a GARCH specification. To examine the role of news and information transmission we consider news announcements regarding changes in credit rating as well as other announcements. The evidence on news spillovers focuses on whether Greek yield spreads changes had a greater impact on excess returns of financial stocks in the aftermath of relevant announcements. Our hypothesis is that an increase in the probability of default (a positive change in the yield spread) leads to a decline in financial firms' stock return beyond any decline in the aggregate market, especially during periods of news announcements (we term this as a spillover).

We find that positive changes in Greek yield spreads had a significant negative impact on the excess returns of Portuguese financial firms during the crisis period. Specifically, a one percentage point change (increase) in Greek yield spreads results in excess returns of -3.30% per

[3] See, e.g., Forbes and Rigobon (2002) and Bekaert, Harvey and Ng (2005).

day, on average, in Portuguese financial firms during the crisis period. We also find economically important evidence of spillovers on days when there are ratings downgrades. Since ratings downgrades only occurred during and as a result of the crisis, these effects are directly attributed to the crisis and are, therefore, a spillover. These spillovers are more pervasive, affecting financial firms from Portugal, Italy, and Spin. Likewise, when there is generally bad news, either about ratings downgrade or negative news about bailout possibilities from multinational organizations, we observe broadly similar results. We also examine whether there is a link between Greek bonds and financial firms of non-crisis Eurozone countries—Austria, Belgium, France, and the Netherlands. The main benefit of this additional analysis is that evidence of spillovers might provide additional insights on the cause of impacts in non-crisis economies.

Our results are consistent with information effects from the news announcements driving the Greek bond market and the financial firms in other countries. The significant impact of positive changes in Greek yield spreads on Portuguese financial firms' excess returns due to announcements of ratings downgrades reflects the fact that these two countries were under scrutiny from the very outset of the crisis. A key implication of the above is that a bailout might be able to contain the risk of spillover from Greece via the banking sector, and to quarantine Greece from its impact on other Eurozone countries.

This study contributes to the literature on the role of news in the transmission of shocks (Baig and Goldfajn (1999), Jiang, Konstantinidi and Skiadopoulos (2012)) and the spillover effects resulting from ratings changes (Kaminsky and Schmukler (2002) and Gande and Parsley (2005)). Our analysis points to the impact of Greek sovereign bonds on other countries' financial stock prices, possibly arising from cross-holdings of distressed assets amongst other reasons. This is similar in spirit to Kyle and Wirick (1990) who examine the effect of the Latin American debt crisis on bank equities. This paper is also related to the literature on financial contagion, an overview of which can be found in Kaminsky, Reinhart and Vegh (2003). It differs from previous work in its focus on crisis originating in and affecting developed financial markets. Several studies examine contagion originating in emerging markets (see, e.g., Baig and Goldfajn (1999), Bae, Karolyi and Stulz (2003), Kaminsky and Reinhart (2001)). Here, greater information asymmetry drives contagion (Kodres and Pritsker (2002)) whereas linkages and

spillovers originating in developed markets and affecting developed markets is more likely to arise from correlated information.

The remainder of this article is organized as follows. Section 2 describes the data and Section 3 outlines the methodology. Section 4 presents the results and Section 5 concludes.

2. Data

Our sample spans the period January 2005 to June 2011. The pre-crisis or base period is 1/2005 to 10/2009, whereas the crisis spans the period 11/2009 to 6/2011. The start date for the crisis period coincides with investors' concerns about the quality of Greek sovereign debt in October 2009, after the Greek government revealed that the government budget deficit for 2009 was 12.7% of GDP, much higher than the 6.7% of gross domestic product (GDP) stated earlier in the year. We obtain daily data on yields of 5-year sovereign bonds for Germany (the benchmark), Greece, Italy, Portugal, and Spain (PIGS) and Austria, Belgium, France, and the Netherlands using Bloomberg.[4] Gaps in the data for both the 5-year and 10-year bonds for Ireland prevented us from including Ireland in our analysis.

The yield spread for Greece is computed as the yield on sovereign debt of Greece minus yield on German debt at time *t*. German debt yields are selected as a reference because of Germany's relative economic stability during the recent credit crisis and its economic centrality within the Eurozone. This spread reflects the perceptions about the incremental sovereign default risk relative to the benchmark. The corresponding change in yield spread over one time period (denoted $Y_{G,t}$) is computed as the first difference in yield spreads. Yield spreads are driven by certain state variables and when these state variables change so do the spreads. Thus changes in yield spreads convey important information about changes in economic conditions that are of interest to market participants. Although yield spreads might capture more than a default premium, e.g., a liquidity premium, this does not raise a substantial concern for us. This is because the default premium should be the dominant premium in the spreads given that these are among the largest and most active bond markets in the world which should minimize the liquidity premium. More important, if the changes in yield spreads are driven by other factors this should weaken our results. Hence, our tests can be regarded as conservative.

[4] We choose the 5-year bonds because of data availability and the fact that they are the most actively traded maturity (Alexopoulou, Andersson and Georgescu (2009)).

We also obtain an index of stock prices of the financial firms for each of the sample of countries (MSCI index of financial stocks) as well as the aggregate market index for each country. We compute daily returns as 100 times log first differences of the respective indices and define "excess" returns as the return on the financial firm index minus the return on the domestic market index (denoted $R_{i,t}$ where *i*=P, I, G and S for Portugal, Italy, Greece and Spain). These data are obtained from Bloomberg. Our objective is to examine the relationship between $R_{i,t}$ and $Y_{G,t}$ during the crisis period and especially around news announcements.

We collect news announcements that pertain to Greece and the Eurozone by scanning the Wall Street Journal (see the Appendix for a listing of announcements and announcement dates). The announcements are separated into three categories: (1) ratings outlooks from the three ratings agencies (denoted *ratings*), (2) unfavorable announcements from "third party" agencies, such as the European Monetary Union and the International Monetary Fund (denoted *bad*) and (3) favorable announcements by third party agencies (denoted *good*).[5] The latter two types include macroeconomic forecasts and bailout package declarations. We separate ratings agency announcements from those by other agencies because the announcements of ratings agencies may have a more substantial impact on bond yields spreads than the announcements of other agencies. For example, Kaminsky and Schmukler (1999) examine market reactions during the Asian crisis to news announcements on fiscal and monetary policy, credit ratings changes, and agreements with international organizations like the IMF or World Bank. They find that markets react negatively to ratings downgrades but positively to agreements with international agencies. Further, markets react more strongly to news by ratings agencies and international agencies than they react to political news and news on capital controls or monetary policy.

Figure 1 plots sovereign yield spreads for Portugal, Italy, Greek and Spain, while Figure 2 plots changes in yield spreads for Greece over the full sample. The figures show that yield spreads and changes in spreads on Greek sovereign debt increased sharply subsequent to October 2009, even though there was a small increase in spreads following the U.S. financial crisis of 2007. Table 1 contains summary statistics of the changes in Greek sovereign bond yield spreads ($Y_{G,t}$) and excess returns on the index of financial firms for Greece ($R_{G,t}$), Portugal ($R_{P,t}$), Italy ($R_{I,t}$), and Spain ($R_{S,t}$). The mean daily change in Greek yield spread over the full sample

[5] In the estimations below we combine the first and second categories as bad news to obtain a more tractable model.

period (Panel A) is positive, 0.013%. On the other hand, all mean excess returns on the financial firms' index are negative, suggesting that these firms underperformed the general market on average.

During the pre-crisis period (Panel B) the mean Greek yield spread is neither economically nor significantly different from zero. Likewise, it is not surprising that there is no particular pattern in the signs of the excess returns in this period. During the crisis period (Panel C) the average change in the Greek yield spread and its volatility are large, 5 and 31 basis points per day, respectively. Similarly, the excess returns increase substantially, especially in Portugal, where the mean excess return is statistically significant. The increase in the volatility of the variables in the crisis period can overstate the correlation between yield spreads and excess returns and lead to spurious evidence of changes in linkages across markets, a potential problem resolved by our methodology which we next detail.

3. Methodology

To provide evidence of spillovers from news about the Greek debt crisis onto the financial and banking stocks of other countries, we estimate the following system of equations for the conditional mean of Greek, Portuguese, Italian, and Spanish financial firms' stock returns (equation 1) and changes in Greek bond yield spreads (equation 2):

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{i,t-L} + \phi Y_{i,t-1} + \sum_{j=P,I,G,S,j\neq i} \delta_{ij} R_{j,t-1} + b_{iM} Mon_t + b_{iH} Hol_t + b_{iC} Crisis_t + \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Crisis_t) + \varepsilon_{i,t} \quad (1)$$

$$Y_{G,t} = b_{G0} + \sum_{L=1}^{3} \beta_{GL} Y_{G,t-L} + \sum_{j=P,I,G,S} \delta_{Gj} R_{j,t-1} + b_{GM} Mon_t + b_{GH} Hol_t + b_{GC} Crisis_t + \varepsilon_{Y,t}. \quad (2)$$

In the conditional mean (Equation (1)) $R_{i,t}$, where *i*=P, I, G and S, is the daily excess return on the index of the Portuguese, Italian, Greek and Spanish financial firms, respectively. $Y_{G,t}$ represents the daily changes in Greek yield spreads, while $Y_{i,t}$ represents changes in country *i*'s own bond yield spread. The model of excess returns in Equation (1) is estimated as a function of the first three lags of the country's own excess return to account for autocorrelation because

untreated autocorrelation can cause misspecification of the conditional variance models. We also include one lag of the change in the country's own bond yield spread, except in the conditional mean for the returns on Greek financial firms. This captures any direct spillover from the Greek bond market to the country's own bond market that might overstate the impact of the Greek bond market on the financial firms. Also included is one lag of each of the other three excess returns to capture any mean spillover between financial firms across countries.

Mon is a dummy variable defined as one on Mondays and zero otherwise to account for the fact that more information may be released over the two-day weekend than on weekdays. The *Crisis* dummy variable is defined as one during the Greek debt crisis, 11/2009 to the end of the sample. Lagged Greek sovereign bond yield spreads are denoted Y_G^+ if the change is positive. To capture the impact of news spillovers we modify the interaction variable as: $\gamma_{iG}(Y_{G,t-1}^{+} \times News_{t-1})$ where $News_{t-1}$ = *Ratings, Bad, or Good* . We conjecture that news about the probability of default and other macroeconomic conditions of the crisis countries have an effect on the extent of the relationship between spreads and financial stock returns. The indicator variable $News_{t-1}$ defined as one on the date of an announcement, regardless of the particular crisis country it pertains to, and zero otherwise. Creating this all-encompassing dummy rather than country-specific dummies reflects the fact that while an announcement about a particular country represents information about that country's fundamentals it also serves as a potential source of news for all the other countries. Thus, while the coefficient λ tells us if an increase in Greek yield spreads impacted the excess returns in the pre-crisis period, the coefficient γ indicates if the impact during the crisis is different from that in the pre-crisis period. That is, it is the differential (incremental) effect of a positive change in yield spreads during the crisis. The sum $(\lambda + \gamma)$ tells us the total effect of an increase in spreads during the crisis. Evidence of spillover requires that $\gamma < 0$; i.e., that higher yield spreads lead to a decline in returns, beyond that of the market, during the crisis relative to the impact in the pre-crisis period. Equivalently, $(\lambda + \gamma) < \lambda$, although there is no need for $(\lambda + \gamma)$ to be positive. Equation (2), specifies the changes in Greek yield spreads similar to above, with the exception of the interaction term.

Equation (1) of the above system could be estimated using ordinary least squares. However, Forbes and Rigobon (2002) demonstrate that this is likely to lead to wrong inferences because it does not account for the change in volatility during the crisis. They note that

estimating the system using a GARCH model adequately addresses this concern. Therefore, we specify the conditional variance for each excess return *i*, where *i*=P, I, G and S, respectively, and the change in Greek yield spreads as follows:

$$\sigma^2_{\varepsilon,t} = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta \sigma^2_{\varepsilon,t-1} + \nu_M Mon_t + \nu_H Hol_t + \nu_C Crisis_t \quad (3)$$

$$\sigma_{ij,t} = \rho_{ij} * [\sqrt{\sigma^2_{\varepsilon i,t}} \sqrt{\sigma^2_{\varepsilon j,t}}]. \quad (4)$$

In equation (3) the conditional variance is a function of a constant, the lagged squared errors from the conditional mean model, lagged own variance, and the Monday, market holiday, and crisis dummies as previously defined.[6] Finally, the conditional covariance between each pair in the system is estimated as a product of a constant correlation, ρ_{ij}, and the standard deviations in the two markets (Equation 4).

It should be noted that if one of the markets has a 'holiday', when it is closed for any trading day other than the weekend (*Hol*), we delete the observations for the other markets. Hence, each market has exactly the same trading days.[7] There are a total of 1,600 observations for each variable, but to account for the lag structure in the models we start the estimations at the 10th observation, thus leaving a sample of 1,591 observations. Also, the changes in Greek yield spreads had a large negative outlier on May 10, 2010, the date the EU announced the €750 billion bailout mechanism and so to ensure it does not overly influence our results, we truncate the change in yield spread throughout the sample and set the lowest return equal to -2%.

The above models are estimated using a quasi-maximum likelihood (QML) approach (Bollerslev and Woolridge (1992)). Hence the standard errors are robust to the distribution (e.g., non-normality) of the errors. Additionally, the models are subject to several model diagnostics, so there is a high probability that the models converged at the global maximum.

4. Results

4.1 Preliminary evidence

[6] All conditional variances for changes in Greek yield spreads were estimated as IGARCH models given concerns of weak-form non-stationarity in some cases. This is not a major concern because our purpose is simply to account for changing variance so as not to overstate the evidence of contagion, not to obtain estimates of the conditional variance for forecasting, where non-stationarity is of concern. Moreover, it should be noted that the IGARCH model can be strongly stationary although it is not weakly stationary (Nelson (1990)).

[7] These features of the model are standard in similar tests using daily data. See, e.g., Karolyi (1995)).

We begin with an examination of the contemporaneous correlation between changes in Greek sovereign bond yield spreads and the excess returns on financial stocks in the PIGS to determine if they are different in the pre-crisis and crisis periods (columns 2 and 4). This provides preliminary evidence on the change in the relationship between Greek yield spreads and the excess returns during the crisis.

Table 2 reports univariate evidence of the change in the relationship between Greek yield spreads and the excess returns on financial firms during the crisis. The left side of Table 2 shows that in the pre-crisis period, the contemporaneous correlation between yield spreads ($Y_{G,t}$) and each excess returns on financial firms is large and significant. Comparing to the right side of Table 2 which shows the post-crisis correlations we can see that the magnitude of each contemporaneous correlation increases between 38% and 160% during the crisis relative to the pre-crisis level. Equally important, the correlations are negative; i.e., an increase in sovereign bond yield spreads is associated with negative excess returns in the current period. This significant increase in correlation led the financial press to conclude that there is contagion from Greece to the Eurozone banks. However, the volatility of Greek bond yield spreads increased more than eight times, from 0.037% to 0.305%, from the pre-crisis to the crisis period (see Table I discussed earlier) and there is also an increase in the volatility of excess returns, albeit to a lesser extent. Thus, a legitimate concern is that the increased correlation is due solely to the increased variance of these variables. Nonetheless, this is the first evidence that higher spreads in the Greek sovereign bond market translates to lower market values for financial firms in the Eurozone crisis countries.

The other columns display cross-correlations ($Y_{G,t-1}$), where yield spreads at *t*-1 are measured prior to excess returns (at *t*). There is no evidence of an increase in cross-correlations between yield spreads and excess returns. If anything, there is a decline in the lead from yield spreads to excess returns during the crisis. What is interesting though is the fact that there is some evidence of a lead and the sign is always negative.

4.2. Empirical evidence of spillovers using changes in yield spreads

Table 3 contains the results of the model specified in equations (1) to (4). The first four columns are parameter estimates of the conditional mean model for excess stock returns, while the last column contains parameter estimates of the conditional mean model of yield spread

changes. The Crisis dummy ($b_{i,C}$) is negative and significant in each excess return. The crisis period witnessed increased spreads and corresponding negative returns in each of the market. Recall that we use the interaction of changes in Greek yield spreads and the crisis dummy variable to determine if there is a spillover from Greek bonds to financial firms' returns (the parameter γ). After controlling for the crisis period average negative returns, our estimate of the parameter γ shows that there is evidence of spillover from the Greek bond market during the crisis to the financial firms of Portugal. Specifically, on average, if Greek yield spreads were to increase by 1 percentage point there would be a decrease in the excess returns on Portuguese financial firms during the crisis period that is 3.30% lower than the excess returns in the pre-crisis period, where excess returns are measured relative to the domestic stock market.

There is no significant effect on the financial firms from the other countries. Overall, this evidence suggests that the spillover from the Greek crisis might be limited to Portugal from among the group of crisis countries examined here. This would be consistent with the heightened concern of the financial media on the likelihood of the crisis affecting Portugal.

It is important to point out that in each of the conditional mean stock return models (except Italy) there is evidence that at least one of the lagged dependent return variables is significant. For example, for the case of Portugal the lagged excess return of stocks for the first and second lag is significant. One implication of this finding is that removing the own autocorrelation from the excess returns reduces the concern that any significant evidence of spillovers might be due to the autocorrelation in excess returns. Autocorrelation causes a "look back bias" arising from the series of negative shocks that financial firms experienced in the crisis (Longstaff (2011)).

The evidence also indicates that, generally, the coefficient estimates on the own-country lagged sovereign bond yield spreads are negative and in the case of Italy economically large and statistically significant. The latter implies that there is spillover from Greek sovereign bonds to Italian sovereign bonds because unless Italian bonds also had a high probability of default it is unlikely that the effect on Italian financial firms would be as large as implied by the coefficient estimate.[8] The result also implies that stock prices of financial firms embedded the loss of value

[8] While we cannot categorically state that this spillover occurred only during the crisis period, without further complicating our model, it is highly likely that the major part of this spillover occurred during the crisis. In an earlier version of the paper we found strong evidence of an increase in such spillover during the crisis.

of the domestic bonds in their portfolios. Important to our main results discussed above, the current result also implies that the impact of the Greek bonds captured in the model, $\hat{\gamma}$, is a "pure" Greek yield effect on financial firms, not contaminated by domestic bonds.

Our next objective is to explore if and how news announcements affect the impact of changes in Greek yield spreads on financial stock returns in each of these countries.

4.3 News Spillovers

We examine how news affects the relationship between changes in Greek yield spreads on financial firm returns - the information channel as a mechanism to transmit shocks. We modify equations (1) to (4) by replacing the crisis dummy variable in the interaction term with the news dummies described earlier. For instance, the model of excess returns when the news pertains to a credit rating announcement is:

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{1,t-L} + \phi Y_{i,t-1} + \sum_{j \neq i,\, j=P,I,G,S} \delta_{ij} R_{jt-1} + b_{iM} Mon_{t} + b_{iH} Hol_{t} + b_{iC} Crisis_{t} + \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Ratings_{t-1}) + \varepsilon_{i,t}. \quad (5)$$

Table 4 reports the estimates of Equation (5). It should be noted that there were no upgrades in credit ratings for any of the countries in the Eurozone during the crisis period. Table 4 shows that several of the lagged financial market returns are again significant. The Crisis dummy ($b_{i,C}$) is negative and significant in each case. The parameter estimate for γ shows that in Portugal, Italy, and Spain there is strong evidence of news spillovers. The differential effects of a one percentage point increase in Greek bond yield spreads during the crisis are -1.49 percent in Portugal, -0.83 percent in Italy, and -1.64% percent in Spain. Each of these results is both statistically and economically significant. These results indicate that, compared to the pre-crisis period, when there is an announcement of downgrades higher Greek bond yield spreads lead investors to significantly lower the stock prices of financial firms from Portugal, Italy, and Spain on the following day.

In Table 5 we report the results when the news announcements are any type of bad news (including credit ratings downgrades).

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{1,t-L} + \phi Y_{i,t-1} + \sum_{j \neq i,\, j=P,I,G,S} \delta_{ij} R_{jt-1} + b_{iM} Mon_{t} + b_{iH} Hol_{t} + b_{iC} Crisis_{t} + \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Bad_{t-1}) + \varepsilon_{i,t} \quad (6)$$

The signs for these results closely reflect those above for ratings changes. The Crisis dummy ($b_{i,C}$) is significant in each case. The signs for the interaction terms are consistent but are significant only for the case of Spain (-1.35%). Overall, these results suggest that even though the general effect of higher Greek bond spreads on other countries' financial firms during the crisis is not pervasive, investors responded significantly to unfavorable news that in turn led to decline in the values of financial firms.

Table 6 displays the results for the specification in which good news is interacted with negative changes in Greek yield spreads, $Y^{-}_{G,t-1}$.

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{1,t-L} + \phi Y_{i,t-1} + \sum_{j \neq i,\, j=P,I,G,S} \delta_{ij} R_{jt-1} + b_{iM} Mon_{\,t} + b_{iH} Hol_{\,t} + b_{iC} Crisis_{\,t} + \lambda_i Y^{-}_{G,t-1} + \gamma_{iG} (Y^{-}_{G,t-1} \times Good_{\,t-1}) + \varepsilon_{i,t} \quad (7)$$

The good news coefficients for Portugal is -2.68% and with a negative sign for each of the other countries. The negative coefficient implies that good news announcements were accompanied by a positive abnormal return in financial stocks for Portugal.

Overall the evidence indicates that financial firms in both Portugal and Spain experience significant loss of value given an increase in the yield spreads in Greece especially on announcement days. On the other hand, good news results in a positive return for Portugal, with consistent signs of the parameter for each of the other countries. Collectively this suggests that the news channel (good news or bad news) was a transmission channel as investors in Portugal, Spain and Italy incorporated the impact of the new information into their evaluation of domestic stock prices.

In Table 7 we report a sample of the diagnostic tests accompanying the estimated models in Tables 3 to 6. The purpose of these tests is to ensure that the estimated models are not misspecified. In particular, in the first panel the evidence is that we cannot reject the null hypothesis that the residuals from the conditional mean models are serially uncorrelated. This suggests that our conditional mean models are well specified and that the lagged dependent variables in the models have removed any autocorrelation in the excess returns of financial firms. Likewise, the insignificance of the squared autocorrelations in the second panel indicates that there are no remaining ARCH errors, implying that the conditional variance models are suitable. Overall, these diagnostics indicate that the models are well specified.

4.4 Economic rationale for news spillovers

News spillovers are a result of economic linkages between Greece and the financial institutions of other Eurozone countries. First, banks in the PIGS countries may have direct holdings of Greek debt on their books. A negative news announcement impairs the value of Greek bonds and therefore the bank assets, resulting in a negative return to the residual stock holders. Second, the news has information for other countries because it may imply similar outcomes for other Eurozone countries that face fiscal constraints. Thus, news that reduced the likelihood of a bailout implies that, for example, Portugal would be less likely to be bailed out were it to face similar circumstances. This in turn leads to an upward spike in interest rates in Portugal and a corresponding depreciation in asset values of financial institutions. Thirdly, higher rates translate into larger funding costs for the financial institutions. Our results provide an indirect way to estimate the impact of these three channels. A direct test would require bank level data and detailed exposures of each financial institution, data to which we do not have access. The European Banking Authority conducted stress tests[9] from 2009 onwards to assess the ability of each bank to withstand shocks. Consistent with our results, the bank-by-bank data shows that the PIGS capital ratios are lower than other Eurozone countries and their asset impairment would result in large write-downs in the value of their assets.

4.5 Was there a spillover in the non-crisis countries?

The financial press speculated that the Greek crisis might affect markets that are not a part of the PIGS. For instance, the Finance Minister of Belgium expressed concern that the Greek debt crisis could spread to Belgium and France. As noted earlier, such effects might arise when either the government-led banks or their private banks are exposed to Greek debt and the capital buffers are not large enough. For instance, France has the largest exposure to Greek debt among all countries; nearly double that of Germany for instance as reported on the ECB web site. This exposure is due to both its private sector banks as well as from the stakes held by government entities. Some of the largest French banks (BNP Paribas, Crédit Agricole, and Société Générale) were threatened with ratings downgrades as a result of their Greek debt holdings. Austria, Belgium, and the Netherland banks had exposure to Greek debt to a lesser

[9]See http://www.eba.europa.eu/EU-wide-stress-testing.

extent. When this exposure is coupled with a country's own debt burden, it is possible that uncertainty in Greece could cause yields to rise in these other countries.[10] However, in unreported results, our parameter estimates for the rating, bad news, and good news model show that there were no significant news spillovers during the crisis period.

4.6. Other evidence and extensions

During the crisis investors might have become concerned not only about changes in the probability of default as measured by changes in the yield spread, but also about the uncertainty with which this was evolving. One way that this uncertainty is manifested is in the volatility of the changes in Greek yield spreads. Consistent with models of investor uncertainty and stock returns (Veronesi (1999) and others), if in periods of high uncertainty investors in financial firms frequently revise and update their estimates of the risk involved in holding these firms, then we should observe a negative relationship between the volatility of changes in yield spreads and the value of financial firms. We use the estimate of the conditional volatility of the errors from the conditional mean model of the changes in Greek yield spreads as a proxy for this uncertainty (Equation 3). This is consistent with common practice (see, e.g., Elder and Serletis (2010) and references therein). The evidence indicates that Greek bond market crisis has a negative effect on the financial firms of the crisis countries in the Eurozone. The results indicate that except for the Greek excess returns all coefficient estimates are negative (we do not include these tables). However, similar to previous results, only the Portuguese financial firms display a statistically significant reduction in value given an increase in the variance of Greek bond yield spreads. Specifically, a one unit increase in the variance of yield spreads leads to a 14.66% decline in the index of financial firms.

5. Conclusions

In this paper we examine whether the sovereign debt crisis in Greece led to spillovers in the banking sector and other firms in the financial sector (financial firms) in Portugal, Ireland, Greece, and Spain (PIGS). We define a spillover as an event where positive changes in Greek yield spreads lead to excess negative returns on an index of financial firms in another country.

[10] See http://www.forex-news.co/belgian-finance-minister-greek-debt-crisis-could-spread-to-france.html for the Finance Minister's comment and "The countries most exposed to Greek debt," The Telegraph, 15 Jun 2011.

The sample period is from 01/2005 to 06/2011, with the crisis being the period 11/2009 to the end of the sample.

Using a multivariate GARCH model containing a conditional mean model for each of the index of financial firms and changes in Greek yield spreads, we find significant evidence of spillovers. We find that on the days when there are announcements of ratings downgrades in any of the Eurozone crisis countries or when there is generally bad news from the IMF or other multilateral agencies, there is a substantial increase in the spillover from the Greek bond market.

Our analysis sheds light on the different means by which new information about potential default of the Greek debt is incorporated in the prices of financial firms in the Eurozone countries. Collectively our results help uncover the extent of economic linkages across the Eurozone countries and provide an independent market based verification of the stress tests conducted by the European Banking Authority. Our results also validate the role of information in the transmission of economic shocks.

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Appendix 1: News Announcements

Date	Announcement
10/22/09	Fitch reduces Greece's rating to A- from A.
10/29/09	Moody's considers possible downgrade of Greek rating.
12/07/09	S&P lowers Portugal's rating to A- from A+.
12/08/09	Fitch lowers Greek ratings to BBB+ with negative outlook.
12/09/09	S&P lowers its rating on Spain to negative.
12/16/09	S&P cuts Greece's bond rating to BBB+ from A minus.
12/22/09	Moody's lowers its rating on Greece's debt from A1 to A2.
02/03/10	The EU endorses Greece's austerity program.
02/09/10	Germany considers joint EU plan to offer loan guarantees to Euro Zone members.
02/11/10	European reach deal on stemming the Greek debt crisis.
02/23/10	Fitch downgrades four major Greek banks to BBB and considers Greek prospects as "negative".
03/04/10	ECB President endorses IMF involvement in Greece.
03/05/10	German Prime Minister avoids giving Greece a commitment of financial assistance.
03/24/10	Fitch reduces Portugal's rating to AA-.
03/25/10	The ECB announces that it will accept bonds with ratings greater than or equal to BBB-.
03/25/10	16 Euro-Zone national leaders back a joint venture with the IMF to bail out Greece.
04/09/10	Fitch lowers the Greek rating to BBB from BBB+ with negative outlook.
04/11/10	16 Euro-Zone finance ministers will allow Greece to borrow up to €30 billion.
04/22/10	Moody's reduces Greek ratings to A3 from A2 with negative outlook.
04/27/10	S&P lowers Greek ratings to Junk.
04/27/10	S&P lowers Portuguese ratings to A-.
04/28/10	S&P lowers Spanish ratings to AA with negative outlook.
05/05/10	Portugal is placed under review for a downgrade by Moody's.
05/07/10	Germany's Lower House passes Greek bailout bill.
05/05/10	Moody's placed Portugal under review for a downgrade.
05/07/10	Germany's Lower House passes the Greek bailout bill.
05/12/10	Spain announces that it will cut public-sector wages by 5% this year (2010).
05/13/10	The Portuguese government approves tax increases and salary reductions for public employees.
05/19/10	Spain will raise taxes for high-income earners to help decrease country's deficit.
05/21/10	Spain's central bank takes over Roman Catholic Church-controlled savings bank CajaSur.
05/29/10	Fitch drops Spain's AAA credit rating to AA plus.
06/14/10	Moody's cuts rating on Greece into junk territory.
07/13/10	Moody's downgrades Portugal's government bond rating from Aa2 to A1.
07/19/10	Moody's cuts Ireland's credit rating from Aa2 to A1.
07/23/10	European stress tests show that 7 of 91 banks need to raise new capital.
08/24/10	S&P reduces Irish ratings 3 notches to AA-.
09/08/10	Greek 2nd Q GDP is revised downward to -1.8% from an initial -1.5%.
09/30/10	Moody's downgrades Spain's rating by one notch to Aa1.
10/06/10	Fitch cuts Irish ratings from AA- to A+ with negative outlook.
10/26/10	Ireland's government says that budget cuts of €15 billion are needed over the next four years.
11/21/10	The EU and IMF indicate that the money requested by Ireland will be forthcoming.
11/24/10	Ireland's government outlines €15 billion in spending cuts and tax hikes over four years.
11/28/10	Europe seals a €67.5 billion bailout for Ireland.

Table I

Summary Statistics of Yields Spread Changes and Financial Firms' Excess Returns

The overall sample period is 1/2005 to 6/2011 and is partitioned into two sub-samples: a pre-crisis period spanning 1/2005 to 10/2009 and a crisis period spanning 11/2009 to 6/2011. Greece sovereign spreads are measured relative to the yields on similar maturity bonds for Germany, and returns on a the MSCSI financial sector index of financial firms are measured as the excess of the returns of the MSCI index for a country relative to the country's aggregate stock market index. * and ** represent significance at the 10% and 5% levels, respectively.

Panel A: Full sample summary statistics

Variable	Obs	Mean	Std	Min	Max
Changes in Greek yield spread ($Y_{G,t}$)	1591	0.013**	0.157	-2.000	1.349
Greek financial firms excess returns ($R_{G,t}$)	1591	-0.008	0.864	-3.669	4.639
Portuguese financial firms excess returns ($R_{P,t}$)	1591	-0.055*	1.148	-5.910	5.958
Italian financial firms excess returns ($R_{I,t}$)	1591	-0.009	0.725	-3.742	5.895
Spanish financial firms excess returns ($R_{S,t}$)	1591	-0.010	0.716	-4.055	5.962

Panel B: Pre-crisis summary statistics

Variable	Obs	Mean	Std	Min	Max
$Y_{G,t}$	1192	0.001	0.037	-0.245	0.359
$R_{G,t}$	1192	0.013	0.759	-3.064	4.411
$R_{P,t}$	1192	-0.026	1.121	-5.910	5.958
$R_{I,t}$	1192	0.008	0.672	-3.742	4.387
$R_{S,t}$	1192	-0.003	0.704	-4.055	5.289

Panel C: Post-crisis summary statistics

Variable	Obs	Mean	Std	Min	Max
$Y_{G,t}$	398	0.051**	0.305	-2.000	1.349
$R_{G,t}$	398	-0.072	1.119	-3.669	4.639
$R_{P,t}$	398	-0.135**	1.221	-3.926	3.981
$R_{I,t}$	398	-0.061	0.862	-3.008	5.895
$R_{S,t}$	398	-0.032	0.749	-2.248	5.962

Table 2

Correlation between Greek Spread Changes and Financial Firms' Excess Returns

This table reports contemporaneous correlations and lead-lag relations between changes in 5-year Greek sovereign bond yield spreads ($Y_{G,t}$) and excess returns on an index of financial firms, for Greece, Portugal, Italy, and Spain. Greece sovereign spreads are measured relative to similar maturity German bonds. Returns on the MSCSI financial sector index of financial firms are measured as the excess of the returns of the MSCI index for a country relative to the country's aggregate stock market index. The full sample (1/2005 to 6/2011) is partitioned into two sub-samples: a pre-crisis period spanning 1/2005 to 10/2009 and a crisis period spanning 11/2009 to 6/2011. All data are at the daily interval. * and ** represent significance at the 10% and 5% levels, respectively.

	Pre-crisis		Post-crisis	
	$Y_{G,t}$	$Y_{G,t-1}$	$Y_{G,t}$	$Y_{G,t-1}$
$R_{G,t}$	-0.189**	-0.053*	-0.428**	-0.001
$R_{P,t}$	-0.111**	-0.017	-0.286**	-0.018
$R_{I,t}$	-0.270**	-0.145**	-0.375**	-0.019
$R_{S,t}$	-0.287**	-0.067**	-0.397**	-0.057*

Table 3

Impact of Changes in Greek Yield Spreads on Financial Firms' Excess Returns

The table reports parameter estimates of the model:

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{i,t-L} + \phi Y_{i,t-1} + \sum_{j=P,I,G,S,\, j\neq i} \delta_{ij} R_{j,t-1} + b_{iM} Mon_t + b_{iH} Hol_t + b_{iC} Crisis_t$$
$$+ \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Crisis_t) + \varepsilon_{i,t}$$

where $R_{i,t}$, i=P, I, G and S, is the daily excess return on the index of the Portuguese, Italian, Greek and Spanish financial stocks, $Y_{i,t-1}$ is the change in yield spread of country i, *Mon* and *Hol* are dummy variables, defined as 1 on Mondays after the reopening of the market after a close for any reason other than the weekend respectively, and zero otherwise; *Crisis* is a dummy variable defined as 1 during the Greek debt crisis, 11/2009 to 06/2011, and zero otherwise; $Y^{+}_{G,t-1}$ is 1 lag of positive changes in Greek yield spreads ; and an interaction term between the lagged positive changes in Greek yield spreads and the crisis variable. The full sample covers the period 1/2005 to 6/2011 and the crisis period is 11/2009 to 6/2011. All data are at the daily interval. The last column reports parameter estimates of the conditional mean of yield spread changes (Equation 3). *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

i = Greece		i = Portugal		i = Italy		i = Spain		i=Greece (Yield Spread)	
β_{i0}	0.0615***	β_{i0}	0.0119	β_{i0}	0.0278*	β_{i0}	0.0175	b_{i0}	-0.0006
$\beta_{i,1}$	0.0379*	$\beta_{i,1}$	0.0425*	$\beta_{i,1}$	0.0373	$\beta_{i,1}$	0.0911***	$\beta_{i,1}$	0.1863***
$\beta_{i,2}$	-0.0657***	$\beta_{i,2}$	-0.0299*	$\beta_{i,2}$	0.0116	$\beta_{i,2}$	-0.0114	$\beta_{i,2}$	0.0052
$\beta_{i,3}$	-0.0467**	$\beta_{i,3}$	-0.0222	$\beta_{i,3}$	0.0017	$\beta_{i,3}$	0.0023	$\beta_{i,3}$	-0.0232
ϕ		ϕ	0.0283	ϕ	-0.8888**	ϕ	-0.0192	δ_G	-0.0003
δ_P	-0.0008	δ_G	-0.0033	δ_G	-0.0321	δ_G	-0.0208	δ_P	0.0001
δ_I	0.0676**	δ_I	0.0043	δ_P	-0.0114	δ_P	0.0122	δ_I	-0.0016*
δ_S	-0.0071	δ_S	0.1028**	δ_S	0.0472*	δ_I	0.0451*	δ_S	0.0006
λ_i	0.0887	λ_i	3.4561**	λ_i	1.453	λ_i	0.868		
γ_{iG}	0.2531	γ_{iG}	-3.2993**	γ_{iG}	-1.1032	γ_{iG}	-0.4605		
b_{iC}	-0.1235***	b_{iC}	-0.1503***	b_{iC}	-0.089**	b_{iC}	-0.0676*	b_{iC}	0.0234***
b_{iM}	-0.1005**	b_{iM}	0.0351	b_{iM}	-0.003	b_{iM}	-0.0513	b_{iM}	0.0005
b_{iH}	-0.0575	b_{iH}	-0.2172**	b_{iH}	-0.0599	b_{iH}	0.0488	b_{iH}	0.0092*

Table 4

Impact of Ratings Downgrade Announcements on Financial Stock Excess Returns

The table reports parameter estimates of the model:

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{i,t-L} + \phi Y_{i,t-1} + \sum_{j=P,I,G,S,\, j\neq i} \delta_{ij} R_{j,t-1} + b_{iM} Mon_t + b_{iH} Hol_t + b_{iC} Crisis_t$$
$$+ \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Ratings_t) + \varepsilon_{i,t}$$

where $R_{i,t}$, i=P, I, G and S, is the daily excess return on the index of the Portuguese, Italian, Greek and Spanish financial stocks, $Y_{i,t-1}$ is the change in yield spread of country i, *Mon* and *Hol* are dummy variables, defined as 1 on Mondays after the reopening of the market after a close for any reason other than the weekend respectively, and zero otherwise; *Crisis* is a dummy variable defined as 1 during the Greek debt crisis, 11/2009 to 06/2011, and zero otherwise; $Y^{+}_{G,t-1}$ is 1 lag of positive changes in Greek yield spreads; *Ratings* is a dummy variable set to 1 if there is a downgrade. The full sample covers the period 1/2005 to 6/2011 and the crisis period is 11/2009 to 6/2011. All data are at the daily interval. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

i = Greece		i = Portugal		i = Italy		i = Spain	
β_{i0}	0.0602***	β_{i0}	0.0228	β_{i0}	0.031**	β_{i0}	0.0181
$\beta_{i,1}$	0.0366	$\beta_{i,1}$	0.04*	$\beta_{i,1}$	0.0358	$\beta_{i,1}$	0.0876***
$\beta_{i,2}$	-0.0651**	$\beta_{i,2}$	-0.031**	$\beta_{i,2}$	0.0098	$\beta_{i,2}$	-0.0113
$\beta_{i,3}$	-0.0469**	$\beta_{i,3}$	-0.0232	$\beta_{i,3}$	0.0016	$\beta_{i,3}$	0.0019
ϕ		ϕ	0.0225	ϕ	-0.8524**	ϕ	-0.0543
δ_P	-0.0011	δ_G	-0.0058	δ_G	-0.0332	δ_G	-0.0248
δ_I	0.0681**	δ_I	-0.0003	δ_P	-0.0118	δ_P	0.0116
δ_S	-0.0069	δ_S	0.0964**	δ_S	0.0449*	δ_I	0.0448*
λ_i	0.3811	λ_i	0.3778	λ_i	0.4885	λ_i	0.6174*
γ_{iG}	-0.689	γ_{iG}	-1.488**	γ_{iG}	-0.8287*	γ_{iG}	-1.6373***
b_{iC}	-0.1205**	b_{iC}	-0.1736***	b_{iC}	-0.0972**	b_{iC}	-0.0755*
b_{iM}	-0.1001**	b_{iM}	0.0378	b_{iM}	-0.0011	b_{iM}	-0.0482
b_{iH}	-0.058	b_{iH}	-0.2179**	b_{iH}	-0.0612	b_{iH}	0.0465

Table 5
Impact of Bad News Announcements on Financial Stock Returns

The table reports parameter estimates of the model:

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{i,t-L} + \phi Y_{i,t-1} + \sum_{j=P,I,G,S,\, j\neq i} \delta_{ij} R_{j,t-1} + b_{iM} Mon_t + b_{iH} Hol_t + b_{iC} Crisis_t$$
$$+ \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{+}_{G,t-1} \times Bad_t) + \varepsilon_{i,t}$$

where $R_{i,t}$, i=P, I, G and S, is the daily excess return on the index of the Portuguese, Italian, Greek and Spanish financial stocks, $Y_{i,t-1}$ is the change in yield spread of country i, *Mon* and *Hol* are dummy variables, defined as 1 on Mondays after the reopening of the market after a close for any reason other than the weekend respectively, and zero otherwise; *Crisis* is a dummy variable defined as 1 during the Greek debt crisis, 11/2009 to 06/2011, and zero otherwise; $Y^{+}_{G,t-1}$ is 1 lag of positive changes in Greek yield spreads, *Bad* is a dummy variable set to 1 if there is a bad news announcement. The full sample covers the period 1/2005 to 6/2011 and the crisis period is 11/2009 to 6/2011. All data are at the daily interval. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

i = Greece		i = Portugal		i = Italy		i = Spain	
β_{i0}	0.0603***	β_{i0}	0.0229	β_{i0}	0.031**	β_{i0}	0.0181
$\beta_{i,1}$	0.0366	$\beta_{i,1}$	0.0408*	$\beta_{i,1}$	0.036	$\beta_{i,1}$	0.087***
$\beta_{i,2}$	-0.065***	$\beta_{i,2}$	-0.0303**	$\beta_{i,2}$	0.009	$\beta_{i,2}$	-0.0127
$\beta_{i,3}$	-0.047**	$\beta_{i,3}$	-0.0225*	$\beta_{i,3}$	0.0018	$\beta_{i,3}$	0.0028
ϕ		ϕ	0.0094	ϕ	-0.8317**	ϕ	-0.075
δ_P	-0.001	δ_G	-0.0061	δ_G	-0.0334	δ_G	-0.0247
δ_I	0.0679**	δ_I	-0.0005	δ_P	-0.0115	δ_P	0.0119
δ_S	-0.0068	δ_S	0.097**	δ_S	0.0451	δ_I	0.0454*
λ_i	0.3641	λ_i	0.3516	λ_i	0.5044	λ_i	0.6476**
γ_{iG}	-0.5589	γ_{iG}	-0.93	γ_{iG}	-0.8408	γ_{iG}	-1.3531*
b_{iC}	-0.1197***	b_{iC}	-0.1732***	b_{iC}	-0.0975**	b_{iC}	-0.0772**
b_{iM}	-0.1003**	b_{iM}	0.038	b_{iM}	-0.0012	b_{iM}	-0.0492
b_{iH}	-0.0579	b_{iH}	-0.2173**	b_{iH}	-0.0612	b_{iH}	0.0467

Table 6
Impact of Good News Announcements on Financial Stock Returns

The table reports parameter estimates of the model:

$$R_{i,t} = \beta_{i0} + \sum_{L=1}^{3} \beta_{iL} R_{i,t-L} + \phi Y_{i,t-1} + \sum_{j=P,I,G,S,\, j\neq i} \delta_{ij} R_{j,t-1} + b_{iM} Mon_t + b_{iH} Hol_t + b_{iC} Crisis_t$$
$$+ \lambda_i Y^{+}_{G,t-1} + \gamma_{iG} (Y^{-}_{G,t-1} \times Good_t) + \varepsilon_{i,t}$$

where $R_{i,t}$, i=P, I, G and S, is the daily excess return on the index of the Portuguese, Italian, Greek and Spanish financial stocks, $Y_{i,t-1}$ is the change in yield spread of country i, *Mon* and *Hol* are dummy variables, defined as 1 on Mondays after the reopening of the market after a close for any reason other than the weekend respectively, and zero otherwise; *Crisis* is a dummy variable defined as 1 during the Greek debt crisis, 11/2009 to 06/2011, and zero otherwise; $Y^{-}_{G,t-1}$ is 1 lag of negative changes in Greek yield spreads ; *Good* is a dummy variable set to 1 if there is a good news announcement. The full sample covers the period 1/2005 to 6/2011 and the crisis period is 11/2009 to 6/2011. All data are at the daily interval. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

i = Greece		i = Portugal		i = Italy		i = Spain	
β_{i0}	0.0611***	β_{i0}	0.0247	β_{i0}	0.0344**	β_{i0}	0.0208
$\beta_{i,1}$	0.0337	$\beta_{i,1}$	0.04*	$\beta_{i,1}$	0.0326	$\beta_{i,1}$	0.0901***
$\beta_{i,2}$	-0.0663**	$\beta_{i,2}$	-0.0305*	$\beta_{i,2}$	0.0078	$\beta_{i,2}$	-0.0124
$\beta_{i,3}$	-0.0476**	$\beta_{i,3}$	-0.0221	$\beta_{i,3}$	-0.0015	$\beta_{i,3}$	-0.0002
ϕ		ϕ	0.0479	ϕ	-0.7634*	ϕ	0.2759
δ_P	-0.001	δ_G	-0.0059	δ_G	-0.0333	δ_G	-0.0256
δ_I	0.0625*	δ_I	-0.0019	δ_P	-0.0102	δ_P	0.0126
δ_S	-0.0085	δ_S	0.0975**	δ_S	0.0465*	δ_I	0.0403
λ_i	-0.1847	λ_i	0.135	λ_i	0.2641	λ_i	0.0008
γ_{iG}	0.2605	γ_{iG}	-2.6843***	γ_{iG}	-1.6362	γ_{iG}	-1.8204
b_{iC}	-0.0959**	b_{iC}	-0.1436***	b_{iC}	-0.0406	b_{iC}	-0.0269
b_{iM}	-0.1009**	b_{iM}	0.0374	b_{iM}	-0.0028	b_{iM}	-0.0496
b_{iH}	-0.0572	b_{iH}	-0.2164**	b_{iH}	-0.0596	b_{iH}	0.0477

Table 7. Sample Residual Diagnostics

This table reports a sample of diagnostic tests accompanying the models reported above. We report *p*-values of the test of the null hypotheses that the joint autocorrelation of the first 15 lags of the standardized residuals is zero (rows 1-5) and that the joint autocorrelation of the first 15 lags of the squared standardized residuals is zero (rows 6-10). We also report tests of the joint null hypotheses that there is no incremental effect from the Greek bond market during the crisis or on the days of the various announcements (row 11) and that there is no GARCH effect in the conditional variance models (row 12).

	Crisis	Ratings	Bad	Good
	p-value: residual autocorrelation Q(15)	*p*-value: residual autocorrelation Q(15)	*p*-value: residual autocorrelation Q(15)	*p*-value: residual autocorrelation Q(15)
Greek financial firms	0.6203	0.6070	0.6419	0.6084
Portuguese financial firms	0.6953	0.6899	0.6603	0.1800
Italian financial firms	0.8568	0.8845	0.9062	0.9014
Spanish financial firms	0.4599	0.4964	0.6453	0.5317
Greek bond yield spreads	0.3790	0.3954	0.3997	0.4541
	p-value: squared residual autocorrelation $Q^2(15)$	*p*-value: squared residual autocorrelation $Q^2(15)$	*p*-value: squared residual autocorrelation $Q^2(15)$	*p*-value: squared residual autocorrelation $Q^2(15)$
Greek financial firms	0.5734	0.5762	0.5781	0.6393
Portuguese financial firms	0.9499	0.9530	0.9543	0.9532
Italian financial firms	0.2258	0.6011	0.4987	0.3038
Spanish financial firms	0.9853	0.9404	0.8760	0.9947
Greek bond yield spreads	0.9999	0.9999	0.9999	0.9999
Overall system	*p*-value: H_0: no Greek effect in mean	*p*-value: H_0: no Greek effect in mean	*p*-value: H_0: no Greek effect in mean	*p*-value: H_0: no Greek effect in mean
	0.1390	0.0000	0.1931	0.0008
Overall system	*p*-value: H_0: no GARCH effect	*p*-value: H_0: no GARCH effect	*p*-value: H_0: no GARCH effect	*p*-value: H_0: no GARCH effect
	0.0000	0.0000	0.0000	0.0000

Figure 1. Greek Sovereign Debt Yield Spreads

The figure below depicts Greek, Italian, Spanish, and Portuguese sovereign 5-year bond yield spreads relative to a German bond yield of the same maturity. The sample period spans 1/2005 to 6/2011.

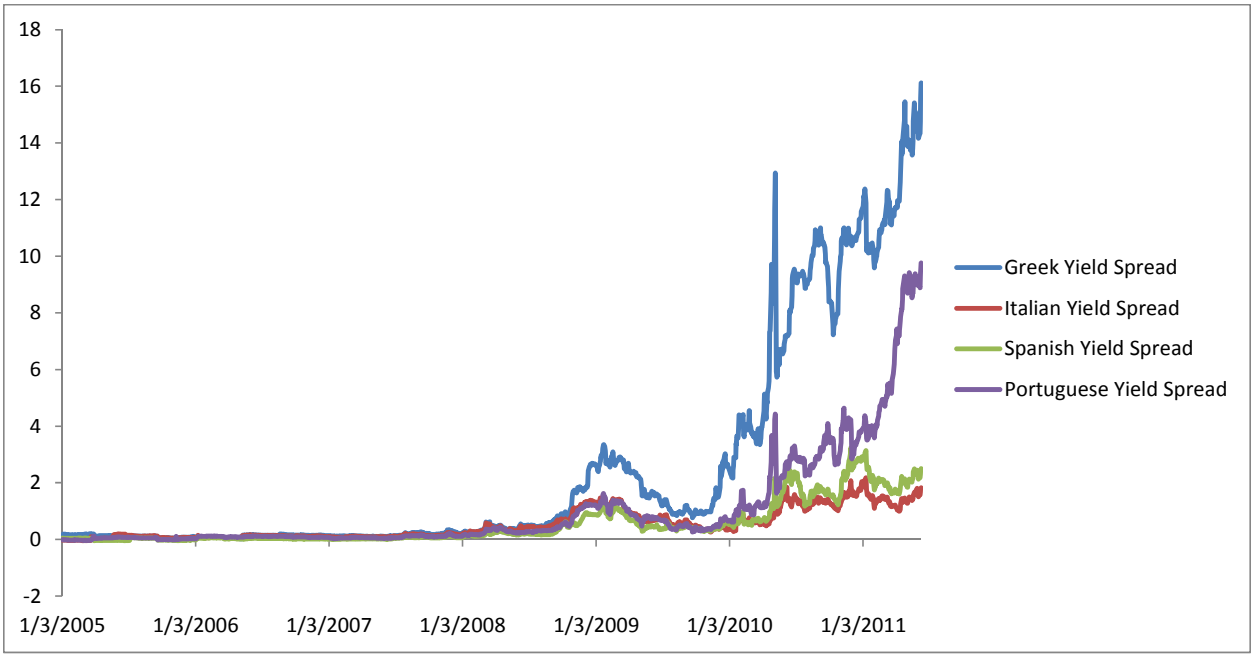

Figure 2. Changes in Greek Sovereign Debt Yield Spreads

The figure below depicts changes in Greek sovereign bond yield spreads relative to a German bond yield of the same maturity. The sample period spans 1/2005 to 6/2011.