Spreads, sovereign ratings and bank ratings in the euro financial crisis

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ABSTRACT

During the euro-area financial crisis, interactions between sovereign spreads, sovereign credit ratings, and bank credit ratings appeared to have featured self-generating feedback loops. To investigate the possibility of feedback loops, we use a simultaneous three-equation model in which spreads and sovereign and bank ratings are endogenous. Using a panel of five euro-area countries, we construct time series comprising the ratings of its sovereigns as determined by the three major rating agencies. We find that, controlling for the economic and political fundamentals, spreads and ratings strongly interacted during the crisis, producing effects well-beyond those predicted by the fundamentals, and with the interactions demonstrating high persistence.

Keywords: euro area financial crisis, sovereign spreads, rating agencies
JEL Classification: E63, G12

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1. Introduction

A large empirical literature has investigated the determinants of sovereign-bond spreads (and, in some cases, CDS spreads) in the euro-area's crisis countries -- typically taken to include Greece, Ireland, Portugal and Spain, but sometimes also Cyprus and/or Italy -- in the years preceding and during the euro-area crisis. A key finding of the literature is the following: the various fundamental variables that have been used in attempts to explain spreads are not able to account for either the very low spreads (measured relative to German sovereigns) that prevailed in the years preceding the outbreak of the euro-area crisis in 2009 or the very sharp rise in spreads that took place following the onset of the crisis. The general finding that spreads overshot (relative to the fundamentals) in a downward direction before the crisis and in an upward direction after the crisis holds regardless of (a) the mix of fundamental variables used to explain spreads and (b) whether the fundamentals are supplemented with additional variables -- for example, measures of contagion (Grammatikos and Vermuelen, 2012), measures of credit risk (Annaert, De Ceuster, Van Roy and Vespro, 2013), and/or sovereign credit ratings (Gibson, Hall, and Tavlas, 2014; Aizenman, Binici and Hutchison 2013; Alfonso, Furceri, and Gomes, 2011). Moreover, this finding is robust to the particular sample and time period used, and the estimation procedure employed.[1]

A prominent feature of the euro-area crisis -- and one that potentially can explain the difficulty that researchers have had in accounting for the movements in spreads on the basis of the fundamental variables -- has been the existence of doom loops -- that is, negative feedback loops -- among sovereign spreads, sovereign ratings, and bank ratings. To explain the intuition underlying these feedback loops, consider a world that includes two rating agencies, A and B. In assigning ratings to a particular sovereign assume that, initially, both agencies have access to essentially identical information sets comprised of the (present and projected) fundamentals, including spreads,

[1] For example, Gibson, Hall and Tavlas (2012, 2014) apply both ordinary least squares and the Kalman filter to Greek data, Arce, Mayordomo, and Peña (2013) apply a two-stage estimation procedure to a pooled sample of 32 euro-area banks, and Maltritz (2012) applies Bayesian estimation on a pooled sample of ten euro-area countries.

competitiveness, real growth, inflation, fiscal and external positions, and, perhaps, non-economic variables such as measures of political stability[2]. Suppose that, based on its assessment of the information set of a particular country, rating agency A moves to downgrade the sovereign debt of the country in question. The announcement of the downgrade will very likely trigger a rise in the sovereign's interest rate.[3] In addition, under the ECB's collateral framework, haircuts on sovereigns rise if ratings fall to a specified (triple-B) level and are non-eligible as collateral below the rating single-B minus. For these reasons, the action by rating agency A changes the information set available to rating agency B since that information set now includes both A's downgrade, the resulting higher interest rates, and possibly higher haircuts on collateral, lower projected growth (because of the rise in interest rates), and less-sustainable fiscal balances for the country in question. Consequently, rating agency B, which may have been content with the rating it had assigned to the sovereign in question prior to A's downgrade, may move to downgrade the sovereign's rating based on the changed information set. In this way, A's original action can precipitate a downgrade by B, triggering self-perpetuating feedback loops between sovereign ratings and spreads.

That, however, is not the end of the story. A salient feature of the euro-area crisis was the fact that (1) sovereign downgrades and rises of sovereign spreads led to downgrades of banks within the sovereign's jurisdiction, and (2) the bank downgrades contributed to both further sovereign downgrades and increases in spreads. This circumstance reflected the following factors. First, in the euro area, the governmental unit responsible for the health of the banks operating within its jurisdiction has been the individual nation state (in contrast to the situation in the United States, in which the federal government bears that responsibility). Second, the largest euro-area banks, which are roughly of the same size (in terms of total assets) as the largest U.S. banks, represent a much larger share of any individual *national* economy compared with the situation of U.S. banks. Hence, while the GDP of the euro-area economy as a whole is similar in magnitude to that of the United States, the governments of individual European countries have much smaller incomes that can be brought to bear in banking

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[2] None of the major rating agencies—Fitch, Moody's, and Standard and Poor's – makes available the analytical models used to determine sovereign ratings and bank ratings.
[3] Typically, market prices of sovereigns are tied to ratings.

crises than does the government of the United States. Third, compared with the United States, domestic euro-area banks typically hold relatively-large shares of debt issued by their respective national governments in their portfolios. An implication of these factors during the crisis was that downgrades of euro-area sovereigns weakened banks' balance sheets, which, in turn, increased the fiscal burdens of the sovereigns and led to doubts about the solvency of the sovereigns.

Thus, a move by a single credit-rating agency to downgrade a sovereign's rating had the potential to set-off a chain reaction of multiple-feedback loops among sovereign ratings, sovereign spreads, and bank ratings during the euro-area crisis. A stylized representation of this process includes the following chain.

- Agency A downgrades a sovereign. This downgrade raises the sovereign's spreads, inducing agency B to downgrade. The rise in spreads lowers the country's growth prospects and increases the debt burden, making it more difficult to service the debt. Banks' balance sheets deteriorate. These developments trigger downgrades of the banks of the country in question and a reduction in credit creation (because of the strains on banks' balance sheets). Spreads rise further.

- The sovereign downgrades by both agencies and the ensuing bank downgrades feed back into further sovereign downgrades. Spreads continue to rise; banks' balance sheets continue to deteriorate.

- Further sovereign and bank downgrades follow.[4]

The failure to account for such feedback loops in previous empirical studies may be a reason that these studies generally underpredicted the impact of changes in economic fundamentals on sovereign spreads during the crisis. In this paper, we account for these feedback loops by using a three-equation simultaneous-equation model that explains sovereign spreads, sovereign ratings, and bank ratings. To carry-out our investigation, we use a panel of five euro-area countries that were at the center of the euro crisis --

[4] The above representation is an accurate description of developments in Greece during the period end-2009 until mid-2012.

Greece, Italy, Ireland, Portugal, and Spain. The data are monthly and the estimation period is 1998m1 to 2013m3. For each country considered, we have constructed time series comprising the ratings of its sovereigns and its banks as determined by the three major rating agencies -- Fitch, Moody's, and Standard & Poor's (S&Ps). Our results indicate that, controlling for economic fundamentals and political stability, sovereign ratings, bank ratings, and spreads exhibit high degrees of auto-correlation and strongly interact with each other. Additionally, simulations suggest that changes in economic fundamentals and political stability can explain only a small proportion of the variation in spreads and ratings. A considerable part of the variation stems from previous movements in sovereign ratings, sovereign spreads and bank ratings, along with interactions among the three variables. These interactions tend to have long-lasting effects. We also find that ratings react slowly to news about the fundamentals, suggesting that the process of setting ratings may be marked by irrational behavior on the part of rating agencies.

The remainder of this paper is structured as follows. Section 2 provides some context to our conjecture that spreads and ratings interact, using the case of Greece, which experienced by-far more sovereign downgrades than any other euro-area country, to illustrate. Whereas Greece experienced 27 sovereign downgrades during the period examined, Portugal had 16, Spain, 15 and Italy, 11. Section 3 provides a theoretical model demonstrating the operation of feedback loops among sovereign spreads, sovereign ratings, and bank ratings. Section 4 describes our data and presents results in simultaneous-equation setting. In that section we also present the simulation results of the effects of changes in the fundamentals on spreads and ratings. Section 5 concludes.

2. Interactions between ratings and spreads

Sovereign ratings are important because they (1) directly influence the interest rate charged to the sovereign in the international capital markets, (2) affect size of the haircut applied to collateral (under the Eurosystem's collateral framework), and (3) impact on the ratings assigned to other borrowers, including banks, particularly of the same national jurisdiction.

Table 1 lists the ratings' categories for long-term debt for each of the three major agencies. Fitch and S&P use identical symbols in assigning credit risk. The symbols used by Moody's differ from those of the other two agencies, but each Moody's symbol has a counterpart in the ratings of Fitch and S&P. Typically, the ratings of sovereigns assigned by the three agencies have been in close correspondence; when the ratings have not been in correspondence they have tended to differ by one notch.

The trigger for the euro-area crisis occurred in early-October 2009 following national elections in Greece on October 4, 2009. Several days later a newly-elected (socialist) government surprised the markets with the announcement that the fiscal deficit for 2009 was on a track that would bring it to more than double the outgoing (conservative) government's projection of a deficit of 6 per cent of GDP.[5] Prior to the elections, each of the rating agencies had maintained the ratings on 10-year Greek sovereigns unchanged since at least 2004, as follows: Fitch, A; Moody's, A1; S&P, A. In reaction to the news about Greece's fiscal position, the rating agencies moved quickly. The following account focuses on Greece, but the ratings-downgrade scenario was replicated (though to a lesser extent) in other euro-area crisis countries.

On October 10, 2009, S&P downgraded the 10-year Greek sovereign from A to Aminus (Figure 1). On October 22, 2009, Fitch followed with an identical move. With the financial situation deteriorating,[6] spreads began to rise sharply (Figure 1). On December 8, 2009, Fitch moved again, cutting the sovereign rating from A-minus to triple-B-plus. On December 15, 2009, S&P followed with an identical move. Six days later, on December 22, 2009, Moody's cut its sovereign rating from A1 to A2. Sovereign downgrades were followed in rapid succession by downgrades of Greek banks. The processes of negative feedback loops between sovereign downgrades and spreads, and between sovereign downgrades and bank downgrades, were underway. Over the next 27 months (*i.e.,* until March 2012), 18 additional downgrades of the sovereign took place; by the beginning of March 2012, Greek sovereigns were rated in the "selective default" category. During that 27-month period, the four major Greek banks (accounting for 85 per cent of the banking sector at the onset of the crisis) underwent a total of 76

[5] The final figure would be a deficit of 15.6 per cent of GDP.
[6] The rises in spreads made it increasing difficult for the government to service the debt.

separate downgrades[7]. At the end of the period, the banks were not able to use Greek sovereigns as collateral at the ECB.[8] The spread on the 10-year sovereign rose from 230 basis points at end-December 2009 to a peak of 3,800 basis points in February 2012.

3. Theoretical model

4. Spreads-credit ratings interactions: system estimates

To shed light on the empirical relationships among sovereign ratings, sovereign spreads, and commercial bank ratings, we now provide estimates for the determinants of those variables using a three-equation simultaneous-equation system.

We use a panel GMM estimator, which is robust to autocorrelation and heteroskedasticity (HAC). To explain our empirical set-up, consider a group of n countries, estimated over T periods. Our baseline model can be expressed as:

$$S_{it} = \alpha_0 + \alpha_1 SR_{it} + \alpha_2 BR_{it} + \sum_{k=1}^{K} \alpha_{2+k} X_{itk} + \varepsilon_{it}$$
$$SR_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 BR_{it} + \sum_{k=1}^{K} \beta_{2+k} X_{itk} + \omega_{it}$$
$$BR_{it} = \chi_0 + \chi_1 S_{it} + \chi_2 SR_{it} + \sum_{k=1}^{K} \chi_{2+k} X_{itk} + \upsilon_{it}$$

where i=1…N, t=1…T and K is the number of exogenous regressors. S_{it} is the interest rate spread between country i and Germany, SR_{it} is the sovereign rating for country i, BR_{it} is the rating for commercial banks in country i, and ε_{it} , ω_{it} and v_{it} are error terms. We assume there are suitable exclusion restrictions on *α's, β's* and *χ's* to either exactly-identify or to over-identify the system.

GMM estimation requires the specification of a set of theoretical moment conditions that the parameters of interest φ should satisfy. Thus,

$$E(m(y,\varphi)) = 0$$

[7] The four major banks and the respective number of downgrades were as follows: NBG 18, Piraeus 18, Alpha Bank 20, Eurobank 21.

[8] The banks had to satisfy their liquidity needs by obtaining Emergency Liquidity Assistance (ELA) from the Bank of Greece. The cost of borrowing ELA is higher than that under the Eurosystem's monetary-policy operations.

where y is a vector of variables relevant for the specific moment conditions being specified , m is the moment function (e.g. mean, covariance, etc.), and the method of moments estimator is defined by replacing these population moments with their sample analogs.

$$\sum_t m(y_t, \varphi)/T = 0$$

In the case of the specific GMM estimator we are using, the moment conditions are specified in terms of orthogonality conditions between the residuals of each equation and a set of instruments (Z_t). That is, ε_{it} ω_{it} and υ_{it} are assumed to be orthogonal to the vector of instrumental variables Z.

If the number of parameters of interest is exactly equal to the number of moment conditions, then we can exactly satisfy these moment conditions and we obtain the method of moment's estimator. However, if the number of moment conditions is greater than the number of parameters of interest, then we cannot meet all the moment conditions at the same time. In this case, we minimize the following function, which gives rise to the Generalised Method of Moments (GMM):

$$\sum_t m(y_t, \varphi) A(y_t, \varphi) m(y_t, \varphi)$$

where A is a weighting matrix. While any positive definite symmetric matrix will give rise to a consistent estimator, the optimal A is given by the inverse of the covariance matrix of the moment conditions. When the number of endogenous variables exactly equals the number of instruments, the model is exactly identified. When there are less instruments than endogenous variables the model is underidentified and cannot be estimated. When there are more instruments than endogenous variables the model is overidentified. In the case of our estimates below, the model is overidentified.

Our focus is on five southern European countries that were at the center of the euro crisis, Greece, Italy, Ireland, Portugal, and Spain. With the exception of Italy, each of these countries came under an ECB-EU-IMF adjustment programme. Italy almost had to resort to such a programme in 2011. In August 2011, however, the ECB began buying Italian government debt under the ECB's Securities Market Programme (SMP) which brought-down Italian spreads, easing the crisis in that country[9]. The data are monthly and the panel is unbalanced; most of the data are, however, available over the entire estimation period, 1998m1 to 2013m3. In those cases for which the original data are quarterly or annual, the data have been interpolated to a monthly frequency. The three dependent variables are defined as follows:

Spreads. Spreads are the yield on each country's 10-year government bond relative to that of Germany.

Sovereign ratings. We constructed a series for sovereign ratings using the ratings of the three rating agencies. We date rating changes after identifying first-moves. Thus, to take a stylized example, assume a country is rated AAA by all three agencies in month 1. Then one agency downgrades the country to AA+ in month 2. This is counted as a downgrade and is registered in our series. If another agency downgrades the country to AA+ in month 3, this does not count in our series (the country is already considered to be at AA+. Similarly, if the country in question is downgraded within the same month by all three agencies, we can count only one of the downgrades – our data are monthly and, therefore, cannot capture multiple downgrades within a month. To the extent that we can only capture first-moves, therefore, our series underestimates downgrades and the potential for doom-loops. Having constructed an ordinal series for ratings, we then transform the series into a cardinal series (as shown in Table 1). A rise in the rating indicates a downgrading of the sovereign.

Banking system ratings. Banking-system ratings are defined as the average rating of the largest (in terms of assets) two banks in each country (four banks in the case of Greece). The data on bank ratings for Italy, Ireland, Portugal, and Spain were provided to us by the ECB under the condition that the data be kept confidential. Once again, a rise in the series on the banking system rating implies a downgrading of the system's banks.

For each of the three equations, we use five explanatory variables that aim to capture the effects of the economic fundamentals and a variable that measures political stability. In addition, for the equation that has bank ratings as a dependent variable we

[9] Cyprus came under an adjustment programme in early 2012. We do not include Cyprus in our sample because of a lack of sufficient data.

use three banking-system-specific variables. In the final specification, the variables are retained if they are significant at the 5 per cent level and if they have the expected sign. The explanatory variables are as follows.

Real GDP growth. A relatively high rate of economic growth suggests that a country's existing debt burden will become easier to service over time. Thus, an increase in the real growth rate should reduce spreads and produce a fall (*i.e.,* improvement) in sovereign ratings and bank ratings.

Relative prices. To help capture relative changes in competitiveness, we use each country's Harmonized Index of Consumer Prices (HICP, all items index) relative to that of Germany. A (substantial) rise in a country's relative prices signals a decline in competitiveness, which should raise the country's spreads, and worsen its sovereign ratings and banks' ratings.

External balance. A large current-account deficit (relative to GDP) indicates that the public and private sectors together rely (heavily) on funds from abroad. Persistent current-account deficits result in growth of foreign indebtedness, which may become unsustainable over time. Thus, an increase in the current-account deficit (a negative change), should cause spreads to rise, so that the expected sign on the current-account variable is negative. Correspondingly, a rise in the deficit, if sustained, should lead to rating downgrades for a country's sovereign and its banks.

Government debt. A higher debt burden should correspond to a higher risk of default. We include the general government consolidated gross debt expressed as a percentage of GDP, interpolated from a quarterly to a monthly frequency. The expected sign of a rise in debt on spreads is positive; the expected sign on the ratings variables is also positive (i.e., a worsening of the sovereign's ratings raises spreads).

Fiscal news. In order to capture both a country's fiscal situation and the news (or surprise) element that has figured strongly in the euro-area experience, we construct real-time fiscal data. In particular, using the European Commission Spring and Autumn forecasts, we create a series of forecast revisions. For example, the revision in the Spring 2001 forecasts is the 2001 deficit/GDP ratio in the Spring compared to the forecast for

2001 made in the Autumn of 2000. This procedure allows us to generate a series of revisions, which, when cumulated over time, provides a cumulative fiscal news variable. A decrease in this variable indicates an unexpected move to a larger fiscal deficit, which should increase spreads. Thus, the expected sign on spreads is negative. Similarly, a decrease in the variable should lead to downgrades in the ratings of both the sovereign and a country's banks. Again, the expected sign is negative.

Political stability. To measure the political climate, we use the IFO World Economic Survey Index of Political Stability. A rise in the index implies greater stability, which implies a negative relationship with spreads and the ratings of both the sovereign and a country's banks.[10]

As mentioned above, with the exception of Greece, we used the ratings on the largest two banks (in terms of total assets) in each of the countries considered as a measure of bank ratings. In the case of Greece, we had access to the ratings of the four largest commercial banks, and so we used the ratings of those four banks as the measure of banks ratings. To explain bank ratings, we use the following three variables to capture developments in a country's banking system, as represented by a country's five largest banks.[11]

Loan loss reserves/non-performing loans (NPLs). Rising NPLs are a problem for banks to the extent that banks cannot cover potential losses. The higher a bank's reserves, the stronger the bank's ability to service NPLs and, hence, the better the rating. Thus we anticipate a negative sign on the coefficient of this variable.

Pre-tax operating income/average total assets. This provides a measure of banking system profitability. Since profits can, if retained, generate internal capital, which covers unexpected losses, a rise in profitability would be expected to improve (decrease) credit ratings. A negative sign is thus expected.

[10] Apart from the fiscal-news variable, the above variables are standard variables used in the empirical literature dealing with the determinants of spreads. The fiscal-news variable was first used by Gibson, Hall, and Tavlas (2012). It has subsequently been incorporated in other studies.

[11] The use of five banks in constructing the explanatory variables for each county's banking system reflects the fact that we had access to such data, in contrast to the availability of data on bank downgrades.

Interbank ratio. This ratio indicates the net position of the banking system in the interbank market. A value above 100 implies that the system is a net lender of funds in the interbank market. Thus a negative relationship between the interbank ratio and banking system ratings is anticipated.

The results of estimating this 3-equation system are presented in Table 2. The following findings merit discussion.

i. As expected, both the sovereign spreads equation and the sovereign ratings equations are directly impacted by the economic fundamentals. For sovereign spreads, the current account, fiscal news, relative prices, and real growth are significant. For sovereign ratings, government debt, fiscal news, and real growth are significant. In addition, political stability is significant in the spreads equation.

ii. The three banking-system-specific variables are each significant in the bank-rating equation. Increases in loan-loss reserves to NPLs, profitability, and the net interbank position all lead to improvements in banking system ratings (a decline in the cardinal index).

iii. All three equations display strong persistence.

iv. All three equations display simultaneity. Sovereign ratings help determine sovereign spreads (note that bank ratings do not directly impact on spreads). Sovereign spreads and bank ratings help determine sovereign ratings. Finally, sovereign ratings and sovereign spreads help determine bank ratings.

These results provide evidence of the presence of negative feedback loops among spreads, sovereign ratings and bank ratings. Exogenous shocks to the economic, banking, and political fundamentals are propagated within the system through the interactions among the equations. To illustrate the propagation of exogenous shocks, we present the results of a simulation exercise, in which we show the impact of a permanent 1-notch downgrade to sovereign ratings, bank ratings and spreads.

The results are shown in Figure 2a to 2c. The long-run effect of the 1-notch downgrade of the sovereign rating on that same variable is a downgrade of about 2.9 notches (Figure 2a). This result reflects the impact of the initial rating downgrade on spreads, which, in turn, feeds back into sovereign ratings, and the impact of the lagged sovereign rating. The effect is non-linear, with more than half of the total adjustment occurring in the first two years.

The propagation mechanisms present in the system imply that a shock to each fundamental determinant of spreads and/or ratings will have both impact effect (equal to $\beta_{2+k}\Delta X_{ik}$) and a long-term effect which takes the interactions into account. To assess the extent to which fundamentals affect spreads and ratings, we calculate these effects. In carrying-out this exercise, we focus on what we considered plausible shocks to the fundamentals, based on developments during the euro-area crisis. For example, in one simulation we assume a 10 percentage points' rise in a country's debt-to-GDP ratio. By way of comparison, Greece's debt-to-GDP ratio rose by 20 percentage points in 2009, while Ireland's debt ratio jumped by 12 percentage points in 2011 and again in 2012. The other shocks that we consider are: (i) a deterioration in the square of fiscal news of 10 percentage points -- that is, an unanticipated rise in the fiscal deficit of somewhat more than 3 percentage points; (ii) a 2.5 percentage points widening of the current-account deficit relative to GDP; (iii) a 10 percent increase in prices relative to German prices; and (iv) a 1-percentage point reduction in real economic growth. All of the shocks are assumed to be sustained.

The results are reported in Table 3. Consider, first, the shock (of 10 percentage points) to the debt-to-GDP ratio. Initially, the shock results in a sovereign downgrade of only 0.13 of a notch. However, the effect builds over time and reaches 1.2 notches in 5 years, a considerable increase as a result of the interactions. The shock has no immediate impact on spreads, but the interaction effects lead to a rise in spreads of 136 basis points after five years. The impact effect on bank ratings is also zero, but the total effect rises to almost 1 notch in the long run.

Both a deterioration in relative prices and a worsening of the current account (as a percentage of GDP) have small impact and long-run effects on both spreads and bank ratings (rises of 40 basis points and 90 basis points, respectively for spreads, and downgrades of one-tenth of a notch in the long run for bank ratings). The impact of shocks to competitiveness on ratings is smaller than the debt-to-GDP increase. Negative fiscal news and a deterioration in growth (equivalent to an annual decline of 1 percentage point) also have small effects on spreads and ratings. In the case of growth, this suggests that most of the negative impact of a deterioration in growth comes through its effect on the debt-to-GDP ratio and the current-account-to-GDP ratio; there is no independent effect from growth. Since the figures in Table 2 examine the effect of a change in growth, holding these two ratios constant, to calculate the full effect of growth on spreads and/or ratings, we would have to add together the direct growth effect plus the indirect effects through the growth-induced reduction in both the current-account-to-GDP ratio and the debt-to-GDP ratio.

The effects of the exogenous macroeconomic shocks at first sight appear rather small relative to the large movement in spreads and ratings that have been observed since 2008 (see Figure 1). However, it is important to recall that euro-area countries experienced simultaneous shocks. In order to assess how much of the rise in spreads and the changes in both sovereign and credit ratings that our model can explain, we undertake a second set of simulations: for each country, we examine the deterioration in the independent variables that, in fact, occurred. For competitiveness, we measure the deterioration in relative prices and the current account-to-GDP ratio over the period 2000 to 2008 (when current-account deficits in most countries peaked). In the case of Italy, relative prices continued to deteriorate until 2011 and so we use that year as our end-date. We employ a similar methodology for the political stability index and fiscal news. In the case of the debt-to-GDP ratio and growth, we focus on more recent developments. We use the cumulative deterioration in the debt-to-GDP ratio and growth from the beginning of 2008 until the beginning of a country's adjustment programme[12]. In the case of Italy, which was not under a programme, we focus on the period from the beginning of 2008 until the sharp rise in spreads in the summer of 2011.

[12] Greece came under an adjustment programme in May 2010, Ireland in December 2010, Portugal in May 2011, and Spain in July 2012. Spain's programme applied to that country's banking sector.

This approach allows us to incorporate possible learning effects in the markets. Specifically, we do not expect rating agencies or markets to react immediately and fully to changes in economic fundamentals; therefore, we allow for lags. Such lags could result either from inertia or from the impact of nonlinearities, reflecting the idea that the deterioration in fundamentals has to cumulate significantly before rating agencies and markets will react.

The results of this exercise, along with the specific assumptions underlying the exercise are reported in Table 4.

Spreads. For Italy and Spain, the model overpredicts the rise in sovereign spreads. In the case of Italy, spreads peaked at around 500 basis points; the model predicts a long-run impact of 720 basis points. For Spain, the predicted rise in spreads is 1,450 basis points, whereas the actual peak in spreads was 550 basis points. In the cases of Ireland and Portugal, the model predictions are close to actual developments. For Ireland, spreads peaked at 1,000 basis points whereas our predicted value is 1,080 basis points. For Portugal, the corresponding figures are 1,230 basis points (actual) and 980 basis points (predicted). In the case of Greece, spreads peaked at 3,360 basis points, compared with a predicted rise of 2,190 basis points.

Sovereign ratings. With the exception of Spain, for which the model predicts a downgrade of 8.9 notches, compared with an actual downgrade of 4 notches, the predictions of the model are close to actual developments. Here are the actual and predicted downgrades, respectively: Greece, 12.4 notches (actual) and 13 notches (predicted); Ireland, 8 notches (actual) and 7 notches (predicted); Italy, 4 notches (actual) and 4 notches (predicted); Portugal, 6.6 (actual) notches and 7 notches (predicted).

Bank ratings. With the exception of Portugal, for which the model predicts a downgrade of 4.8 notches, compared with an actual downgrade of 8 notches, the predictions of the model are again close to the actual downgrades. The predicted and actual downgrades, respectively, are as follows: Greece, 9.3 notches (actual) and 11.7 notches (predicted); Ireland 7 notches (actual) and 5.5 notches (predicted); Italy 3.1 notches (actual) and 4.3 notches (predicted); Spain, 5.5 notches (actual) and 6.8 notches (predicted).

Finally, Table 5 reports the contributions of the specific banking variables to bank ratings. We examine the impact on bank ratings of a 1 standard deviation deterioration in (i) the loan loss reserves ratio, (ii) profitability and (iii) net lending in the interbank market. Since there is considerable variation across countries, we provide results both by country and for all countries as a group. The results suggest that bank-specific fundamentals play only a small role in explaining movements in bank ratings. The largest effect comes from a decline in pre-tax operating income as a proportion of assets which in the long run is predicted to lead to a 2.5-notch downgrade on average for all countries and a 3-notch and 4-notch downgrades in the cases of Ireland and Greece, respectively.

5. Conclusions

This paper has examined the interactions between sovereign spreads and sovereign ratings and bank ratings, while controlling for economic fundamentals and political stability which also influence spreads. The aim was to examine whether there was any support for the widely-held view that the current euro area crisis has been characterised by interactions between sovereign spreads and credit ratings of the sovereign and banks which led to self-generating feedback loops.

To this end, we estimated a simultaneous three-equation model. Using a panel of 5 euro-area countries, those more likely to be affected by the feedback loops, we found that, controlling for the economic and political fundamentals, spreads and ratings strongly interacted with each other during the crisis. The effects produced go well-beyond those of the fundamentals and the dynamics demonstrate high levels of persistence.

Simulations suggest that this system of equations can explain movements in spreads and ratings better than focusing purely on fundamentals. They also suggest that spreads in Spain and Italy rose by less than would have been predicted by the model, whereas those in Portugal, and even more so Greece, rose by more. Similarly, downgrades were more prevalent in Greece and Portugal than would have been predicted by the model, whereas in Spain they were less so. The results taken together provide support for the view that Greece's treatment, relative to other euro-area countries during the crisis, was special.

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Table 1: S&P, Moody's and Fitch ratings

Interpretation	Moody's	Fitch/Standard and Poor's	Numerical representation in the paper
INVESTMENT - GRADE RATINGS			
Highest credit quality – Lowest expectation of default – exceptionally strong capacity for payment	Aaa	AAA	1
Very high credit quality – Very low default risk – Very strong capacity to meet financial commitments	Aa1 Aa2 Aa3	AA+ AA AA-	2 3 4
High credit quality – Low default risk -Strong payment capacity	A1 A2 A3	A+ A A-	5 6 7
Good credit quality – Expectations of default risk are currently low - Adequate payment capacity but subject to business or economic conditions	Baa1 Baa2 Baa3	BBB+ BBB BBB-	8 9 10
SPECULATIVE - GRADE RATINGS			
Speculative - Elevated vulnerability to default risk - Likely to fulfill obligations, ongoing uncertainty	Ba1 Ba2 Ba3	BB+ BB BB-	11 12 13
Material default risk present, but a limited margin of safety remains – High-risk obligations	B1 B2 B3	B+ B B-	14 15 16
Substantial Credit Risk – Default is a real possibility	Caa1 Caa2 Caa3	CCC+ CCC CCC-	17 18 19
Very high levels of credit risk – Default appears probable	Ca	CC	20
Exceptionally high levels of credit risk – default is imminent or inevitable, or the issuer is at a standstill	C	C	21
Issuer has experienced an uncured payment default on any material financial obligation but is has not entered into bankruptcy filings, administration, liquidation or any other formal winding-up procedure		SD/RD	22
Default - Issuer has entered into bankruptcy filings, administration, liquidation or any other formal winding-up procedure		D	23

Table 2: System estimation: the determinants of sovereign spreads, sovereign ratings and banking system ratings.

GMM estimation
Observations: 1630 **Sample: 1998(11)-2013(3)**

		Coefficient	Std. Error	t-Statistic	Prob.
Constant – GR	SPREADS EQUATION	-0.849184	0.014243	-59.62264	0.0000
Current account to GDP		-0.022613	0.000538	-42.02571	0.0000
Relative prices		0.240805	0.048763	4.938326	0.0000
Cumulative fiscal news		-0.003432	9.85E-05	-34.85228	0.0000
Growth		-2.045392	0.384427	-5.320620	0.0000
Political stability		-0.003217	0.001088	-2.956038	0.0031
Spreads (t-1)		0.890246	0.001380	645.2097	0.0000
Sovereign rating		0.127111	0.001643	77.38063	0.0000
Constant – GR	SOVEREIGN RATING EQUATION	-0.526808	0.010873	-48.45042	0.0000
Debt to GDP		0.012619	0.000159	79.39651	0.0000
Cumulative fiscal news		-0.001173	3.49E-05	-33.62990	0.0000
Growth		-6.236736	0.289837	-21.51810	0.0000
Sovereign rating (t-1)		0.777853	0.002161	359.9345	0.0000
Spreads		0.064031	0.000657	97.46705	0.0000
Banks rating		0.070018	0.001183	59.18073	0.0000
Constant – GR	BANKS RATING EQUATION	0.337792	0.013429	25.15452	0.0000
Spreads		0.004667	0.000952	4.904434	0.0000
Sovereign rating		0.028959	0.001535	18.86567	0.0000
Loan-loss reserves/NPLs		-0.000434	2.22E-05	-19.55080	0.0000
Profits/total assets		-0.068317	0.002618	-26.09449	0.0000
Interbank position		-0.000823	5.70E-05	-14.45217	0.0000
Banks rating(t-1)		0.958607	0.001370	699.8056	0.0000
Constant – PT – spread eq.		-0.655299	0.011337	-57.79937	0.0000
Constant – PT – sovereign rating eq.		-0.344423	0.006798	-50.66428	0.0000
Constant – PT – banks rating eq.		0.305544	0.012048	25.36034	0.0000
Constant – SP – spread eq.		-0.303297	0.009227	-32.87086	0.0000
Constant – SP – sovereign rating eq.		-0.603665	0.007325	-82.41048	0.0000
Constant – SP – banks rating eq.		0.341608	0.010447	32.69890	0.0000
Constant – IT – spread eq.		-0.480201	0.008127	-59.08815	0.0000
Constant – IT – sovereign rating eq.		-0.817332	0.013058	-62.59229	0.0000
Constant – IT – banks rating eq.		0.217112	0.008940	24.28496	0.0000
Constant – IR – spread eq.		-0.176652	0.004955	-35.65385	0.0000
Constant – IR – sovereign rating eq.		-0.546392	0.008218	-66.48565	0.0000
Constant – IR – banks rating eq.		0.279047	0.008863	31.48370	0.0000
Determinant residual covariance			5.72E-19		
J-statistic			0.207718		

Greek equation for spreads

R-squared	0.967434	Mean dependent var	3.930459
Adjusted R-squared	0.965884	S.D. dependent var	7.544456
S.E. of regression	1.393509	Sum squared resid	285.4544

Durbin-Watson stat	1.270892

Greek equation for sovereign ratings

R-squared	0.966417	Mean dependent var	8.077419
Adjusted R-squared	0.965055	S.D. dependent var	4.249577
S.E. of regression	0.794397	Sum squared resid	93.39788
Durbin-Watson stat	1.616068		

Greek equation for banks ratings

R-squared	0.991759	Mean dependent var	8.964072
Adjusted R-squared	0.991450	S.D. dependent var	3.364830
S.E. of regression	0.311126	Sum squared resid	15.48793
Durbin-Watson stat	1.636632		

Portuguese equation for spreads

R-squared	0.984154	Mean dependent var	1.778279
Adjusted R-squared	0.983415	S.D. dependent var	3.084730
S.E. of regression	0.397261	Sum squared resid	23.67240
Durbin-Watson stat	1.206978		

Portuguese equation for sovereign ratings

R-squared	0.989999	Mean dependent var	5.000000
Adjusted R-squared	0.989601	S.D. dependent var	2.897396
S.E. of regression	0.295460	Sum squared resid	13.18181
Durbin-Watson stat	1.864393		

Portuguese equation for banks ratings

R-squared	0.993331	Mean dependent var	6.214221
Adjusted R-squared	0.993104	S.D. dependent var	2.113866
S.E. of regression	0.175534	Sum squared resid	5.453774
Durbin-Watson stat	1.547790		

Spanish equation for spreads

R-squared	0.976426	Mean dependent var	0.873311
Adjusted R-squared	0.975326	S.D. dependent var	1.361855
S.E. of regression	0.213920	Sum squared resid	6.864273
Durbin-Watson stat	1.401377		

Spanish equation for sovereign ratings

R-squared	0.970643	Mean dependent var	2.037975
Adjusted R-squared	0.969476	S.D. dependent var	1.199183
S.E. of regression	0.209509	Sum squared resid	6.628004
Durbin-Watson stat	1.214803		

Spanish equation for banks ratings

R-squared	0.992557	Mean dependent var	4.763287
Adjusted R-squared	0.992305	S.D. dependent var	1.891656
S.E. of regression	0.165941	Sum squared resid	4.873932
Durbin-Watson stat	1.897821		

Italian equation for spreads

R-squared	0.958377	Mean dependent var	0.879503
Adjusted R-squared	0.956590	S.D. dependent var	1.180973
S.E. of regression	0.246058	Sum squared resid	9.868728

Durbin-Watson stat	0.982985		

Italian equation for sovereign ratings

R-squared	0.966943	Mean dependent var	4.578948
Adjusted R-squared	0.965733	S.D. dependent var	1.264177
S.E. of regression	0.234015	Sum squared resid	8.981147
Durbin-Watson stat	1.080870		

Italian equation for banks ratings

R-squared	0.988379	Mean dependent var	5.330407
Adjusted R-squared	0.987971	S.D. dependent var	1.010421
S.E. of regression	0.110821	Sum squared resid	2.100095
Durbin-Watson stat	1.717290		

Irish equation for spreads

R-squared	0.967655	Mean dependent var	1.579903
Adjusted R-squared	0.966458	S.D. dependent var	2.306770
S.E. of regression	0.422476	Sum squared resid	24.09556
Durbin-Watson stat	1.343515		

Irish sovereign ratings equation

R-squared	0.989744	Mean dependent var	2.773050
Adjusted R-squared	0.989285	S.D. dependent var	2.788673
S.E. of regression	0.288669	Sum squared resid	11.16620
Durbin-Watson stat	1.881685		

Irish banks ratings equation

R-squared	0.994887	Mean dependent var	6.044400
Adjusted R-squared	0.994688	S.D. dependent var	1.893348
S.E. of regression	0.137992	Sum squared resid	2.932438
Durbin-Watson stat	1.632692		

Instruments:

Current account to GDP, relative prices, general government balance to GDP ratio, debt to GDP, fiscal news, growth, political stability, lagged spreads, lagged ratings (both bank and sovereign), lagged debt to GDP, lagged GDP growth and, specific to the banks ratings equations, loan reserve losses to NPLs, profits to total assets and interbank position.

Table 3: The impact of changes in economic fundamentals: some simulation results

	Impact on sovereign ratings (notches)*		Impact on spreads (basis points)		Impact on banks ratings (notches)*	
Exogenous shock	Impact effect	Long-run effect	Impact effect	Long-run effect	Impact effect	Long-run effect
10pp increase in debt-to-GDP ratio	0.13	1.2	0	136	0	0.85
Deterioration in the square of cumulative fiscal news of 10 points	0.1	0.32	0.02	37	0	0.24
2.5pp deterioration in the current account to GDP ratio	0	0.34	5.7	90	0	0.28
10% increase in prices relative to Germany	0	0.14	2	38	0	0.12
1pp lower growth (per annum)	0.005	0.06	0.02	4	0	0.85
* a positive number implies a deterioration						

Table 4: Simulation results a simultaneous deterioration in the exogenous determinants of spreads and ratings

	Impact on sovereign ratings (notches)*			Impact on spreads (basis points)			Impact on banks ratings (notches)*		
	Impact effect	Long-run effect	Actual change	Impact effect	Long-run effect	Actual change	Impact effect	Long-run effect	Actual change
Greece	0.78	12.4	13	99	2190	3363	0.02	9.3	11.7
Ireland	0.7	8.0	7	30	1080	994	0.02	5.7	7
Italy	0.3	4.0	4	34	720	491	0.01	3.1	4.3
Portugal	0.57	6.6	7	33	973	1232	0.02	4.8	8
Spain	1.0	8.9	4	74	1450	555	0.03	6.8	5.5

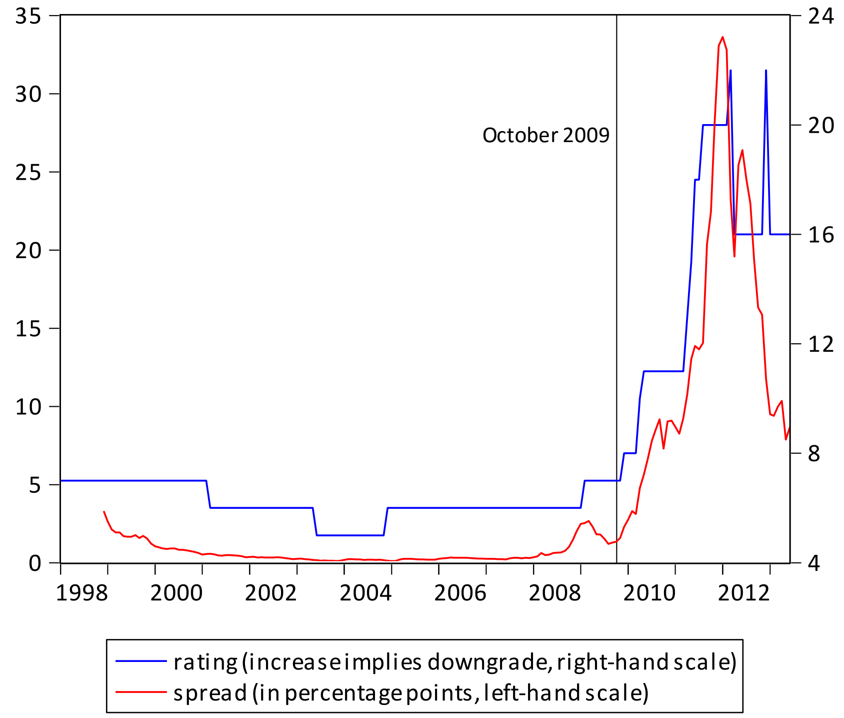
Assumptions:	
(i) Greece	
Current account to GDP	10pp deterioration
Relative prices	17% deterioration
Debt to GDP	37pp deterioration
Cumulative fiscal news	11.3pp deterioration
Political stability	6 point deterioration
Growth	actual growth 2009-2010
(ii) Ireland	
Current account to GDP	6pp deterioration
Relative prices	14% deterioration
Debt to GDP	52pp deterioration
Cumulative fiscal news	11.3pp deterioration
Political stability	3 point deterioration
Growth	Actual growth 2008-2010
(iii) Italy	
Current account to GDP	6pp deterioration
Relative prices	7% deterioration
Debt to GDP	15pp deterioration
Cumulative fiscal news	4.5pp deterioration
Political stability	3 point deterioration
Growth	actual growth 2008-2010
(iv) Portugal	
Current account to GDP	2pp deterioration
Relative prices	8% deterioration
Debt to GDP	37pp deterioration
Cumulative fiscal news	5.7pp deterioration
Political stability	no change

Growth	actual growth 2009-2010
(v) Spain	
Current account to GDP	6.5pp deterioration
Relative prices	19.5% deterioration
Debt to GDP	39pp deterioration
Cumulative fiscal news	7.5pp deterioration
Political stability	2.5 point deterioration
Growth	actual growth 2009-2012

Table 5: The impact of a deterioration in banking fundamentals on bank ratings

		Spain	Portugal	Italy	Ireland	Greece	All countries
Loan loss reserves/NPLs	Impact	0.03	0.02	0.002	0.005	0.006	0.02
	Long-term	1.04	0.85	0.08	2.1	0.25	0.86
Pre-tax operating income/total assets	Impact	0.04	0.04	0.03	0.08	0.11	0.07
	Long-term	1.48	1.43	0.97	3.16	4.05	2.5
Interbank ratio	Impact	0.02	0.02	0.02	0.008	0.04	0.03
	Long-term	0.82	0.58	0.56	0.34	1.43	1.0

Figure 1: Spreads and ratings in Greece



Note: Ratings have been transformed into a numerical series running from 1, equivalent to AAA, through to 22, which is selected default.

Figure 2a: The response of sovereign ratings to a 1-notch permanent downgrade of the sovereign

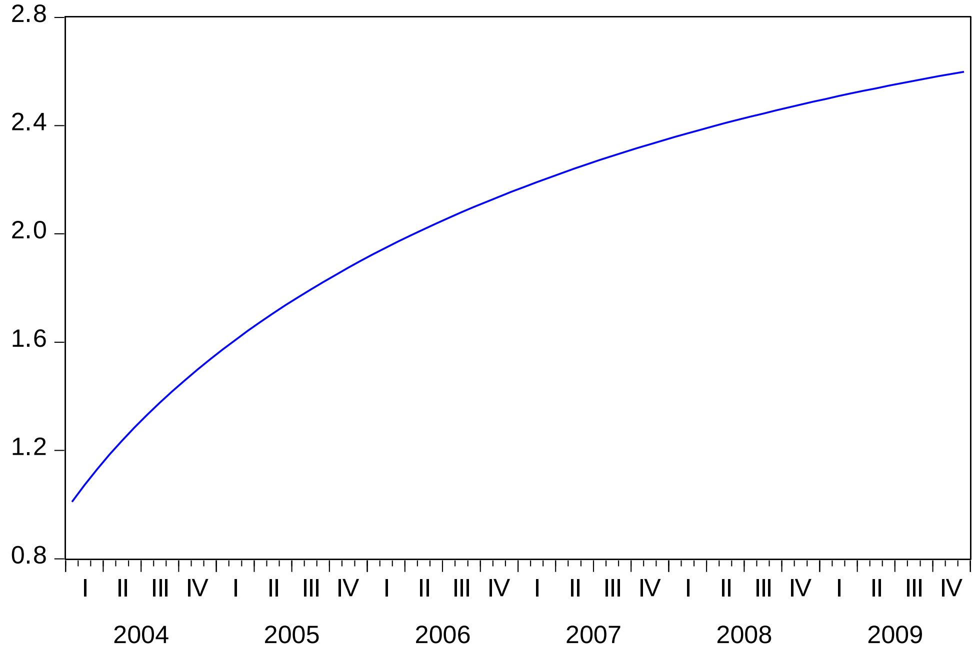


Figure 2b: The response of spreads to a 1-notch permanent downgrade of the sovereign

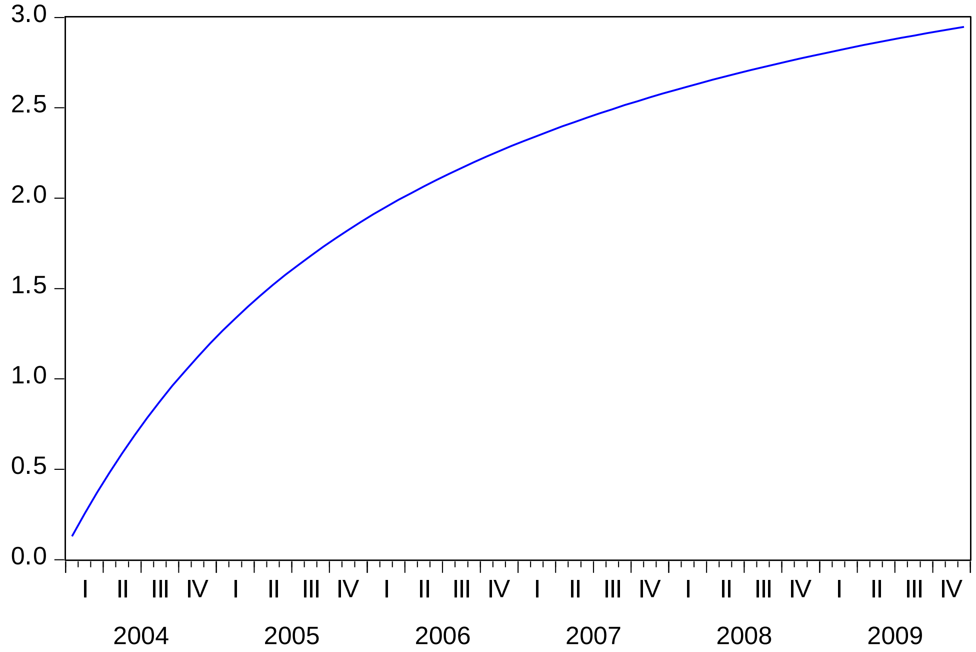


Figure 2c: The response of banking system ratings to a 1-notch downgrade in sovereign ratings