Sovereign credit ratings, market volatility, and financial gains*

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Abstract

We investigate the reaction of bond and equity market volatilities in the EU to sovereign rating announcements (Standard & Poor's, Moody's, and Fitch), using panel analysis with daily stock market and sovereign bond returns. The parametric volatilities are defined using EGARCH specifications. We find that upgrades do not have significant effects on volatility, but downgrades increase stock and bond market volatility. Contagion is present, with a downgrade increasing the volatility of all other countries. There is a financial gain and risk reduction, value-at-risk, for portfolio returns when taking into account sovereign credit ratings' information for volatility modelling, with financial gains decreasing with higher risk aversion.

JEL: C22; C23; E44; G11; G15; H30.

Keywords: sovereign ratings; yields; stock market returns; volatility; EGARCH; optimal portfolio; financial gain; risk management; value-at-risk.

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1. Introduction

In the last few years, we have seen the importance of credit rating agencies (Standard & Poor's, Moody's, and Fitch) and their crucial task in providing information on which investors base their decisions. These agencies often had a more important role than the one played by governments, and their actions even more often neutralized the decisions taken by those government institutions. After the 2008-2009 financial and economic crisis, volatility in financial markets has increased markedly in several European Union (EU) countries, notably in the euro area, either in the sovereign debt market or in the equity market segment. While policymakers have looked at rating agencies as a possible source contributing to the increase in financial markets volatility, so far the literature does not seem to have tackled the link with the second moments of those financial variables. Indeed, such volatility may exacerbate the level of financial instability and its unpredictability, since high volatility levels are associated with higher risk perception of market participants. Moreover, such increased volatility and perceived risk can have similar unwarranted effects regarding macroeconomic uncertainty by amplifying output volatility.

The objective of the present paper is to study the volatility of stock market returns and sovereign bond market returns notably before and during the current economic and financial crisis in the EU countries. We particularly focus on the role of sovereign credit rating announcements of upgrades and downgrades. Our daily data set covers the period from January 1995 until October 2011.

Our main contributions encompass the following aspects: **i)** we analyse whether countries with higher credit ratings exhibit more or less volatility than lower rating countries; **ii)** we look at differences in the effects of positive versus negative announcements; **iii)** whether volatility in some countries reacts to rating announcements of other countries (contagion), and whether there are asymmetries in the transmission of these spillover effects; **iv)** we model the asymmetric volatility effects of negative and positive returns via EGARCH specifications; and **v)** we examine the financial gains and risk reduction for investors, when considering the information on credit rating announcements in their portfolio decision.

The organization of the paper is as follows. Section 2 reviews the related literature. Section 3 presents the dataset and discusses the construction of the returns' volatility measures. Section 4 assesses the reaction of market volatility to rating announcements and test for the presence of contagion in both stock and bond EU markets. Section 5 studies the relevance of rating information to portfolio diversification. Section 6 concludes.

2. Related literature

Our analysis is complementary to several areas in finance, particularly credit rating announcements and sovereign yields and CDS spreads, and bond and stock market volatility.

Several authors have analysed the effects of credit rating agencies, notably in terms of credit rating announcements. Kräussl (2005) uses daily sovereign ratings of long-term foreign currency debt from Standard & Poor’s and Moody’s. For the period between 1 January 1997 and 31 December 2000, he reports that sovereign rating changes and credit outlooks have a relevant effect on the size and volatility of lending in emerging markets, notably for the case of downgrades and negative outlooks.

Using also an event study for the period 1989–1997, with sovereign ratings from Standard & Poor’s, Moody’s, and Fitch, Reisen and von Maltzan (1999) find a significant effect on the government bond yield spread when a country was put on review for a downgrade. They also report the existence of two-way causality between sovereign ratings and government yield spreads for 29 emerging markets.

Ismailescu and Hossein (2010) assess the effect of sovereign rating announcements on sovereign CDS spreads, and possible spillover effects. For daily observations from January 2, 2001 to April 22, 2009 for 22 emerging markets, positive events have a greater impact on CDS markets in the two-day period surrounding the event, being then more likely to spill over to other countries. Moreover, a positive credit rating event is more relevant for emerging markets, and markets tend to anticipate negative events.

Gande and Parsley (2005) report the existence of spillover effects across sovereign ratings, in a study for the period 1991-2000, for a set of 34 developed and developing economies. This implies that contagion effects are present when a rating event occurs. In addition, Arezki, Candelon and Sy (2011), studying the European financial markets during the period 2007-2010, also find evidence of contagion, of sovereign downgrades of countries near speculative grade, on other euro area countries.

Afonso, Furceri and Gomes (2012) report for the EU significant responses of government yield spreads to changes in rating notations and outlook, particularly in the case of negative announcements. In addition, there is bi-directional causality between ratings and spreads within 1-2 weeks; spillover effects especially among EMU countries and from lower rated countries to higher rated countries; and persistence effects for recently downgraded countries. Usually, one of the recurrent conclusions of such studies is that only negative credit rating announcements have significant impacts on yields and CDS spreads (Reisen and von Maltzan (1999); Norden and Weber (2004); Hull et al. (2004); Kräussl (2005)).[1]

Heinke (2006), for corporate sector bond spreads, and Reisen and von Maltzan (1998), for sovereign bond yield spreads, have addressed the relevance of rating events for the historical spread volatility. Heinke (2006) reports that for German eurobonds from international issuers, credit ratings tend to rank the risk of each bond in accordance to the respective bond spread volatility. Moreover, spread volatility increases significantly with lower credit ratings. Reisen and von Maltzan (1998) compute historical volatility of sovereign bond yield spreads as an average over a window of 30 days. They report a significant change in the level of volatility for bond yield spreads (and for real stock market returns) when a rating event occurs, with volatility increasing (decreasing) with rating downgrades (upgrades).

Two other papers have analysed the effects of sovereign rating changes on stock market volatility. Hopper et al. (2008) analyse data from 42 countries over the period of 1995 and 2003. They find that upgrades reduce volatility and downgrades increase volatility, but to different extents. Ferreira and Gama (2007) analyse 29 countries over the period 1989-2003 and find similar results. Additionally, they report a spillover effect of announcement on other countries, which is also asymmetric.

Other studies have focused on the effect of macroeconomic news on the bond yields and stock market volatilities. Jones, Lamont and Lumsdaine (1998) have investigated the reaction of daily Treasury bond prices to the release of U.S. macroeconomic news (employment and producer price index). They studied whether the non-autocorrelated new announcements give rise to autocorrelated volatility. They found that announcement-day volatility does not persist at all, consistent with the immediate incorporation of information into prices. They also find a risk premium on these release dates.

Borio and McCauley (1996) have examined the links between bond market volatility and domestic economic factors (inflation, growth, fiscal policy, and money market yields) and international influences (spillover of volatility from one national market to another and the influence of increasingly mobile international capital flows). They found that bond yield volatility typically rises in response to downward movements in the bond market, but over time tends to revert to its mean. The long-term level of volatility responds to the success of price stabilisation policies and reflects difficulties in fiscal management.

[1] Related analysis, between rating announcements and corporate CDS spreads, has been performed notably by Micu, Remolona and Wooldridge (2006).

Variations in bond market volatility are associated with variations in money market volatility. They also report that there is little evidence that uncertainty about fundamentals such as inflation, growth, fiscal balances or the short-term conduct of monetary policy lay behind the 1994 turbulence in bond markets. On the international side, they found evidence of spillovers and of a powerful and hitherto unappreciated influence of foreign disinvestment. Spillovers gained in strength and geographical scope in the period of market turbulence in 1994.

Christiansen (2007) looked at the effect of volatility in the US and aggregate European bond markets on the individual European bond markets volatility. Using a GARCH model, they report a strong statistical evidence of volatility spillover from the US and aggregate European bond markets. For EMU countries, they found that the US volatility spillover effects are rather weak whereas for Europe the volatility spillover effects are strong.

3. Data and stylized facts

3.1. Sovereign ratings

A rating notation is an assessment of the issuer's ability to pay back in the future both capital and interests. The three main rating agencies use similar rating scales, with the best quality issuers receiving a triple-A notation.

Our data for the credit rating developments are from the three main credit rating agencies: Standard and Poor's (S&P), Moody's (M) and Fitch (F). We transform the sovereign credit rating information into a discrete variable that codifies the decision of the rating agencies. In practice, we can think of a linear scale to group the ratings in 11 categories, where the triple-A is attributed the level 11, and where we could put together in the same bucket the observations in speculative grade (notations at and below BB+ and Ba1), which all receive a level of one in the scale.

On a given date, the dummy variables *up* and *down* assume the following values:

$$up_{it} = \begin{cases} 1, & \text{if an upgrade of any agency occurs} \\ 0, & \text{otherwise} \end{cases} \quad down_{it} = \begin{cases} 1, & \text{if a downgrade of any agency occurs} \\ 0, & \text{otherwise} \end{cases} . \qquad (1)$$

We constructed a similar set of discrete variables for S&P, Moody's and for Fitch separately.

3.2. Data

In our analysis, we cover 21 EU countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Spain, Sweden, and United Kingdom. No data were available for Cyprus, Estonia and Luxembourg and the data for Malta Slovakia and Slovenia had a very limited sample.

The daily dataset starts as early as 2 January 1995 for some countries and ends on 24 October 2011.[2] The three rating agencies, S&P, Moody's and Fitch, provided the data for the sovereign rating announcements and rating outlook changes.

The data for the sovereign bond yields, which is for the 10-year government bond, end-of-day data, comes from Reuters. For the stock market, we use an equity index, as reported in Datastream, which starts as early as 1 January 2002.

3.3. Rating announcements

In total, since 1995, there were 345 rating announcements from the three agencies. S&P and Fitch were the most active agencies with 141 and 119 announcements, respectively, whereas Moody only had 87. Out of these announcements, mostly of them were upgrades (135) rather than downgrades (75), positive (71) and negative (54) outlooks.[3] However, we cannot use the full set of rating announcements because we only have data on sovereign yields starting at a later period. Therefore, in our study we have 179 announcements overlapping with sovereign yield data and 214 overlapping with stock market returns.

Finally, the sovereign yield data are not fully available or are less reliable for several eastern European countries, namely Romania, Lithuania, Latvia or Estonia.

3.4. Measuring stock market and bond market volatilities

We first define stock market return at time *t* and for each country *i*, say $r_{i,t}^{s}$, as the difference in log prices of equity index at time *t* and *t-1*, while the bond market return at time *t* and for each country *i*, say $r_{i,t}^{b}$, is defined as the difference in log yield at time *t-1* and *t*:

[2] This covers the period of the euro debt crisis, when some sovereign bond markets were distorted or not functioning, and were also helped via the ECB's Securities Market Programme.

[3] A full summary of rating announcements, as well as per country data for sovereign yields, CDS spreads and rating developments, is available on request.

$$r_{i,t}^{s} = \ln(stock_{i,t}) - \ln(stock_{i,t-1}) \, , \quad (2.1)$$

$$r_{i,t}^{b} = \ln(yield_{i,t-1}) - \ln(yield_{i,t}) \, . \quad (2.2)$$

As the conditional volatilities of stock and bond market returns cannot be observed, they have to be estimated. We start our analysis of the impact of sovereign credit rating news on the financial market volatilities using the Exponential Generalized Autoregressive Conditional Heteroskedasticity model (hereafter EGARCH model), developed by Nelson (1991). This model filters the conditional volatility processes from the specification of the conditional marginal distribution. Later on and for robustness check, we will also use the absolute value and the squared returns as proxies of volatilities.

The EGARCH models stipulate that negative and positive returns have different impacts on volatility, known as the asymmetric volatility phenomenon. For the EGARCH specification, we assume that the following model generates the equity and bond returns for each country *i*:

$$r_{i,t+1} = \mu_i + \varepsilon_{i,t+1} \, , \quad (3)$$

with

$$\varepsilon_{i,t+1} = \sigma_{i,t+1} z_{i,t+1} \quad (4)$$

and $z_{i,t+1}$ are i.i.d. Student, and where $r_{i,t+1}$ is the continuously compounded return from time t to $t+1$ on the equity (bond) of the country *i*. We assume that the volatility of returns $r_{i,t+1}$, say $\sigma_{i,t+1}$, is given by the following Nelson (1991) EGARCH (1,1) model that can be rewritten in a simpler and intuitive manner as follows:

$$\ln(\sigma_{i,t+1}) = \omega_i + \beta_i \ln(\sigma_{i,t}) + \gamma_i z_{i,t} + \alpha_i (|\, z_{i,t} \,| - E \,|\, z_{i,t} \,|) \, . \quad (5)$$

In equation (5), $z_{i,t} = \varepsilon_{i,t} / \sigma_{i,t}$ defines the standardized residuals and α_i is the coefficient that captures the asymmetric volatility phenomena that means that negative returns have a higher effect on volatility compared to positive returns of the same magnitude. In the above model, the response of volatility to positive and negative shocks is asymmetric: for positive shocks, the slope is equal to $\gamma_i + \alpha_i$ and for negative shocks, it is equal to $\gamma_i - \alpha_i$. Further, if the coefficient α_i is positive and if the coefficient γ_i is negative (which is the case in our estimation results), then a negative shock has a higher impact on volatility than the positive one of the same magnitude, because $|\gamma_i - \alpha_i| \geq |\gamma_i + \alpha_i|$.

In Table 1 we report the estimation results of the EGARCH volatilities for equities and bonds across countries. From this, we see that, for most countries, the coefficients of the estimated EGARCH models are statistically significant. The high values of the estimates of β_t indicate that volatilities are persistent. Moreover, the estimated coefficient α_i that captures the asymmetric effect of returns on volatility is also statistically significant for all countries, either in the case of equity returns or in the case of sovereign bond returns.

[Table 1]

Table 2 shows the average volatility in stock and bond markets for different rating categories. From this, we see that there is a ranking in terms of volatility, but not completely straightforward. For bond markets, there is no sharp difference in the top categories between AAA and AA-, but speculative grade countries experience between 3 to 4 times more volatility than AAA countries. For stock market volatility, such pattern is weaker, with triple-A countries having similar volatilities as BBB countries and, while speculative grade rated countries have only about 50 percent more volatility.

[Table 2]

4. Reaction of market volatilities to credit rating news

4.1. Reaction to upgrades and downgrades

In this section, we study the reaction of equity and bond market volatilities to sovereign rating upgrading and downgrading across the European countries. Therefore, we estimate the following country fixed effect panel regressions:

$$\log(\sigma_{i,t}) = \mu_i + \sum_{j=0}^{k} \lambda_j down_{i,t-j} + \sum_{j=0}^{k} \alpha_j up_{i,t-j} + \beta \log(\sigma_{i,t-1}) + \zeta^T \mathrm{X}_{\text{t-1}} + \varepsilon_{i,t} \quad (6)$$

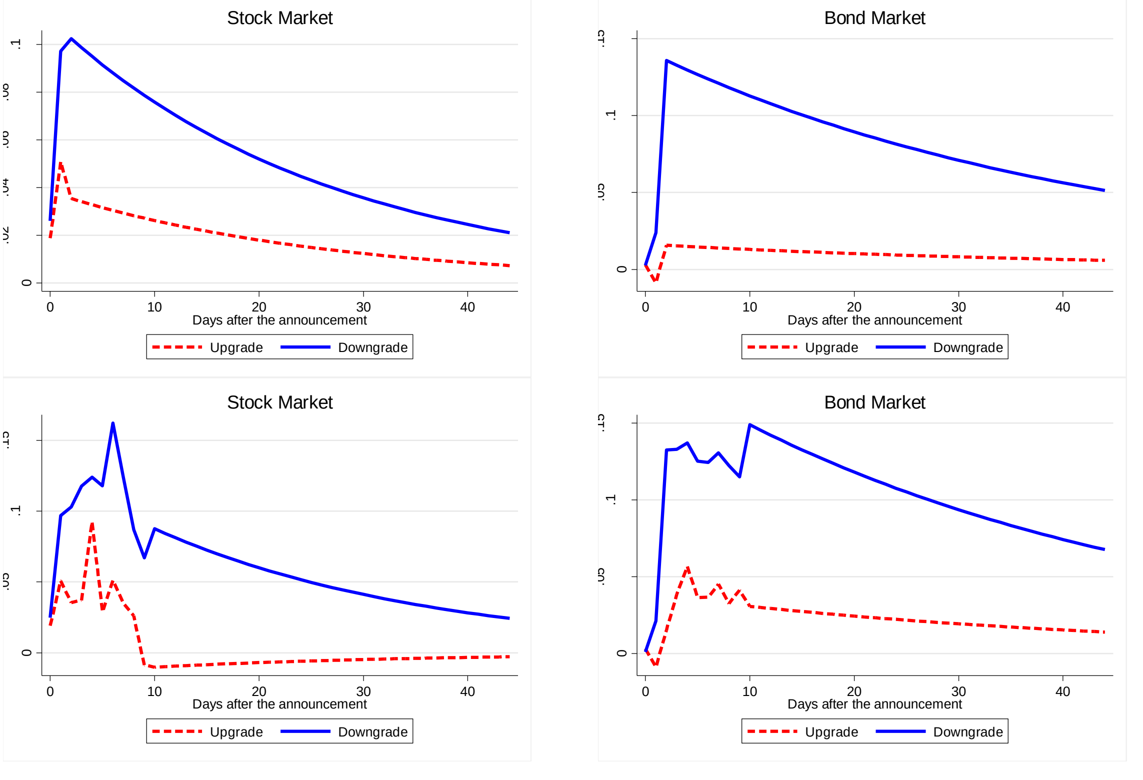
where μ_i are country fixed effects and $up_{i,t-j}$ and $down_{i,t-j}$ are the dummies at time *t-j* of the upgrading and downgrading (see Equation (1)) that correspond to all rating agencies (S&P, Moody's, and Fitch) together, and X is a vector of other control variables such as dummy variables for the weekday, month and annual effects.

Table 3 shows the estimation results for specification (6) using two lags. We have tested several lags and in general, two lags are sufficient to capture the dynamics. Looking at Table 3, we observe the existence of an asymmetry on the effects of sovereign rating developments on volatility. Upgrades do not have any significant effect on volatility. On the other hand, for the stock market sovereign downgrades increase volatility both contemporaneously and with one lag. For bond markets, downgrades raise volatility after two lags.

In addition, Figure 1 below illustrates the impulse response functions of the impact of upgrade and downgrade announcements on volatility. From this evidence, we see that the downgrade announcements have more impact on bond and equity market volatilities than the upgrade announcements. The effect of downgrade announcements is dominant, persistent, and it is robust to the number of lags considered in the models.

[Table 3]

Figure 1 – Impulse responses of stock and bond market volatilities to upgrade and downgrade news, baseline estimations using 2 and 10 lags



Notes: This figure shows the impulse response functions of the impact of upgrade and downgrade announcements on volatility, using the specification in (6) with 2 and 10 lags. On the vertical axis, we have the effects of announcements on volatility. Upper panel corresponds to two lags and lower panel corresponds to 10 lags.

4.2. Robustness analysis

We have used, as an alternative, non-parametric measures of volatility: the absolute value and the squared returns as proxies of volatilities (see Jones, Lamont, and Lumsdaine, 1998, among others). We have also looked at the effects of positive and negative outlooks. Furthermore, we have estimated our above specifications with different samples and control variables (only for the Euro Area, for the period starting in 2008, using week dummies instead of year dummies), we have also looked at the CDS market volatility, and we have run the estimations by agency (all results are available on request).

Our robustness analysis confirms that downgrades have a strong effect on volatility, while positive and negative outlooks do not have a statistical significant effect on volatility. Markets respond more to rating actions from S&P and Moody's by delivering higher stock and bond returns' volatility when sovereign downgrades take place. None of the estimated coefficients is significant for the case of Fitch.

4.3. Contagion

In this subsection, we have restricted the analysis to Euro Area countries only and we have included in the regressions the upgrades and downgrades rating announcements from other countries in the Euro Area. We then divide the sample into the *Core* (Austria, Finland, Germany, France, and Netherlands) and *Periphery* (Belgium, Ireland, Italy, Greece, Portugal and Spain) countries.[4] The volatility of both stock and bond markets of a given country responds to announcements of agencies for other European countries. Table 4 shows that when a country has an upgrade, this is followed by a reduction of volatility in the rest of the Euro-area, which is more pronounced in the *Core* countries. As for downgrading movements, they increase the volatility of all other countries, specifically in the periphery countries, although in the covered period there were no downgrades in the core set of countries.

[Table 4]

5. Economic value of sovereign ratings' information

5.1. The investor's problem

In this section, we examine the economic implications of the impact of sovereign credit ratings on the financial volatilities for the optimal diversification of risk. We assume that the investors are risk averse with preferences defined over the conditional expectation and the variance-covariance matrix of the asset returns.

To find the optimal conditional weight of the investment in each European asset (bonds and equities), we consider the mean-variance behaviour characterized by an optimization problem in which the efficient frontier can be described as the set of portfolios that satisfy

[4] This distinction is in line notably with the results reported by Afonso, Arghyrou and Kontanikas (2012), who split the euro area countries in a rather similar way, on the basis of a principal component analysis.

the constrained maximization problem below. The investor with an initial wealth of W_t=1 diversifies his or her portfolio between the European assets according to the following problem:

$$\underset{\{\omega_t\}}{Max}\left\{\mu_p(\omega_t)-\frac{\eta}{2}\sigma_p^2(\omega_t)\right\} \qquad (7)$$
$$\text{s.t. } \omega_t^T e=1$$

where $\omega_t=(\omega_{1,t},...,\omega_{n,t})'$, with n is the number of the European assets in the portfolio, is the vector of portfolio weights, e is the $n\times 1$ vector of ones, and

$$\mu_p(w_t)=\sum_{i=1}^{n}\omega_{i,t}\mu_i \qquad (8)$$

$$\sigma_p^2(\omega_t)=\omega_t^T\sum\nolimits_t\omega_t=\sum_{i=1}^{n}\omega_{i,t}^2\sigma_{i,t}^2+2\sum_{1\le i<j\le n}^{n}\omega_{i,t}\gamma_{ij,t}\omega_{j,t} \qquad (9)$$

are the mean and variance of portfolio return, respectively, with μ_i and γ_{ij} are the mean asset return of the country i and the covariance between asset returns of countries i and j, respectively. The solution to the maximization problem in (7) is given by the optimal vector of weights:

$$\omega_t=\frac{\sum_t^{-1}e}{e^T\sum_t^{-1}e}+\frac{R\mu}{\eta}, \quad R=\sum\nolimits_t^{-1}-\frac{\sum_t^{-1}ee^T\sum_t^{-1}}{e^T\sum_t^{-1}e}, \qquad (10)$$

where the "multiplier" η can be interpreted as a "risk aversion" coefficient and Σ_t is the variance-covariance matrix of the vector of returns that corresponds to the n European assets.

5.2. Financial gains from sovereign ratings' information

We want to assess the financial gain of an investor who takes into account sovereign credit ratings information for volatility modelling. We base our analysis on the following expected utility function of the investor:

$$E(U(\omega_t))=\mu_p(\omega_t)-\frac{\eta}{2}\sigma_p^2(\omega_t)\,. \qquad (11)$$

As in the previous subsection, the initial wealth is normalised to unity W_t=1, which we can interpret as investing one euro at the beginning of the period. We define the gain g_t as the additional fraction of wealth necessary for an investor, who is not aware of the sovereign credit rating information, to match the same level of utility of an investor who is aware of this sovereign credit rating information. To get a simple analytical solution to our problem, we assume that the additional fraction of wealth g_t is not invested. Therefore, we want the solution of the following equation[5]

$$E(U(\omega_t^b)+g_t)=E(U(\omega_t^*)) , \quad (12)$$

where ω_t^b is the optimal vector of weights invested in the European assets when the investor is not aware of the sovereign credit rating information, while ω_t^* is the optimal vector of weights when the investor considers that information. Since g_t is not random, the mean-variance utility function implies that

$$g_t = E(U((\omega_t^*)) - E(U((\omega_t^b)) \qquad (13)$$

with

$$w_t^* = \frac{\sum_t^{*-1} e}{e^T \sum_t^{*-1} e} + \frac{R^*(w_t)}{\eta} , \quad R^* = \sum_t^{-1} - \frac{\sum_t^{*-1} ee^T \sum_t^{*-1}}{e^T \sum_t^{*-1} e} \quad (14)$$

where Σ_t^* is the variance-covariance matrix in which the diagonal elements or the variance terms are forecasted by taking into account the sovereign credit ratings information. In our empirical application, we report the results for different values of risk aversion: η=3, 5, and 7. We choose these alternative values based on the empirical findings in the literature (see, for example, French and Poterba, 1991).

To estimate the mean expected utility and the financial gain functions we proceed as follows. First, we measure the volatilities of asset returns included in our dataset using the approach described in section three. Second, we estimate the panel regressions:

$$\log(\sigma_{i,t}) = \mu_i + \sum_{j=0}^{k} \lambda_j down_{i,t-j} + \sum_{j=0}^{k} \alpha_j down_{i,t-j}^{-i} + \beta \log(\sigma_{i,t-1}) + \zeta^T \mathrm{X}_{t-1} + \varepsilon_{i,t} \quad (15)$$

and

$$\log(\sigma_{i,t}) = \bar{\mu}_i + \bar{\beta} \log(\sigma_{i,t-1}) + \vartheta^T \mathrm{X}_{t-1} + \bar{\varepsilon}_{i,t} . \qquad (16)$$

The specifications in (15) and (16) correspond to models of volatilities with and without taking into account the effect of sovereign credit ratings downgrade information on stock and bond return volatilities, respectively. We abstract from the rating upgrades.

[5]If instead we assume that this fraction g_t is invested, we will end up with a second order problem where the solution will depend on the values of the coefficients, and in some circumstances, the solution does not exist.

Following section 4.3, we also include the dummies of downgrades from other countries, $down_{i,t-j}^{-i}$. Here X_{t-1} is still a vector of other control variables including dummy variables for weekday and monthly effects. We include 10 lags of each.

Thereafter, we first recuperate the corresponding fitted-values of volatilities that we use to estimate the weights ω_t and ω_t^*, and then we compute the average values of the expected utility functions $E(U((\omega_t^b))$ and $E(U((\omega_t^*))$, and of the financial gain g_t. In order to focus on the effect of sovereign credit ratings information on the volatilities, we use the unconditional estimate of the mean returns and the correlation coefficients between the asset returns. In every period and following Bollerslev (1990), we update the covariance matrix to have a constant correlation equal to the unconditional correlation. Therefore, we capture the impact of sovereign credit ratings' information on the optimal portfolio weights, and measure the financial gain g_t due to the incorporation of such information.

5.3 Financial gains: empirical results

Our empirical results show the existence of a financial gain when we take into account Sovereign credit ratings downgrade information for volatility modelling. Table 5 reports the average financial gain in annualized basis points in the two weeks following downgrade news. The in-sample prediction of the gains is based on the sample period 2002-2011 and includes 2562 days of which around 500 days are within 2 weeks of downgrade announcements. The in-sample prediction analysis shows that the gains range between 5 and 10 annualized basis points (bp) for stock market and between 7 and 19 for bond markets.

[Table 5]

Another important issue to mention is that the financial gain is a decreasing function of the degree of risk aversion. We find that a less risk averse agent outperforms a more risk averse agent when both use the effect of credit ratings information on volatility to optimize their portfolios. The fact that higher risk aversion portfolios might tend to be more biased towards lower volatility countries can also explain this result. Indeed, such countries are in practice less prone to downgrades, as we have seen in our dataset.

We also did an out-of-sample exercise to evaluate the financial gains. To predict the financial gains we first predict the volatilities of all European assets that make up our portfolio with and without using the credit rating information. Again, as in our in-sample analysis, we only predict the volatilities, and thus we evaluate the mean returns and correlation coefficients between European equity and bond returns at their unconditional estimates. We consider one period (day) ahead static prediction during one year. For each additional day within the last year of our sample, we re-estimate our volatility models using the data available until that day, we make one-day ahead prediction of these volatilities with and without using the Sovereign credit ratings information, and compute the financial gains. The out-of-sample prediction is based on the last 2 years of the sample. It includes 518 days of which 287 days are within 2 weeks of downgrade announcements. Table 5 reports the results of the out-of-sample prediction of the financial gains. These results show that the out-of-sample financial gains range between 2 and 6 bp for the stock market and between 200 and 492 bps for the bond market. The reason for the performance of the bond market is that it responds more significantly to downgrade news after two days, while the stock market responds contemporaneously and with one lag. However, because we assume that we can only restructure the portfolio one day after downgrades, thus we are not using all the relevant information.

5.4 Risk management: value-at-risk

We also examine whether sovereign credit ratings' information can help protect investors against market risk. We compare the value-at-risk (VaR) of mean-variance portfolios with and without taking into account the effect of credit ratings information on stock and bond return volatilities. We discuss the empirical results below.

[Table 6]

Table 6 shows that for both in sample and out-of sample predictions, the value-at-risk of portfolios that consider the information of sovereign credit ratings are smaller than the ones of portfolios that do not take into account such information. It is true that the difference is small in magnitude, but this could be very significant when we invest important amounts of money. The result is similar in both stock and bond markets. In addition, we find that the value-at-risk is decreasing with the degree of risk aversion.

6. Conclusion

We have used a panel fixed-effects analysis of daily EU stock market and sovereign bond market returns to study the impacts of the three main rating agencies announcements (S&P, Moody's, Fitch) on financial markets volatility. Indeed, after the 2008-2009 financial and economic crises the volatility in capital markets increased in most EU countries, both in sovereign debt and equity markets, challenging the euro area common currency framework. The analysis covered the period between 2 January 1995, for some countries, and 24 October 2011.

In practical terms, we have first filtered the negative and positive effects of market returns on volatility via EGARCH models. Then, we have analysed the information content of sovereign upgrades and downgrades on the volatility. Moreover, we then assessed the potential financial gain for investors when considering such rating information on theoretical portfolio diversification decisions.

Our main results can be summarised as follows. We have uncovered the existence of an asymmetry of the effects of sovereign rating developments on volatility. Indeed, upgrades do not have any significant effect on volatility, but sovereign downgrades increase stock market volatility both contemporaneously and with one lag, and rise bonds volatility after two lags. Interestingly, a rating upgrade in a given country reduces the volatility in the rest of the Euro-area, particularly in the core countries. On the other hand, a downgrade increases the volatility of all other countries, specifically in the periphery countries.

We have also shown the existence of a financial gain and risk reduction for portfolio returns when taking into account sovereign credit ratings information for volatility modelling. In addition, the financial gains are decreasing with the degree of risk aversion.

In addition, the value-at-risk of portfolios that consider the information of sovereign credit ratings are smaller than the ones of portfolios that do not take such information into account, with the value-at-risk decreasing with risk aversion.

References

Afonso, A., Arghyrou, M., Kontonikas, A. (2012). "The determinants of sovereign bond yield spreads in the EMU", mimeo.

Afonso, A., Furceri, D., Gomes, P. (2012). "Sovereign credit ratings and financial markets linkages: application to European data", *Journal of International Money and Finance*, 31 (3), 606-638.

Amira, K, Taamouti, A., Tsafack, G. (2011). "What drives international equity correlations? Volatility or market direction?", *Journal of International Money and Finance*, Volume 30, Issue 6, pages 1234-1263.

Arezki, R., Candelon, B., Sy, A. (2011). "Sovereign rating news and financial markets spillovers: Evidence from the European debt crisis", IMF Working Papers 11/68.

Bollerslev, T. (1990). "Modelling the coherence in short-run nominal exchange rates: a multivariate generalized ARCH approach", *Review of Economics and Statistics*, 72 (3), 492-505.

Borio, C., McCauley, R. (1996). "The economics of recent bond yield volatility". BIS Working Paper 45.

Christiansen, C., (2007). "Volatility-spillover effects in European bond markets", European Financial Management, 13 (5), 923-948.

Dufour, J-M, Garcia, R., Taamouti, A. (2912). "Measuring high-frequency causality between returns, realized volatility and implied volatility", *Journal of Financial Econometrics*, Volume 10, Issue 1, pages 124-163.

Erb, C., Harvey, C., Viskanta, T. (1996). "Expected returns and volatility in 135 countries". *Journal of Portfolio Management*, 22 (3), 46–58.

Ferreira, M., Gama, P. (2007), "Does sovereign debt ratings news spill over to international stock markets", *Journal of Banking and Finance*, 31, 3162-3182.

French, M., Poterba, J.M. (1991). "Investor diversification and international equity markers", *American Economic Review*, 81, 222-226.

Gande, A., Parsley, D. (2005). "News spillovers in the sovereign debt market", *Journal of Financial Economics*, 75 (3), 691-734.

Goeij, P., Marquering, W. (2004). "Modeling the conditional covariance between stock and bond returns: A multivariate GARCH approach", Journal of Financial Econometrics, 2 (4), 531-564.

Heinke, V. (2006). “Credit spread volatility, bond ratings and the risk reduction effect of watchlistings”, *International Journal of Finance and Economics*, 11, 293-303.

Hooper, V., Timothy, H., Kim, S. (2008). “Sovereign rating changes – Do they provide new information to stock markets”, *Economic Systems*, 32 (2), 142-166.

Hull, J.C., Predescu, M., White, A. (2004). The relationship between credit default swap spreads, bond yields, and credit rating announcements. *Journal of Banking and Finance* 28, 2789-2811.

Ismailescu, J., Kazemi, H. (2010). “The reaction of emerging market credit default swap spreads to sovereign credit rating changes”, Journal of Banking & Finance, 34 (12), 2861-2873.

Jones, C., Lamont, O., Lumsdaine, R. (1998). “Macroeconomic news and bond market volatility”, Journal of Financial Economics, 47 (1998) 315-337.

Kräussl, R. (2005). “Do credit rating agencies add to the dynamics of emerging market crises?” *Journal of Financial Stability*, 1 (3), 355-85.

Kilponen, J., Laakkonen, H., Vilminen, J. (2011). “Sovereign risk, uncertainty and policy”, mimeo.

Micu, M., Remolona, E., Wooldridge, P. (2006). “The price impact of rating announcements: which announcements matter?”. BIS Working paper.

Nelson, D.B. (1991). “Conditional heteroskedasticity in asset returns: A new approach”. *Econometrica*, 59, 347-370.

Norden, L., Weber, M., (2004). “Informational efficiency of credit default swap and stock markets: the impact of credit rating announcements”. *Journal of Banking and Finance* 28, 2813-2843.

Reisen, H., Maltzan, J. (1998). “Sovereign credit ratings, emerging market risk and financial market volatility”. *Intereconomics*, 1(2), 73-82.

Reisen, H., Maltzan, J. (1999). “Boom and bust and sovereign ratings”. *International Finance*, 2 (2), 273-29.

Table 1 – Summary of EGARCH estimation results (Equation (5))

Country	Slope γ_i	Asymmetry α_i	Persistence β_i	D.F.	Obs.	Gaps
Stock Market						
Austria	-0.074*** (0.000)	0.186*** (0.000)	0.981*** (0.000)	8.79	2564	0
Belgium	-0.118*** (0.000)	0.159*** (0.000)	0.979*** (0.000)	11.08	2564	0
Finland	-0.065*** (0.000)	0.105*** (0.000)	0.991*** (0.000)	6.41	2564	0
France	-0.153*** (0.000)	0.102*** (0.000)	0.982*** (0.000)	15.44	2564	0
Germany	-0.129*** (0.000)	0.113*** (0.000)	0.985*** (0.000)	11.41	2564	0
Greece	-0.053*** (0.000)	0.158*** (0.000)	0.985*** (0.000)	7.78	2564	0
Ireland	-0.072*** (0.000)	0.169*** (0.000)	0.986*** (0.000)	6.52	2564	0
Italy	-0.109*** (0.000)	0.105*** (0.000)	0.989*** (0.000)	8.95	2564	0
Netherlands	-0.131*** (0.000)	0.110*** (0.000)	0.987*** (0.000)	16.12	2564	0
Portugal	-0.073*** (0.000)	0.219*** (0.000)	0.978*** (0.000)	6.46	2564	0
Spain	-0.121*** (0.000)	0.127*** (0.000)	0.985*** (0.000)	8.05	2564	0
Bulgaria	-0.028 (0.204)	0.589*** (0.000)	0.933*** (0.000)	3.31	2564	0
Czech Republic	-0.061*** (0.000)	0.238*** (0.000)	0.969*** (0.000)	6.58	2564	0
Denmark	-0.069*** (0.000)	0.155*** (0.000)	0.981*** (0.000)	7.91	2564	0
Yield						
Austria	0.024*** (0.004)	0.134*** (0.000)	0.996*** (0.000)	7.27	4271	18
Belgium	0.021*** (0.010)	0.112*** (0.000)	0.995*** (0.000)	6.38	4034	1
Finland	0.026*** (0.009)	0.136*** (0.000)	0.994*** (0.000)	6.14	4372	8
France	0.032*** (0.000)	0.100*** (0.000)	0.997*** (0.000)	9.85	4020	2
Germany	0.031*** (0.000)	0.100*** (0.000)	0.998*** (0.000)	6.99	4380	4
Greece	-0.029** (0.042)	0.192*** (0.000)	0.977*** (0.000)	9.85	3384	3
Ireland	-0.006 (0.484)	0.117*** (0.000)	0.993*** (0.000)	5.69	4038	6
Italy	-0.012 (0.213)	0.120*** (0.000)	0.987*** (0.000)	7.31	4014	0
Netherlands	0.029*** (0.000)	0.095*** (0.000)	0.998*** (0.000)	7.78	4031	2
Portugal	-0.002 (0.818)	0.205*** (0.000)	0.988*** (0.000)	4.86	4312	25
Spain	-0.004 (0.728)	0.100*** (0.000)	0.990*** (0.000)	5.32	3992	3
Czech Republic	0.029* (0.092)	0.383*** (0.001)	0.994*** (0.000)	3.32	2989	10
Denmark	0.019** (0.035)	0.156*** (0.000)	0.994*** (0.000)	5.00	4305	33
Hungary	-0.082*** (0.004)	0.427*** (0.000)	0.943*** (0.000)	2.52	3160	25
Poland	-0.030 (0.101)	0.347*** (0.000)	0.962*** (0.000)	3.38	3172	11
Sweden	0.033*** (0.000)	0.113*** (0.000)	0.997*** (0.000)	8.81	3223	37
United Kingdom	0.027*** (0.000)	0.077*** (0.000)	0.998*** (0.000)	8.89	3928	4

Note*:* P-values are in brackets. In this table "***", "**", "*" represents statistical significance at 1%, 5%, and 10%, respectively.

Table 2 – Average of stock and sovereign yield market volatilities for different rating categories

Rating	Stock market volatility			Yield volatility		
	S&P	Moody's	Fitch	S&P	Moody's	Fitch
AAA	0.00023	0.00023	0.00023	0.00015	0.00014	0.00014
AA+	0.00021	0.00020	0.00025	0.00011	0.00011	0.00011
AA	0.00019	0.00018	0.00013	0.00010	0.00013	0.00011
AA-	0.00014	0.00016	0.00027	0.00011	0.00007	0.00012
A+	0.00024	0.00020	0.00029	0.00014	0.00037	0.00011
A	0.00022	0.00021	0.00017	0.00057	0.00016	0.00011
A-	0.00018	0.00027	0.00018	0.00019	0.00049	0.00018
BBB+	0.00025	0.00020	0.00023	0.00023	0.00023	0.00022
BBB	0.00022	0.00021	0.00027	0.00029	0.00012	0.00035

BBB-	0.00029	0.00032	0.00027	0.00041	0.00035	0.00058
<BB+	0.00032	0.00025	0.00030	0.00065	0.00044	0.00046

Note: The volatility measures are based on EGARCH estimations in Table 1.

Table 3 – Estimation results of regressions of stock and bond market volatilities (Equation (6)), Full sample

Events		**Stock market** (1)	**Bond market** (2)
Upgrade	*t*	0.019	0.029
		(0.81)	(0.18)
	t-1	0.033	-0.012
		(0.66)	(-0.63)
	t-2	-0.013	0.024
		(-0.54)	(0.83)
Downgrade	*t*	0.026**	0.025
		(2.30)	(0.13)
	t-1	0.072***	0.021*
		(4.02)	(1.97)
	t-2	0.008	0.112***
		(0.59)	(3.55)
Lagged volatility		0.963*** (156.87)	0.977*** (300.61)
R2		0.955	0.973
Observation		53821	66539
Countries		21	17
#Upgrades		74	65
#Downgrades		93	67
# Positive outlooks			
# Negative outlooks			
Test 3^{rd} lag$^{\$}$		0.42 (0.661)	0.30 (0.747)
Test 5^{th} lag$^{\$}$		8.06 (0.003)	0.64 (0.539)
Test 22^{nd} lag$^{\$}$		1.16 (0.334)	0.93 (0.414)

Note: Coefficients with associated t-statistics reported in brackets. In this table "***", "**", "*" represents statistical significance at 1%, 5%, and 10%, respectively. Control variables include weekday, month and year dummies. $^{\$}$ F-test for joint significance of the 3^{rd}, 5^{th} and 22^{nd} lag.

Table 4 – Estimation results of regressions of stock and bond market volatilities, Contagion

Events		Stock market			Bond market		
		Euro Area	*Core* Countries	*Periphery* Countries	Euro Area	*Core* Countries	*Periphery* Countries
Upgrade	*t*	-0.044*	-0.048***	-0.039	-0.005	-0.015***	-0.001
		(-2.21)	(-5.69)	(-1.75)	(-0.30)	(-47.15)	(-0.06)
	t-1	-0.038	-0.049***	-0.035	-0.004	0.045***	-0.017
		(-1.76)	(-5.50)	(-1.46)	(-0.28)	(102.85)	(-1.76)
	t-2	-0.049***	-0.015	-0.049**	-0.004	0.018***	-0.011
		(-4.01)	(-1.86)	(-3.83)	(-0.59)	(48.44)	(-2.08)
Downgrade	*t*	0.023**	-	0.020**	0.015	-	0.017
		(3.09)	-	(2.64)	(0.94)	-	(1.07)
	t-1	0.078***	-	0.075***	0.028***	-	0.030**
		(6.99)	-	(6.66)	(3.27)	-	(3.32)
	t-2	-0.013	-	-0.016	0.098**	-	0.100**
		(-1.59)	-	(-1.86)	(2.73)	-	(2.66)
Upgrade Others	*t*	-0.010	-0.010**	-0.010	0.016***	0.020***	0.011*
		(-1.61)	(-3.36)	(0.74)	(4.75)	(7.10)	(2.17)
	t-1	-0.048***	-0.056*	-0.042	-0.016***	-0.015***	-0.017*
		(-3.40)	(-2.43)	(0.61)	(-5.08)	(-29.97)	(-2.62)
	t-2	-0.027**	-0.031**	-0.024	-0.018***	-0.011***	-0.024***
		(-2.20)	(-3.65)	(-0.52)	(-5.30)	(-6.38)	(-4.27)
Downgrade Others	*t*	0.030***	0.029***	0.031**	0.011**	0.007***	0.014*
		(6.09)	(4.57)	(3.81)	(3.12)	(10.78)	(2.03)
	t-1	0.045***	0.042***	0.049***	0.003	0.003	0.003
		(6.94)	(5.05)	(4.69)	(0.76)	(1.32)	(0.36)
	t-2	-0.005	-0.010	-0.000	-0.004	-0.014	0.005
		(-1.45)	(-1.83)	(-0.04)	(-0.83)	(-20.04)	(0.72)
Lagged volatility		0.977***	0.978***	0.974***	0.980***	0.984***	0.975***
		(596.08)	(145.25)	(541.03)	(350.92)	(524.77)	(255.90)
R2		0.976	0.975	0.977	0.984	0.989	0.979
Observation		28193	12815	15378	45434	21227	24207
Countries		11	5	6	11	5	6
#Upgrades		10	1	9	38	8	30
#Downgrades		56	0	56	57	0	57
#Upgrades (other)		100	49	51	349	175	174
#Downgrades (other)		533	265	268	558	273	275

Note: Coefficient with associated t-statistics reported in brackets. In this table "***", "**", "*" represents statistical significance at 1%, 5%, and 10%, respectively. Control variables include weekday, month and year dummies. Core (Austria, Finland, Germany, France, Netherlands); Periphery (Belgium, Ireland, Italy, Greece, Portugal and Spain).

Table 5 – Financial gain in annualised basis points (bp) of credit rating downgrades information

	Observations	η=3	η =5	η =7
Stock Market				
In-sample prediction	*2562(554)*	9.8	6.1	4.6
Out-of-sample prediction	*518 (289)*	5.4	3.3	2.4
Bond Market				
In-sample prediction	*2562(446)*	19.1	10.7	7.2
Out-of-sample prediction	*518 (287)*	492.4	287.8	200.1

Note: In this table "η" represents the risk aversion parameter. These financial gains are within two weeks of a downgrade. In brackets is the number of periods corresponding to two weeks after a downgrade.

Table 6 – Value at Risk with and without credit rating downgrades information

	η=3	η =5	η =7
Stock Market			
In-sample prediction			
Without rating information	-0.0824	-0.0508	-0.0376
With rating information	-0.0820	-0.0506	-0.0375
Out-of-sample prediction			
Without rating information	-0.1450	-0.0873	-0.0627
With rating information	-0.1439	-0.0866	-0.0622
Bond Market			
In-sample prediction			
Without rating information	-0.0509	-0.0342	-0.0279
With rating information	-0.0505	-0.0340	-0.0278
Out-of-sample prediction			
Without rating information	-0.1605	-0.0961	-0.0689
With rating information	-0.1583	-0.0949	-0.0680

Note: In this table "η" represents the risk aversion parameter. The value-at-risks are within two weeks of a downgrade. These value-at-risks correspond to each unit invested in the mean-variance portfolios.