Spread of Greek Bond vs German Bund hits 165bps: Sign of a junk-rated economy or another side effect the financial crisis?

Veni Arakelian*

Research and Forecasting Division, EFG EUROBANK.

25th December 2008

1 Introduction

The interest of modeling bond yields can be traced both in academics and practitioners. The current crisis that we are going through raises again questions about the drivers of a key variable, defined as the difference between two categories of yields, known as yield spread. Differences between the spreads of different borrowers can indicate the relative riskiness of various categories of debt. Hence, it reflects the markets assessment of default risk.

During the last months, the evolution of the yield spreads is a key indicator of the panic that conquers market players. A widening of spreads means that investors judge it riskier to buy the debt of, say, Greece and Italy than the debt of Germany. Accordingly, they demand a higher premium. The widening of the spreads hit new highs incomparable to their past. Ending October 2008, yield spreads of Portugal, Italy, Greece and Spain widened to record levels against Germany, as fears rose that these economies could face increasing problems in a deteriorating financial climate.The widening bond spreads come amid growing risk aversion after a big fall in global stock markets and increased concerns about the financial health of the banking system.

Investors experienced times of stress, switched into German bonds, that are the most liquid and

*20 Amalias and Souri, 10559, Athens, Greece. Email: varakelian@eurobank.gr

are considered the safest. Yields on benchmark 10-year Portuguese, Italian and Spanish bonds rose to their widest levels against Germany since the launch of the eurozone in January 1999, while the Greek spreads rose to highs not seen since it joined the single currency in April 2001, reaching its pick of 165bps on November 3. It still moves in a range of 139-161bps. Some analysts attribute the widening of the Greek spread to worries about the high debt-to-GDP ratio and the rising risk aversion. Other reasons for Greek bonds underperforming is due to the large amount of government supply and competition from government-backed bank bonds (e.g. UK government-backed bank bonds have higher ratings Greece, which attracts some investors to the bank bonds).

The literature on the subject of bond spreads is exorbitant as there is a vast amount of approaches from different viewpoints. We focus on the papers where national and global factors are assumed of high importance and are modeled jointly with yield spreads. Favero, Francesco and Luigi (1997) attempt to model the determinants of the interest rate differentials on government bonds between high yielders, namely Italy, Spain and Sweden, and Germany. Concentrate on daily frequencies, where the relevance of economic fundamentals is rather limited, they identify and measure three components of total yield differentials: one due to expectations of exchange rate depreciation-which they call the exchange rate factor-another which reflects the market assessment of default risk and a last one due to the different taxation treatment of long-term yields. Dungey, Martin and Pagan (2000) perform a factor analysis of long-term bond spreads by decomposing international interest rate spreads into national and global factors. The factor model is applied to weekly data on long-bond spreads between five countries - Australia, Japan, Germany, Canada and the UK - and the USA over the period 1991 to 1999. The resulting factor decomposition is used to examine the international investor's optimal portfolio decision in a mean-variance framework. On the other hand, Dullmann and Windfuhr (2000) examine the suitability of one-factor affine models to explain the observed spreads between Italian and German government bond yields. While some empirical work has been conducted on spreads of individual issuers, empirical evidence on factors driving spreads in a multi-issuer context is scarce. Seeking for factors affecting yield spreads, Eichengreen and Mody (2000) conclude that the changes in spreads are mostly explained by shifts in market sentiment rather than by shifts in fundamentals.

Codogno, Favero, and Missale (2003) use US corporate bond and swap spreads and debt-to-GDP ratios (as a measure of default risk) to explain the ten year spreads of all EMU issuers. Based on an interaction model they present weak evidence that the effects of shocks in the international bond markets (proxied by U.S. bond data) differ with default risk, establishing statistically significant results only for Austria, Italy and Spain. They conclude that default risk plays a small but important role in explaining EMU government bond spreads. On the other hand, Geyer, Kossmeier and Pichler (2004) focus on the joint dynamics of yield spreads derived from government bonds issued by member states of the European Monetary Union. Adopting the originally proposed by Duffie and Singleton (1999) model jointly with a state-space approach, they conclude that a parsimonious two-factor version of the multi-issuer model sufficiently captures the main features of the data. The first factor turns out to be related to long term yield spreads across different issuers, whereas the second factor is related to short term yield spreads, whereas they do not find evidence for a significant impact of macroeconomic or liquidity related variables.

Special attention is also given to emerging market yield spreads. Mauro, Sussman and Yafeh (2002) thoroughly analyze yield spreads on sovereign bonds issued by emerging markets, using modern data from the 1990s and historical data on bonds traded in London during 1870-1913. They show that spreads today comove across emerging markets to a significantly higher degree than they did in the historical sample. Moreover, sharp changes in spreads in the 1990s tend to be mostly related to global events, whereas they were primarily related to country-specific events in 1870-1913. IMF (2004) argues that global liquidity, as measured by the 3-month LIBOR, was the most important determinant of the narrowing of emerging market spreads post-September 2001. Seeking for global factors that drive the emerging market spreads, Gonzalez-Rozada and Yeyati (2008) conclude that emerging market spreads depend negatively on international risk appetite (as proxied by high-yield corporate spreads in developed markets) and positively on international liquidity (proxied by US Treasury notes) and that ratings appear to be largely endogenous, reflecting changes in spreads rather than anticipating them.

This paper contributes to the growing debate that the widened Greek spreads is a warning bell, that Greece could run into difficulties in funding its spending programme, since its economy slows and its debt costs rise, making it less competitive in relation to Germany, Europe's biggest economy. Hereupon several questions may be asked: Who are the factors driving the yield spreads and what are the linkages among the different yield spreads? Is it is possible to identify the changing point among the dependence structure of the spreads?

In the first part of the paper, we employ a model to analyze the lead-lag relations between Greek bond spreads and a vector of independent variables, such as, other yield spreads, measure of health of global credit markets (in other words, liquidity), changes in the fear of stock market volatility. The second part deals with the dependence structure among the already mentioned spreads through the notion of contagion. It is proposed a methodology for modeling dynamic dependence structure through copula functions, allowing copula function or copula parameters to change across time. Thus, the constructed test for contagion is based on more general structures than correlation. We employ a threshold approach so these changes do not evolve in time but occur in distinct points. This strategy resembles the threshold or change-point models applied in time-series analysis (see Tong (1983)).

2 Descriptive Analysis

The data set analyzed consists of time series of yield spreads of 10YR government bonds of Austria, Belgium, France, Greece, Italy, Spain, Sweden and Portugal vs German Bund (figure 2.1). The sample period is from January 1, 2000 to November 30, 2008, excluding holidays or N/A data points. As the main source of data we use daily yields provided by Bloomberg.

Table 2.1: Descriptive Statistics

	Mean	StD	Max	Min	Median	Kurtosis	Skewness	Jarque-Bera*
AUSTRIA	13.493	12.874	74.3	−6.1	9.1	3.8339	0.94276	403.09
BELGIUM	17.480	13.952	75.8	−3.5	13.3	3.5720	0.90135	345.47
FRANCE	8.0490	6.8398	44.8	−1.4	6.8	6.0365	1.3214	1563.1
GREECE	37.922	25.089	164.6	8.1	30.1	6.4563	1.7290	2305.6
ITALY	28.3534	14.688	124.8	3.5	24.75	11.9538	2.3585	9892.2
PORTUGAL	23.517	14.548	93.6	−3.2	20	4.6591	0.97450	583.88

* *Jarque-Bera critical value:5.9915. Normality is rejected.*

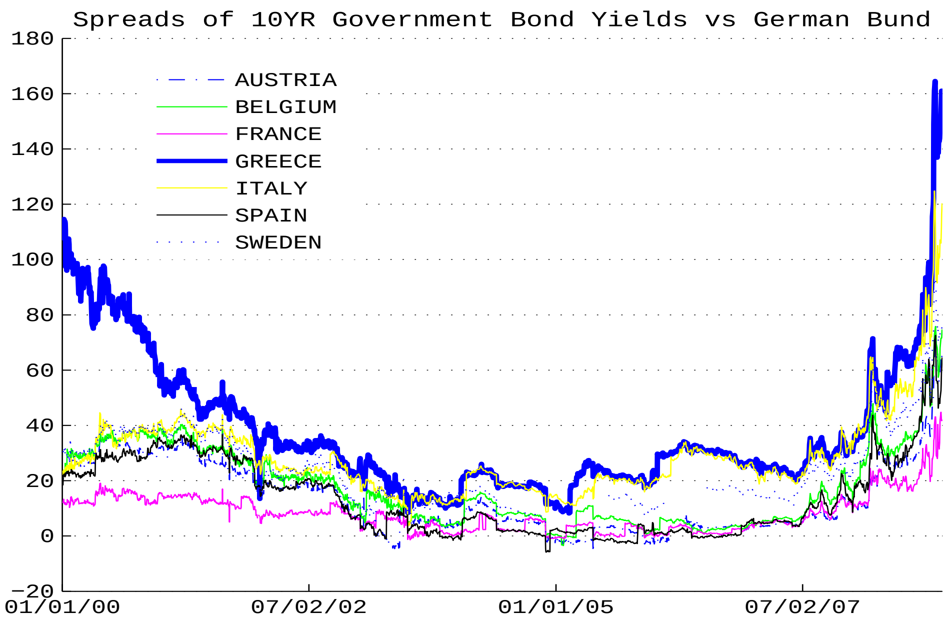

Figure 2.1: Co-evolution of the yield spreads

3 Contagion

3.1 Discussion

Economists interest in "contagion" surged during the second half of the 1990s, when financial crises spread across emerging countries, affecting nations with apparently healthy fundamentals and whose policies, only a few months earlier, had been praised by market analysts and the multilateral institutions. Analysts, academics and policy makers ask three fundamental questions related to contagion: (1) What are the channels through which financial upheaval is transmitted across countries. (2) Why do some crises spread so quickly and violently, while others are constrained to a particular country. And, (3), is there anything can be done to reduce a countrys vulnerability to externally-originated shocks. Contagion has been defined in the economics literature in many different ways, including as any transmission of shocks across countries. Eichengreen and Rose (1999) and Kaminsky and Reinhart (1999), for example, have defined contagion as a situation where the knowledge that there is a crisis elsewhere, increases the probability of a domestic crisis. Three are the mechanisms through which economic shocks are transmitted across countries. The first one corresponds to global disturbances that affect all (or most) countries in the world, e.g. the oil shocks of 1973 and 1979. The second mechanism, known as fundamental-based contagion (or spillover) corresponds to shocks coming from a related country. And the last mechanism includes all instances not covered by the two previous cases. That is, contagion is defined as a residual, and thus as a situation where the extent and magnitude of the international transmission of shocks exceeds what was expected by market participants. The last definition is discussed by Forbes and Rigobon (2002). They specify contagion as an increase in cross-market linkages occurring if two markets (or group of markets) do not present high degree of comovement during both stability and crisis periods. Thus, a conditional correlation test can be carried out to investigate whether the correlation between two markets changes in contagion periods.

3.2 Proposed methodology

To be inserted

4 Model

Let SP_t , for $t = 1, \ldots, T$, be realizations of a variable of interest. We model the data using two specifications for the variance. Specifically,

$$SP_t = c + X_t + \epsilon_t$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \gamma\varepsilon_{t-1}^2 d_{t-1} + \beta\sigma_{t-1}^2 \quad [1] \qquad (1)$$

where $d_t = 1$ if $\varepsilon_t < 0$, and 0 otherwise,

or

$$SP_t = c + X_t + \epsilon_t$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma z_t \qquad (2)$$

4.1 Explanatory variables

1. The LIBOR / OIS spread.

   It represents the difference between LIBOR (the rate at which major banks lend money to each other for a certain period of time, say 3mth, 1yr, etc.), and the Overnight Index Swap, or OIS (basically the same thing, but with no exchange of cash, just a "bet" on the rate itself). Hence this spread represents the "liquidity premium", i.e. the premium someone has to pay over the expected level of interest tares (OIS) to get access to physical cash (LIBOR) (figure 4.1).

   The LIBOR / OIS spread is followed extremely closely by all market participants in the inter-bank Money Market. Historically at pre-crisis levels of 10bps, it widened in August 2007 to 100bps, and recently reached unprecedented levels of 350bps as liquidity dried-up:

[1]The errors are estimated using the GJR-GARCH(1,1) model (Glosten, Jagannathan and Runkle (1993), Zakoian (1994)) incorporating the property of the volatility to be an asymmetric function of the past and allowing good news, $\varepsilon_t > 0$, and bad news, $\varepsilon_t < 0$, to have different effects on the conditional variance (Good news has an impact of α whereas bad news has an impact of $\alpha + \gamma$.). In addition we detect the presence of leverage effect, whenever $\gamma > 0$. If $\gamma \neq 0$, the news impact is asymmetric.

LIBOR shooting up as banks became reluctant to lend cash to each other by fear of counterparty default, while expected rates moved down as the market expects the central bank to cut its rate, on which the OIS resets.

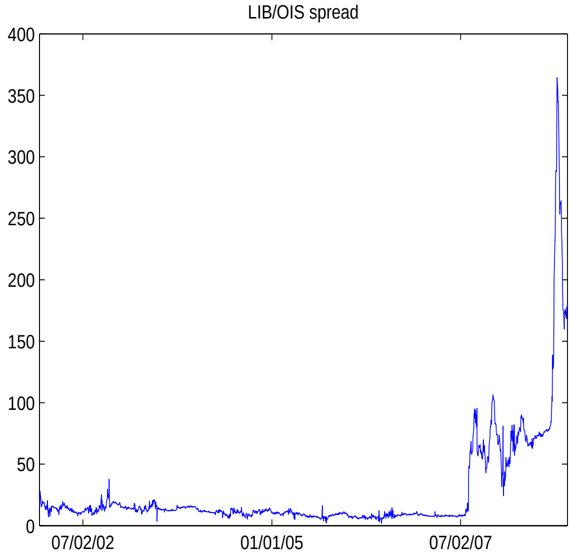

Figure 4.1: LIB/OIS spread

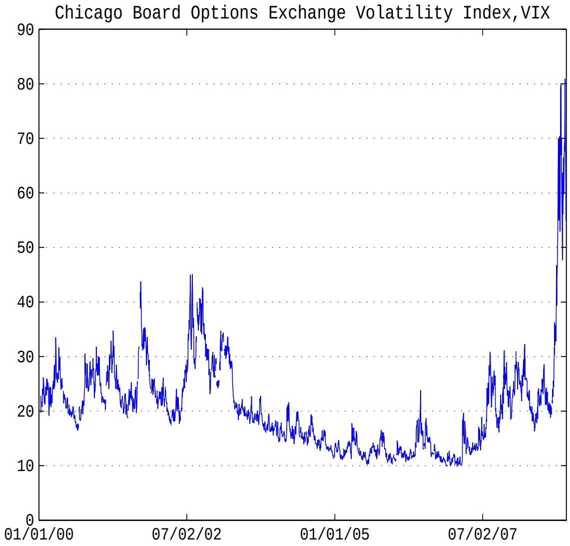

Figure 4.2: VIX Index

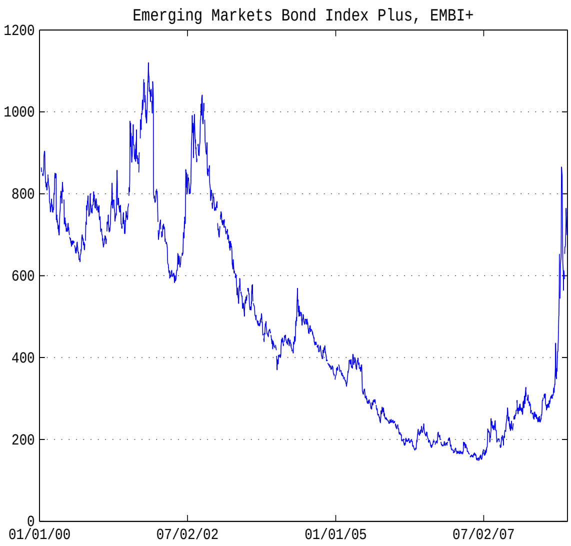

Figure 4.3: EMBI+ Index

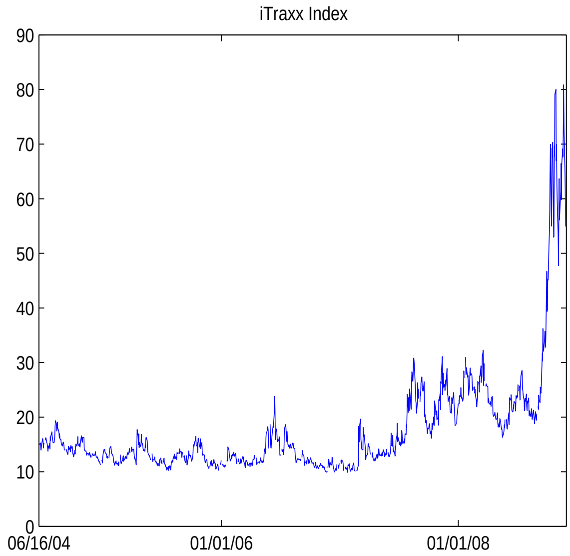

Figure 4.4: iTraxx Index

2. The Chicago Board Options Exchange Volatility Index (VIX).

VIX, introduced by Whaley (1993), is a key measure of market expectations of near-term volatility conveyed by S&P500 stock index option prices. It has been considered by many to be the world's premier barometer of investor sentiment and market volatility (figure 4.2).

3. The Emerging Markets Bond Index Plus (EMBI+).
   EMBI+ tracks total returns for traded external debt instruments (external meaning foreign currency denominated fixed income) in the emerging markets. The regular EMBI index covers U.S.dollar-denominated Brady bonds, loans and Eurobonds (figure 4.3).

4. Credit Default Swap Index (iTraxx Europe Index).
   Indices of this type allow an investor to transfer credit risk in a more efficient manner than using groups of single CDSs. They are standardised contracts and reference a fixed number of obligators with shared characteristics. Investors can be long or short the index which is equivalent to being protection sellers or buyers.

   The most widely traded of the indices is the iTraxx Europe index composed of the most liquid 125 CDS referencing European investment grade credits (figure 4.4).

5. Other yield spreads.

5 Estimation Results

The analysis is contacted using a modified sample size, since iTraxx Index launched on June 16, 2004. The total number of observations is 584. We use the first 524 (i.e. until 08/31/2008) to estimate the models and the rest to evaluate the out-of-sample forecasting ability of the models.

Table 5.1: Estimation results for model 1

	Coefficient	Std. Error	z-Statistic	Prob.
c	-0.000711	0.000721	-0.985510	0.3244
ΔEMBI	0.055355	0.037026	1.495045	0.1349
ΔFRANCE	0.003118	0.004936	0.631625	0.5276
ΔITALY	0.459273	0.016213	28.32678	0.0000
ΔITRAXX	0.070941	0.016423	4.319587	0.0000
ΔLIB/OIS	-0.011062	0.008541	-1.295173	0.1953
ΔPORTUGAL	0.148031	0.011542	12.82579	0.0000
ΔVIX	0.001908	0.011130	0.171444	0.8639
ω	5.50E-06	2.00E-06	2.753422	0.0059
α	0.108611	0.026643	4.076557	0.0000
γ	0.639058	0.092870	6.881179	0.0000
β	0.797647	0.018020	44.26512	0.0000

Table 5.2: Measures of forecasting ability of model 1

RMSE	0.027267	Theil Inequality Coefficient	0.266525
MAE	0.016039	Bias Proportion	0.087976
MAPE	58.64936	Variance Proportion	0.397268
		Covariance Proportion	0.514756

Table 5.1 gives the estimated values and the significant tests for the parameters. It seems that the changes in French spreads and in VIX index do not affect the changes of Greek spreads, due to the insignificant coefficients. The changes in LIB/OIS spread affect the dependent variable and the interesting finding is the opposite sign of the coefficient. This indicates the move of the funds to Greek bonds every time the difference between two subsequent values of LIB/OIS spread decreases.

The p-value of 0 for all the estimated parameters involved into the variance equation, indicates the presence of heteroscedastic errors, that have both GARCH effects and leverage effect, $\gamma > 0$. The last strengthens our view that the volatility is an asymmetric function of the past and that the good news, $\varepsilon_t < 0$, have different effects on the conditional variance than bad news, $\varepsilon_t < 0$. Good news has an impact of α whereas bad news has an impact of $\alpha + \gamma$.

We turn now to the second model where the changes of VIX index are assumed to drive the volatility of the spreads. The results are given in table 5.3. Recall that it is a key measure of investor sentiment and market volatility related to S&P500 stock index option prices. The intuition behind this parametrization is to model the well-known, '*flight - to - quality*' in periods of high volatility of stock markets and global uncertainty. The results are changed as far as it concerns

Table 5.3: Estimation results for model 2

	Coefficient	Std. Error	z-Statistic	Prob.
c	-0.000562	0.000464	-1.211134	0.2258
ΔEMBI	0.034521	0.027762	1.243431	0.2137
ΔFRANCE	0.012717	0.004831	2.632600	0.0085
ΔITALY	0.589943	0.010307	57.23614	0.0000
ΔITRAXX	0.064435	0.014969	4.304449	0.0000
ΔLIB/OIS	-0.007074	0.008918	-0.793204	0.4277
ΔPORTUGAL	0.169584	0.009522	17.80907	0.0000
ω	0.000147	1.20E-05	12.32474	0.0000
α	2.190750	0.188357	11.63084	0.0000
β	0.050846	0.009865	5.154008	0.0000
γ	-0.000235	0.000100	-2.340542	0.0193

the changes of French spreads. The t-statistic give a significant coefficient contrary to the model 1. Again, it is strongly supported the presence of GARCH effects. Changes in VIX index have a significant effect and the sign is according to our expectations.

Table 5.4: Measures of forecasting ability of model 2

RMSE	0.023114	Theil Inequality Coefficient	0.207128
MAE	0.013748	Bias Proportion	0.077995
MAPE	62.19163	Variance Proportion	0.121196
		Covariance Proportion	0.800810

5.1 Evaluating the forecasting ability of the models

Since the measures of RMSE, MAE, MAPE or the Theil's inequality coefficient give fuzzy results about the superiority of a model versus to the other, we apply the Diebold - Mariano test (1995) (Diebold and Mariano, 1995). The DM test will be used to compare the accuracy of forecasts against random walk predictions. When comparing two forecasts, the question arises of whether the predictions of a given model, A, are significantly more accurate, in terms of a loss function $g(\dot{})$, than those of the competing model, B. The Diebold-Mariano test aims to test the null hypothesis of equality of expected forecast accuracy against the alternative of different forecasting ability across models. The null hypothesis of the test can be, thus, written as

$$DM_t = E[g(e_t^A) - g(e_t^B)] = 0 \tag{3}$$

where e_t^i refers to the forecasting error of model $i = A, B$ when performing h -steps ahead forecasts (for details of the test statistic and its asymptotic properties, see Diebold and Mariano (1995)). Taking the loss function g to be the absolute value, we conduct significant test of the constant c, $DM_t = c + u_t$ [2]. From table 5.1, it becomes that we reject the null $H_0 : c = 0$ supporting the forecasting ability of model 1. The p-value is not so strong, but it is clear the necessity of a model with time varying volatility.

[2] A difficulty is that the series DM_t is likely to be autocorrelated. Applying the Breusch-Godfrey serial correlation test, we accept the hypothesis of no-autocorrelation.

	Coefficient	Std. Error	z-Statistic	Prob.
C	7.26E-07	0.001167	0.000622	0.9995
RESID(-1)	0.038803	0.132371	0.293140	0.7705

Table 5.5: Diebold-Mariano test: $\widehat{DM}_t = 0.002291 + \widehat{u}_t$

	Coefficient	Std. Error	z-Statistic	Prob.
c	0.002291	0.001158	1.979264	0.055

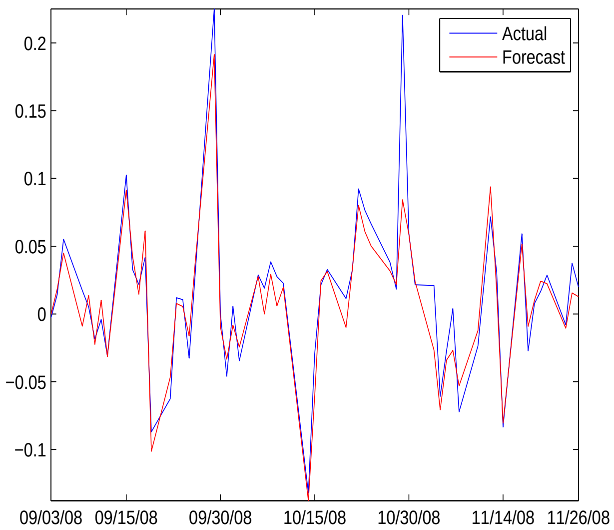

Figure 5.1: Model 1: Out-of-sample forecasts

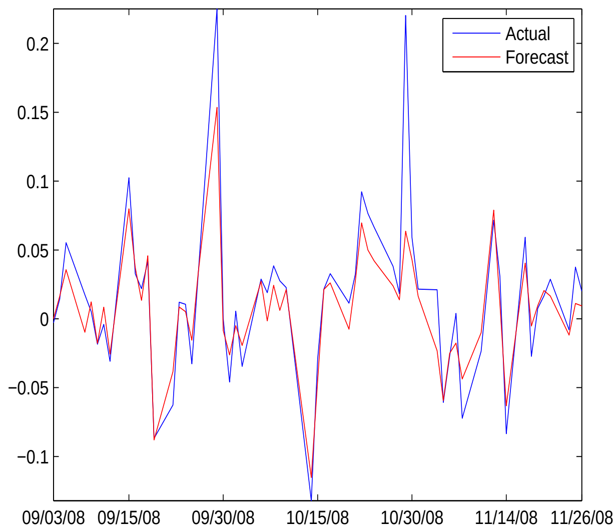

Figure 5.2: Model 2: Out-of-sample forecasts

6 Conclusions

The goal of this paper is model the spread between Greek and German Bund, comparing competing GARCH models. The results support the time varying volatility of the spreads.**to be revised**

References

[1] Codogno, Lorenzo, Carlo Favero and Alessandro Missale, 2003, "Yield spreads on EMU government bonds", *Economic Policy*, vol.**18**, 503-532.

[2] Diebold F.X. and R.S. Mariano, 1995, "Comparing predictive accuracy", *Journal of Business and Economic Statistics*, vol.**13**, 25363.

[3] Duffie, Darrell, and Kenneth J. Singleton, 1999, "Modeling the term structure of defaultable bonds", *Review of Financial Studies*, vol.**12**, 687-720.

[4] Dullmann, Klus, and Mare Windfuhr, 2000, "Credit spreads between German and Italian Sovereign bonds do affine models work?", *Canadian Journal of Administrative Sciences*, vol.**17**, 166-181.

[5] Dungey, Mardi, Vance L. Martin and Adrian R. Pagan, 2000, "A multivariate latent factor decomposition of international bond yield spreads", *Journal of Applied Econometrics*, vol.**15**, 697-715.

[6] Eichengreen, Barry, and Ashoka Mody, 2000, "What explains changing spreads on emerging market debt: Fundamentals or market sentiment?", NBER Working Paper.

[7] Eichengreen, Barry, and Andrew K. Rose, 1999, "Contagious currency crises: Channels of conveyance", in T. Ito and A.O. Krueger, *Changes in Exchange Rates Rapidly Developing Countries*, University of Chicago Press.

[8] Favero, Carlo A., Francesco Giavazzi and Luigi Spaventa, 1997, "High yields: The spread on German interest rates", *Economic Journal*, vol. **107**, 956-985.

[9] Forbes K.J. and R. Rigobon, 2002, "No contagion, only interdependence: Measuring stock markets comovements", *Journal of Finance*, vol. **57**, 2223-2261.

[10] Geyer, Alois, Stephan Kossmeier and Stefan Pichler, 2004, "Measuring systematic risk in EMU government yield spreads?", *Review of Finance*, vol.**8**, 171-194.

[11] Glosten, Lawrence R., Ravi Jagannathan and David E. Runkle, 1993, "On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks", *Journal of Finance*, vol.**48**, 1779-1801.

[12] Gonzalez-Rozada, Martin, and Eduardo Levy Yeyati, 2008, "Global factors and emerging market spreads", *The Economic Journal*, vol.**118**, 1917 - 1936.

[13] Grandes, Martin, 2003, "Convergence and divergence of sovereign bond spreads: theory and facts from Latin America", SSRN Working Paper.

[14] International Monetary Fund, 2004, "Determinants of the rally in emerging market debt liquidity and fundamentals", *Global Financial Stability Report*, April, chapter **2**, 53-63.

[15] Kaminsky, Graciela and Carmen Reinhart, 1999, "Bank lending and contagion: Evidence from the East Asian Crisis", NBER Working Paper.

[16] Mauro, Paolo, Nathan Sussman and Yishay Yafeh, 2002, "Emerging market spreads: Then versus now", *The Quarterly Journal of Economics*, vol.**117**, 695-733.

[17] Tong H., 1983, *Threshold Models in Nonlinear Time Series Analysis*, Lecture Notes in Statistics, No. **21**, Springer & Verlag, Heidelberg.

[18] Whaley, Robert E., 1993, "Derivatives on market volatility: Hedging tools long overdue", *Journal of Derivatives*, vol.**1**, 71-84.

[19] Zakoian J.M., 1994, "Threshold heteroskedastic models", *Journal of Economics and Dynamics Control*, vol.**18**, 931-995.