Determinants of Recovery Rate in the Financial Sector

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First Draft

Abstract

Understanding the determinants of recovery rates has been one of the most important objectives of academic research in the credit risk field in recent years. This work analyzes the determinants of recovery rates in European financial sector bonds using a reduced-form model without *a priori* fixing any modelization to the loss function.

We obtain an implicit loss function from Covered Bonds (CB) and Bonds (B) issued by financial institutions. Both assets, CB and B, share the same issuer and, since in both cases the hazard rate is driven by the probability of bankruptcy of the issuer, they should have the same hazard rate function. Therefore, we can study whether certain determinants like interest rates, the business cycle or inflation, affect the ratio between loss functions for CB and B.

Keywords: Recovery, implicit loss function, Covered Bonds.

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1 Introduction

Understanding the determinants of recovery rates has been one of the most important objectives of academic research in the credit risk field in recent years. One of the main approaches in the literature about credit risk consists of using reduced-form models, beginning with the work of Jarrow and Turbull (1995), Lando (1998) and Duffie and Singleton (1999). Under this approach it is not possible to estimate the recovery rate and the hazard rate function separately. Therefore, within such framework, the analysis requires from the researcher to fix one variable in order to study the other, or to study the loss function, which is a combination of both. One of the aims of this paper is to analyze the determinants of the recovery rate in the European financial sector, using a reduced-form model without fixing the hazard rate *a priori*.

In the literature of reduced-form models three different models of recoveries are considered; recovery of face value, recovery of market value and recovery of treasury value. The first measures the recovery payment as a fraction of the face value, the second as a fraction of the pre default debt's market value, and the last as a fraction of the value at the time of default of a treasury bond with the same maturity.

The difference among these assumptions imply alternative characterisations of the economic mechanism by which recovery payments are settled in the market, and also as has been said, differences in the scale by which those payments are measured. This change of scale *per se* is irrelevant for mathematical purposes and should not render any pricing deviations among models which solely differ on this point. The discussion about the recovery mechanism in those terms is spurious and mainly motivated by the fact that in most practical settings the recovery payment is assumed constant or, at most, time dependent, but always non random. This assumption allows us to obtain implicit default probabilities but forget about the recovery risk component.

Given that extracting meaningful recovery rates from market price data is difficult to implement within the reduce-form context, some authors try to overcome this problem introducing complementary specifications in the model to obtain an "identification condition". Bakshi et al (2006) incorporate an economic equilibrium model for the recovery rate, Jarrow (2001), Guo, Jarrow and Zeng (2005), Karoui

(2005) and Das and Hanouna (2006) rely on a structural framework for the recovery rate, in what constitutes overall a hybrid approach between structural and reduce-form models.

However, the most prominent and prolific approach up to date in the area of recovery rate analysis has been carried out using historical data of recovery rates. In this branch of the literature, empirical indicators have been found to explain the high volatility of the recovery rates in the last years. There are studies that try to explain the recovery rates using endogenous variables related to the bonds' issuer; some others consider the dependence of recovery rates on the level of defaults among issuers that are somehow correlated, while others consider economy-wide macroeconomic variables. Finally, the most recent studies consider a general mix of all possible variables that have been found successful in explaining recoveries. E.g. Altman et al. (2005) found that the recovery rate was very variable and that there exists a negative relationship between default probabilities and recovery rates. The same negative correlation is found in Hu and Perraudin (2002). Acharya et al. (2003) focus on the importance of industry effects. Schürmann (2004) finds that some of the factors which should play a role in any recovery rate model should be the characteristics of the collateral, industry and timing of business cycle. Frye (2000) shows that in recession periods, recoveries are much lower that in expansions. Carey (2004) finds that the nature of the firm's debt is correlated with the level of recovery rate. Another important studies are Hamilton et al. (2001), Gupton et al (2000), Van de Castle and Keisman (1999).

This study makes use of some of the previous approaches applied to our particular setting. First, given that we use a loss function proportion between Bonds and Covered Bonds, and that issuer characteristics should be almost irrelevant with respect to CB, and that collateral characteristics should be even less relevant to Bonds in turn, we have refrained from using issuer and collateral variables and employ only macroeconomic variables as determinants of recovery rate (Interest rates, Business cycle, Inflation, Volatility...). Second, since there are no historical data of recoveries for Covered Bonds (as none has defaulted yet), and on account of the special characteristics of the CB's collateral, it is not advisable to transfer knowledge from the bond market, we rely on market value data. This study provides a different approach and a new contribution to the literature since helps to understand the determinants of the recovery of the Covered Bonds in terms of the recovery of Bonds from the same issuer, or viceversa.

Following Duffie and Singleton (1999), we obtain an implicit loss function (ILF) using data of Covered Bond and Bond issued by financial institutions. Both assets, Covered Bonds and Bonds, share the same issuer and should, therefore, have the same hazard rate function since in both cases the hazard rate is driven by the probability of bankruptcy of the issuer. Hence, differences in the loss function should reflect underlying differences in the recovery rates of each instrument. Covered Bonds investors have a pool of eligible Covered Bonds collateral as preferential security and, most often enjoy a certain degree of over collateralisation (OC) and a special legal framework. Thus, they expect a very high recovery, whereas bond investors enjoy comparably lower rights and thus might expect a lower recovery.

Obtaining the ratio between loss functions for Covered Bonds and Bonds (Implicit Loss function , ILFR), the hazard rate function cancels, and only the determinants that affect to the recoveries function remain. Although we cannot study the determinants that affect each recovery function separately, we are able to study how some common determinants such as interest rates, the business cycle or inflation, affect recoveries of both Covered Bonds and Bonds in a qualitative manner (quantitatively the effects should be studied individually for Bonds and Covered Bonds which we are not able to do). Finally, we can compare this effect with the effect that the same variables have in the loss function.

An outline of the paper is as follows. Section 2 provides the general framework and presents the data. Section 3 analyses the implicit loss function for Bonds and Covered Bonds, whereas the analysis of the implicit ratio of recovery rate between Bonds and Covered Bonds is reserved for Section 4. Finally, Section 5 concludes.

2 DATA ANG GENERAL FRAMEWORK

In the recent literature about credit risk there are two main approaches: Structural models and Reduced-form models. The Structural approach was founded by the seminal work by Merton (1974) which has been subsequently expanded and adapted in several manners in order to obtain a better matching with the term structure of spreads observed empirically, e.g. Black and Cox (1976), Geske (1977), Nielsen et al. (1993), Leland and Toft (1996), Longstaff and Schwarz (1995) and Saá-Requejo and Santa Clara (1997). This approach relies on the value of the assets of the bond issuer, which is infrequently observable, and the subordination structure of its liabilities which is often complex. In the structural models, default occurs whenever the asset value falls below the value of the liabilities. Without including market frictions like bankruptcy cost, time to recovery, etc, these models give rise to high recoveries relative to empirical observations.

The other branch of reduced-form models has as landmark papers those of Jarrow and Turnbull (1995), Lando (1998), and Duffie and Singleton (1999). This approach ignores the mechanism that makes a company default. It suffices to know that the moment such an event takes place is a random variable that can be subject to a stochastic representation. The problem usually with this approach is that it is not possible to identify the hazard rate and recovery rate separately without imposing further conditions. We try to overcome this problem by using two different assets for the same issuer to extract an implicit recovery ratio without imposing any "identification condition".

Taking price at time t of a zero-coupon riskless bond maturing at T which is known to be given by

$$B(t,T) = E^{Q}\left(e^{-\int_t^T r(u)du} \mid \mathcal{F}_t \right)$$

where *r(t)* is the risk-free short rate, *Q* is the martingale probability, and $\mathcal{F}\{t\}$ is the amount of information available for investors at time t.

In contrast with such a risk-free bond, the value of a risky one is given by

$$V(t,T) = E^Q\left(S(T)e^{-\int_t^T r(u)du} \mid \mathcal{F}_t \right) + E^Q\left(\frac{F'(\tau)}{S(\tau)} Z_\tau e^{-\int_t^\tau r(u)du} \mid \mathcal{F}_t \right)$$

where *S(t)* is the survival probability, *F(t)* represents the probability of default on or before some time *t* , *Z(t)* is the recovery function and τ is the time of default . The first summand indicates the present value of a unitary payment at *T* weighted by the probability that the bond survives until such time, and the second expresses the present value of a payment *Z* received at the time of default τ weighted by the probability of default.

For simplicity we will follow Duffie and Singleton (1999) in assuming a market value recovery, and assuming that *r(t)*, τ, and *Z* are all independent quantities

$$Z_\tau \equiv \delta_\tau V(\tau,T)^-$$

In other words, contingent upon default, investors receive a random payment comprised of some fraction of the pre-default value of the bond.

Thus, we have,

$$V(t,T) = E^Q\left(e^{-\int_t^T [r(u)+\lambda(u)]du} \mid \mathcal{F}_t \right) + E^Q\left(\left(1 - e^{-\int_t^T \lambda(u)du}\right) e^{\int_t^\tau \lambda(u)du} \delta V(\tau,T)^- e^{-\int_t^\tau r(u)du} \mid \mathcal{F}_t \right)$$

which if worked out recursively renders

$$V(t,T) = E^Q\left(e^{-\int_t^T [r(u)+\lambda(u)(1-\delta)]du} \mid \mathcal{F}_t \right)$$

For that we can show that the price of a risk-adjusted zero coupon bonds would be then determined as

$$P^*(t,T) = E^Q\left(e^{-\int_t^T R(u)du} \mid \mathcal{F}_t \right)$$

where $R(t) = r(t) + \lambda(t)(1-\delta(t)) = r(t) + ILF(t)$ has a different specification depending on the particular setting. In this case we will extract the implicit loss function by the calibration of an LF constant every day for each issuer.

THE DATA

Bonds and Covered Bonds

We use daily closing price observations of Bonds[2] (22 issues) and Covered Bonds (59 issues) from six different issuers; Deutsche Postbank (DP), Bayerische Hypho und Vereinsbank (BHV), Munchener Hypothekenbank (MH), Caja Madrid (CM), Caja Catalunya (CC) y Caja Galicia (CG). The data span is two years, from May 2005 to May 2007.

All Bonds and Covered Bonds have similar characteristics (Tables 1 and 2); fixed annual coupon (between 3,1 and 5,5), time to maturity between 4 and 11 years, and very good rating. We use data from these countries because they are some of the most important components of the European covered market. The main issuers in the Covered Bonds market are Germany, Denmark, Spain and France, and the initial idea was to work with issuers from all these countries to study the country effect, but it hasn't been easy to find pairs of Bonds and Covered Bonds with compatibility characteristics required for the analysis, and finally we have settled to work only with issuers from Germany and Spain.

Interest rates

The daily European swap curves (IRS), between 1 and 30 years, has been employed to obtain the term structure of risk-free discount factors *B(t,T)*, following the Nelson-Siegel (1987) methodology.

Explanatory Variables

The macroeconomic variables used for the analysis are the stock market represented by the Eurostoxx50 Index (ESX50), which is known to be a good representative of the busyness cycle in the European Union, the HIPC-linked inflation Index (HIPCLI) to capture de inflation expectations in EU, two interest rate variables; the six year IRS (LTSIR) for the level of the term structure of interest rates, and the difference between the 30 years and 1 year IRS curves for the slope (STSIR). Finally, the VDAX index expresses implied volatility of the DAX anticipated on the derivatives market. These variables have the advantage of being available daily as available are the daily closing prices for the same sample of Bonds and Covered Bonds, from may 2005 to may 2007.

[2] The source for the different data are: Reuters, Bloomberg and Ecowin.

3 IMPLICIT LOSS FUNCTION ANALYSIS

We calibrate the implicit loss function for Bonds and Covered Bonds, by a nonlinear least squared approach, in which the root-mean-squared percentage pricing errors is minimized. We estimate an ILF for every day and every firm using the price of the available assets for each day and each issuer for Bonds and Covered Bonds.

$$V_k^B(t,T) = \sum_{i=1}^{n} c_{j,k}^B(t,s_i)B(t,s_i)e^{-ILF_k^B} + B(t,T)Ne^{-ILF_k^B}$$

$$V_k^{CB}(t,T) = \sum_{i=1}^{n} c_{j,k}^{CB}(t,s_i)B(t,s_i)e^{-ILF_k^{CB}} + B(t,T)Ne^{-ILF_k^{CB}}$$

Table 4 reports a summary of the ILF estimates for Bonds and Covered Bonds. Mean ILF estimates range from 0.0028 to 0.034 for bonds and from 0.0071 to 0.0014 in the case of Covered Bonds. Median and mean values are very close in all cases. Bond ILF means are consistently higher than those for Covered Bonds, except for the case of Caja Madrid where the difference is quite small.

We analyse first the macro-determinants of the loss function for Bonds and Covered Bonds and then compare with the results obtained for the loss function ratio. We perform twelve different estimations, one for each firm and type of instrument, where the estimated ILF acts as dependent variable, and our five macro-variables (ESTX, HIPCLI, LTSIR, STSIR, VDAX) as explanatory variables. We employ the seemingly unrelated regression equations (SURE) methodology following Zellner (1962), which allows us to account for heteroskedasticity and contemporaneous correlation in the errors across equations.

$$\begin{aligned} \Delta ILF_i^k = \beta_{i,1}^k + \beta_{i,2}^k \Delta HIPCLI + \beta_{i,3}^k \Delta ESTX + \beta_{i,4}^k \Delta LTSIR \\ + \beta_{i,5}^k \Delta STSIR + \beta_{i,6}^k \Delta VDAX + \varepsilon_i^k \end{aligned}$$

$$i = \{DP, BHV, MH, CM, CC, CG\} \quad k = \{B, CB\}$$

Table 5 shows the estimation results for Bonds. As it appears, only the *HIPC*-linked inflation index and the level of the term structure of interest rates are significant for the majority of firms. The STSIR is significant only for Caja Madrid. Whereas the sign of *HIPC*-linked inflation is positive, as expected, the sign of the influence for $\Delta LTSIR$ is negative, which is unexpected. However, this effect can be due to the fact that it might be measuring a neat effect of this variable when the inflation effect is removed.

Table 7 summarizes the estimation results for Covered Bonds. As for the bonds, the variations in the *HIPC*-Linked Inflation Index and the variations in the level of the term structure of interest rates *(ΔLTSIR)* are significant for all issuers, also with the same signs. The difference comes from the effect of the Eurostoxx index, which here becomes significant for four issuers (*BHV, MH, CC* and *CG*), and the slope of the term structure of interest rates, which appears to be significant for Spanish issuers, with the expected signs.

The Adjusted-R^2 reflects a quite good adjustment of the model to the variation of the loss function.

Next, we test if all variables affect all issuers in the same manner, and the results are provided in Table 6 and 8. We use the Wald Test to check for equality of coefficients. In the case of Bonds we cannot reject the null hypothesis of equality of coefficients only in the case of the HIPCLI variable, and limited to German issuers. The results for Covered Bonds show that we cannot reject the null hypothesis for the HIPCLI, ESTX and STSIR variables as they affect Spanish issuers, and the LTSIRS variable across all issuers. This results reflect first, that the Covered Bonds market is less issuer specific relative to the Bond Market, and second, that there might be a country effect for Covered Bonds..

Results are also indicative of the importance of the level of the term structure of interest rates (LTSIR) and HIPC-Linked Index (HIPCLI) for pricing any instrument. The HIPC-Linked Index captures the inflation expectations in the economy, and appears an essential variable for modelling variations in the loss function of European Financial Sector Bonds. It is difficult to find other works that consider inflation as a determinant of the loss function for bonds. Das and Hanouna (2007) didn’t find the inflation rate (as a measure of changes in the consumer price index) to be significant for explaining implicit recovery rates (implied from CDS spreads of US firms). On the other hand they found the implicit volatility of the S&P 500 to be an essential variable for the US market. One possible explanation for this apparent contrast of our results with theirs could rest in the fact that our study only covers Financial Sector issuers. A further analysis of a broader spectrum of issuers in the European could make for an interesting future exercise in order to test whether on not this divergence maintains.

The differences between the determinants of the ILF in the Bond and Covered Bond markets must be related to differences in the recovery structure for both types of instruments. Given that both have the same default probabilities, such differences should be attributed to the way those macro-variables impact fundamentally different recovery structures.

Given our previous findings we could postulate that the ESTX index and the slope of interest rates are determinants of the recovery rate of Covered Bonds but not of Bonds. Remember that the recovery in the case of Bonds depends of the value of the firm after default, while recovery in the case of Covered Bond depends on the value, at the time of default, of the pool of mortgages that act as collateral. The Eurostoxx and the slope of the interest rate reflect expectations of the business cycle, and the collateral mortgage pool of the covered bonds could be more sensitive to changes in this variable that the value of the firm.

The level of interest rates appears to explain the ILF for bonds and Covered Bond in the same manner, and thus we cannot determine if they have an effect on the recovery rates. On the other hand, the HIPC-linked index seems to affect the ILF of bonds and Covered Bonds in a different way, and thus, it could be a particular determinant of the recovery rate for both. To study how much of this dependence remains when we eliminate the effect of default probabilities from the loss function, in the next section we work with the ratio of ILFs for Bonds and Covered Bonds.

4 IMPLICIT LOSS FUCTION RATIO ANALYSIS

We build our implicit loss function ratio (ILFR) as the ratio of the ILF of Covered Bond to that of Bonds which were calibrated in last section. We expect that this ratio represents the implicit Loss Given Default (LGD) rate ratio between Covered Bonds and Bonds, as the default probability factor should cancel out.

$$ILFR_t^k = \frac{ILF_t^{k,CB}}{ILF_t^{k,B}} = \frac{\lambda_t^k(1-\delta_t^{k,CB})}{\lambda_t^k(1-\delta_t^{k,B})} = \frac{(1-\delta_t^{k,CB})}{(1-\delta_t^{k,B})}$$

We expect the ILFR to be between zero and one, as the LGD (recovery rate) for Covered Bonds is lower (higher) than for Bonds. We would also expect for the same reason that the ILFR is strictly less than one. Descriptive statistics in Table 9, show ILFRs higher than one for some days of our estimation period, but median values (means are more influenced by the days were the ratio is higher than one) are always below one and in most cases far from it.

We applied the same macro-analysis of the last section to the ILFR data carrying out six regressions with the variation in the ILFR as the dependent variable and the HIPCLI, ESTX, LTSIR, STSIR, VDAX as explanatory variables. On the basis of our previous findings of the last section, we expect to find that the HIPCLI, ESTX and STSIR all have explaining power.

$$\Delta ILFR_i = \varphi_{i,1} + \varphi_{i,2}\Delta HIPCLI + \varphi_{i,3}\Delta ESTX + \varphi_{i,4}\Delta LTSIR + \varphi_{i,5}\Delta STSIR + \varphi_{i,6}\Delta VDAX + \varepsilon_i$$

$$i=\{DP,BHV,MH,CM,CC,CG\}$$

Table 10 presents the results of the estimation. Contrary to our guess, except for Caja Galicia and Caja Catalunya, macroeconomic variables do not seem to have significant explanatory power on the ILFRs. This could be a result of the cancellation of the default probabilities, a signal that macroeconomic factors affect in the same way the recovery rate expectations for both Bonds and Covered Bonds, or, that it is more probably, especially for the ESTX index, that the relacionship between the variables is non-linear. However, our results show that the LTSIR variable is one of the few explicative variables remaining in the regressions. In fact the LTSIR parameter for Caja Madrid, could be causing the ILFR to exceed one sometimes for this particular issuer. Results do not reject the possibility of a size effect in recoveries that would explain the differences between the results for CC and CG, and the rest of issuers, which in terms of volume outstanding in fixed income are so much bigger.

Assuming that our model is not misspecified, if the variation of the ILFR was more or less zero would involve that the ILFR is a constant or maybe a time moving constant. A constant ILFR appears as reasonable hypothesis which if validated would then lead to the possibility of finding the recovery rate for Covered Bonds indirectly from the recovery rate of bonds .

If a link between both recovery rates were to exist, it could have great importance for practical reasons in a context were there is an absence of historical data on Covered Bond recoveries and were the study of performance of the collateral is highly limited to the investor. Rating agencies enjoy a better access to such collateral information, and in fact have improved their methods for understanding the risk component underlying recoveries. Nevertheless neither the philosophy or the scope of the rating analysis which the rating agencies perform nor the frequency basis on which the information is communicated affords for kind of analysis that practitioners demand.

In order to study whether we could characterize the ILFR as a constant or it is depending on time, we implement a statistical test to observe if the ratio is significantly different from the median or significantly different from a moving constant less than one. We use a test of the family of the Kolmogorov- Smirnov tests, implemented by Ferreira and Gil (2004), that allows us to test the equality between two regression functions with a different set of alternatives[3].

$$H_0 : \frac{LFCB_t}{LFB_t} = \hat{p}$$
$$H_1 : \frac{LFCB_t}{LFB_t} = m_t$$

Under the null hypothesis

$$z_1 = \frac{1}{\sqrt{\hat{a}}} \max S_n(t) \Rightarrow_d \max_{0<v<1} B(v) \qquad to\ test\ for\ m > 0$$
$$z_2 = \frac{1}{\sqrt{\hat{a}}} \max|S_n(t)| \Rightarrow_d \max_{0<v<1} |B(v)| \qquad to\ test\ for\ m \neq 0$$

where $B(v)$ denotes the standard Brownian motion

$$S_n(t) = \frac{1}{\sqrt{m}} \sum_{i=1}^{m_t} (LFCB_{it} - \hat{p} LFB_{it})$$

Under the null our function is equal to a constant p (a "proportional constant" that we have identified with the median), which is more restrictive than testing whether the function's mean is equal to a constant. Under the alternative we have that our function is a constant changing with time, m_t is a continuous function that captures the time-varying structure due the presence of other factors.

Table 11 depicts the value of the Z_1 and Z_2 statistics for all firms and critical values. We cannot reject the null hypothesis for all issuers except for CC and CG, which support the idea of a size effect. This means that in general (for the "big issuers") we can express the recovery rate of Covered Bonds as the recovery rate of an otherwise

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[3] For more details show "Beyond Single-Factor Affine Term Structure Models" Ferreira and Gil, Journal of Financial Econometrics 2004

equivalent Bond issued by the same issuer, plus a constant, that could be estimated. Within this approach all the knowledge already gained from the study of recovery rates in the Bonds market could be transferred and applied to the Covered Bonds market.

5 CONCLUSIONS

In this work we follow Duffie and Singleton (1999) to obtain an implicit loss function (ILF) for Covered Bonds and Bonds issued by financial institutions in the European Market and study their macroeconomic determinants . We compare the results obtained for both assets, to find whether they reflect underlying differences in the recovery rate of each instrument. As a complementary analysis we build an implicit loss function ratio to study the proportion between both recovery rates and to analyse the possibility of expressing the recovery rate of Covered Bonds like a function of the recovery rate of Bonds from the same issuer.

The results are important in several ways. First, we find some evidence in favour of the importance of the level of the term structure of the interest rates and the HIPC-Linked Inflation Index (HIPCLI) in the recovery rate of European Financial Sector Bonds and Covered Bonds. There are several works that show the influence of interest rates as a determinant of recovery rates, but to the best of our knowledge, this is the first time that evidence in favour of the role of the inflation on recovery rates has been found.

Second, we also find that the variation in Eurostoxx has a significative linear effect in the covered bond loss function. On the contrary, we do not find a similar effect on bonds, result consistent with the previous work by Altman (2001). All together means that the Eurostoxx should have some linear effect in the recovery rate of the covered bonds, and therefore, this effect should somehow translate to the ratio between recoveries, expressed as the ratio between the LGD. However, if this effect stays, the results do not support a linear effect.

Third, the results for the ratio supports that we can think on the LGD for bonds and covered bonds as proportional for “big companies” and varying with time for “small companies”. This could be consistent with the idea of more stability on big companies than on small ones.

Finally, we have shown how to express the recovery rate of covered bonds as a function of the recovery rate of equivalent bonds plus a possibly time moving constant. Our risk neutral assessment of recovery rates in Covered Bonds can be profitably complemented with the more fundamental and risk management-oriented analysis of rating agencies, which place important emphasis on structural aspects of the instruments as collateral pool information, legal framework, domestic markets' idiosyncrasies, tax and liquidity effects, etc.. Here, we have given an arguably good approximation of recovery rates of the Covered Bonds when this relevant information is lacking.

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Table 1: Bonds Characteristics

BOND	Issuer	Coupon	Issue	Maturity	Rating	Agency	Amoustanding
DE007789017	DEUTSCHE POSTBANK	6,88	23/07/1997	23/07/2007	AA	FIT	154.937.070
DE251444	BAYERISCHE HYPO UND VEREINSBANK	4,75	27/01/1999	27/01/2009	NR	MOO	200.000.000
DE010048524	BAYERISCHE HYPO UND VEREINSBANK	5,63	08/09/1999	08/09/2009	A-	FIT	200.000.000
DE210366	BAYERISCHE HYPO UND VEREINSBANK	5,5	01/10/1962	01/10/2007	A	FIT	20.451.675,25
DEBLB003	BAYERISCHE HYPO UND VEREINSBANK	3,64	04/08/2005	23/12/2014	WR	MOO	10.000.000
DE214632	BAYERISCHE HYPO UND VEREINSBANK	4,75	28/08/1998	28/08/2008	AAA	FIT	153.387.564,36
DE214645	BAYERISCHE HYPO UND VEREINSBANK	4,00	08/12/1998	08/01/2008	AAA	FIT	153.387.564,36
DE214656	BAYERISCHE HYPO UND VEREINSBANK	4,25	25/03/1999	25/04/2008	AAA	FIT	200.000.000
DE214667	BAYERISCHE HYPO UND VEREINSBANK	5,00	03/08/1999	03/08/2009	AAA	FIT	200.000.000
DEBLB2XL	BAYERISCHE HYPO UND VEREINSBANK	3,25	26/04/2006	26/04/2011	Aaa	MOO	20.000.000
DE101585	MUNCHENER HYPOTHEKENBANK	5,00	10/01/2001	10/01/2011	Aa3	MOO	50.000.000
DE215856	MUNCHENER HYPOTHEKENBANK	4,75	26/01/1999	26/01/2009	NR	MOO	150.000.000
DE101586	MUNCHENER HYPOTHEKENBANK	5,75	17/01/2001	17/01/2011	Aa3	MOO	50.000.000
DE101592	MUNCHENER HYPOTHEKENBANK	5,00	10/08/2001	10/08/2011	Aa3	MOO	50.000.000
ES31495006	CAJA MADRID	5,00	26/12/1997	29/12/2007	AA-	FIT	
ES31495008	CAJA MADRID	4,00	06/10/1998	06/10/2008	AA-	FIT	
ES31495015	CAJA MADRID	3,1	07/04/2004	31/03/2009	Aa1	MOO	
ES31495018	CAJA MADRID	3,5	10/08/2004	10/08/2009	AA-	FIT	
ES31484006	CAJA CATALUYA	3,19	28/12/2004	28/07/2009	A	FIT	
ES31484319	CAJA GALICIA	3,25	02/09/2004	02/09/2009	Aa3	MOO	

Table 2: Covered Bonds Caracteristics

Covered Bond	Issuer	Coupon	Issue Date	Maturity	Credit Rating	Agency	Amt. Outstanding
DE243098	DEUTSCHE POSTBANK	4,500	21/10/1998	21/10/2008	Aaa	MOO	20.451.675,25
DE243619	DEUTSCHE POSTBANK	4,125	09/08/1999	09/08/2007	Aaa	MOO	20.000.000
DE243583	DEUTSCHE POSTBANK	4,000	12/01/1999	12/01/2009	Aaa	MOO	50.000.000
DE251520	BAYERISCHE HYPO UND VEREINSBANK	5,500	18/12/1999	18/12/2009	AAA	FIT	30.000.000
DE251541	BAYERISCHE HYPO UND VEREINSBANK	6,000	10/05/2000	10/05/2010	AAA	FIT	50.000.000
DEHV0EB1	BAYERISCHE HYPO UND VEREINSBANK	1,350	03/06/2005	03/06/2008	AAA	FIT	125.000.000
DEHV0A1A	BAYERISCHE HYPO UND VEREINSBANK	2,250	02/03/2004	02/03/2009	AAA	FIT	50.000.000
DEHV0EBA	BAYERISCHE HYPO UND VEREINSBANK	3,500	03/02/2005	03/02/2015	AAA	FIT	1.500.000.000
DEHV0EB4	BAYERISCHE HYPO UND VEREINSBANK	2,500	22/06/2005	22/06/2009	AAA	FIT	1.250.000.000
DEHV0EDW	BAYERISCHE HYPO UND VEREINSBANK	3,750	01/06/2006	01/06/2010	AAA	FIT	20.000.000
DEBLB0T1	BAYERISCHE HYPO UND VEREINSBANK	4,000	31/03/2006	31/03/2010	AAA	S&P	250.000.000
DE212180	BAYERISCHE HYPO UND VEREINSBANK	5,370	03/01/2001	03/01/2011	AAA	FIT	200.000.000
DE213105	BAYERISCHE HYPO UND VEREINSBANK	5,250	13/03/2001	13/03/2009	AAA	FIT	1.500.000.000
DE212198	BAYERISCHE HYPO UND VEREINSBANK	3,150	06/06/2003	06/11/2007	AAA	FIT	50.000.000
DE212175	BAYERISCHE HYPO UND VEREINSBANK	4,000	12/01/1999	12/01/2009	AAA	FIT	300.000.000
DEBLB1YQ	BAYERISCHE HYPO UND VEREINSBANK	3,250	08/06/2005	08/06/2015	Aaa	MOO	1.250.000.000
DE212200	BAYERISCHE HYPO UND VEREINSBANK	2,250	27/06/2003	27/06/2008	AAA	FIT	200.000.000
DE147622	BAYERISCHE HYPO UND VEREINSBANK	3,650	04/08/2003	04/12/2008	AAA	FIT	50.000.000
DEBLB0T2	BAYERISCHE HYPO UND VEREINSBANK	4,000	30/06/2006	30/06/2010	AAA	S&P	75.000.000
DE213107	BAYERISCHE HYPO UND VEREINSBANK	3,750	23/05/2003	23/05/2011	AAA	FIT	1.750.000.000
DE147616	BAYERISCHE HYPO UND VEREINSBANK	3,950	01/07/2003	29/10/2010	AAA	FIT	50.000.000

DEMHB002	MUNCHENER HYPOTHEKENBANK	4,000	11/07/2006	12/07/2010	Aaa	MOO	20.000.000
DEA0BNTF	MUNCHENER HYPOTHEKENBANK	3,000	03/11/2004	17/11/2008	Aaa	MOO	50.000.000
DEA0D4JU	MUNCHENER HYPOTHEKENBANK	1,7500	20/06/2005	22/06/2009	Aaa	MOO	50.000.000
DE533547	MUNCHENER HYPOTHEKENBANK	4,5000	03/01/2003	03/01/2013	Aaa	MOO	15.000.000
DE215870	MUNCHENER HYPOTHEKENBANK EG	5,7500	04/09/2000	03/09/2010	Aaa	MOO	1.000.000.000
DEA0EY1S	MUNCHENER HYPOTHEKENBANK	2,8750	21/09/2005	23/08/2013	Aaa	MOO	10.000.000
	CAJA MADRID	3,7500	22/10/2003	22/10/2009	Aaa	MOO	
	CAJA MADRID	5,5000	08/10/1999	15/01/2010	AA-	FIT	
	CAJA MADRID	5,2500	01/03/2002	01/03/2012	Aaa	MOO	
ES0414950610	CAJA MADRID	3,5000	25/03/2004	25/03/2011			2.000.000.000,00
ES0414950594	CAJA MADRID	5,0000	30/10/2002	30/10/2014			1.500.000.000,00
ES0414950636	CAJA MADRID	3,5000	14/12/2005	14/12/2015			2.000.000.000,00
ES0414950560	CAJA MADRID	5,7500	29/06/2001	29/06/2016			1.000.000.000,00
ES0414950669	CAJAMADRID	4,2500	05/07/2006	05/07/2016			2.500.000.000,00
ES0414950651	CAJA MADRID	4,2500	25/05/2006	25/05/2018			2.000.000.000,00
ES0414950628	CAJA MADRID	4,0000	03/02/2005	03/02/2025			2.000.000.000,00
ES0414950644	CAJA MADRID	4,1250	24/03/2006	24/03/2036			1.500.000.000,00
ES0414840274	CJ CATALANA	3,5000	07/03/2006	07/03/2016			1.750.000.000,00
ES0414840290	CJ CATALANA	4,0150	09/11/2006	09/11/2016			150.000.000,00
ES0414843146	CAJA GALICIA	4,3750	23/01/2007	23/01/2019			1.500.000.000,00

Table 3: Correlations					
	ΔHIPCLI	ΔESTX	ΔLTSIR	ΔPTSIR	ΔVDAX
ΔHIPCLI	1	0.0384	0.4744	0.3823	-0.0382
ΔESTX		1	0.1821	0.0675	-0.7933
ΔLTSIR			1	0.4707	-0.1803
ΔPTSIR				1	-0.0244
ΔVDAX					1

Table 4. Descriptive Statistics for the Implicit Loss Function						
BONDS						
	$\mathbf{ILF_{DP}}$	$\mathbf{ILF_{BHV}}$	$\mathbf{ILF_{MH}}$	$\mathbf{ILF_{CM}}$	$\mathbf{ILF_{CC}}$	$\mathbf{ILF_{CG}}$
Mean	0.034632	0.005637	0.008067	0.002829	0.007107	0.006083
Median	0.032585	0.004450	0.009678	0.002868	0.006441	0.006756
Maximum	0.075478	0.013912	0.015391	0.007781	0.010934	0.010224
Minimum	0.010349	0.001571	0.000102	0.000108	0.000969	0.000196
Std. Dev.	0.015719	0.003027	0.004669	0.001938	0.002108	0.002960
COVERED BONDS						
	$\mathbf{ILF_{DP}}$	$\mathbf{ILF_{BHV}}$	$\mathbf{ILF_{MH}}$	$\mathbf{ILF_{CM}}$	$\mathbf{ILF_{CC}}$	$\mathbf{ILF_{CG}}$
Mean	0.007152	0.003168	0.001479	0.002667	0.001885	0.001245
Median	0.007448	0.003210	0.001355	0.002751	0.002073	0.001226
Maximum	0.011300	0.005343	0.005152	0.004667	0.003996	0.001950
Minimum	0.002246	0.000513	0.000127	0.000717	0.000114	0.000621
Std. Dev.	0.002287	0.000929	0.000728	0.000725	0.001005	0.000272

Table 5: BONDS

	ΔILF_{DP}	ΔILF_{BVH}	ΔILF_{MH}	ΔILF_{CM}	ΔILF_{CC}	ΔILF_{CG}
K	0.0001 (1.620)	1.2E-05 (0.622)	4.3E-05 (1.628)	2.1E-05 (1.190)	3.1E-05 (1.451)	1.4E-05 (0.619)
$\Delta HIPCLI$	0.0012 (0.437)	**0.0016 (2.223)**	**0.0037 (3.580)**	**0.0023 (3.568)**	**0.0067 (7.909)**	**0.0007 (0.819)**
$\Delta ESTX$	2.7E-06 (1.145)	1.4E-07 (0.230)	1.1E-06 (1.390)	7.1E-07 (1.298)	7.4E-07 (1.141)	9.6E-07 (1.313)
$\Delta LTSIR$	**-0.0049 (-1.895)**	**-0.0081 (-11.847**)	**-0.0080 (-8.622)**	**-0.0066 (-11.100)**	**-0.0082 (-11.092)**	**-0.0053 (-6.562)**
$\Delta STSIR$	-0.0005 (-0.159)	0.0005 (0.663)	**0.0025 (2.220)**	-0.0005 (-0.700)	0.0003 (0.381)	-0.0006 (-0.615)
$\Delta VDAX$	0.0001 (0.909)	-1.2E-05 (-0.334)	-5.3E-06 (-0.104)	3.1E-05 (0.981)	1.2E-05 (0.314)	1.8E-05 (0.412)
$Adj\ R^2$	0.0034	0.2480	0.1270	0.2281	0.2567	0.1090
SSR	0.0013	9.5E-05	0.0001	7.5E-05	7.2E-05	0.0001

Explaining the changes in the Implicit Loss Function of each Bond issuer using changes in market variables; HIPC-linked inflation Index, Eurostoxx 50 Index, the level and slope of the term structure of interes rates and implied volatility of the DAX Index. All parameters are obtained by a SURE estimation. T-statistics are reported below the coefficient values. Bold type shows significant variables of 5% of significant level.

Table 6: Wald Test of Table 5

Null Hipótesis	Chi-square Stat.	*P*-value
$\beta^B_{2,2} = \beta^B_{2,3} = \beta^B_{2,4} = \beta^B_{2,5}$	28.58	0.000003
$\beta^B_{2,2} = \beta^B_{2,3}$	2.77	0.095827
$\beta^B_{2,4} = \beta^B_{2,5}$	21.10	0.000004
$\boldsymbol{\beta^B_{4,1} = \beta^B_{4,2} = \beta^B_{4,3}}$	**1.41**	**0.492149**
$\beta^B_{4,4} = \beta^B_{4,5} = \beta^B_{4,6}$	7.289	0.026131

Bold type shows that we cannot reject the null hypothesis significant variables of 5% of significant level.

Table 7

COVERED BONDS

	ΔILF_{DP}	ΔILF_{BVH}	ΔILF_{MH}	ΔILF_{CM}	ΔILF_{CC}	ΔILF_{CG}
K	3.0E-05 (1.373)	3.7E-06 (0.328)	1.1E-05 (0.822)	-4.2E-06 (-0.419)	1.9E-06 (0.145)	9.3E-06 (0.443)
$\Delta HIPCLI$	**0.0024** **(2.917)**	**0.0051** **(11.467)**	**0.0054** **(9.867)**	**0.0069** **(17.561)**	**0.0064** **(11.135)**	**0.0052** **(4.939)**
$\Delta ESTX$	1.04E-06 (1.499)	**8.2E-07** **(2.235)**	**9.8E-07** **(2.185)**	2.4E-07 (0.754)	**6.8E-07*** **(1.752)**	**1.0E-06*** **(1.787)**
$\Delta LTSIR$	-0.0066 (-8.525)	**-0.0072** **(-18.581)**	**-0.0073** **(-14.573)**	**-0.0074** **(-20.818)**	**-0.0075** **(-15.533)**	**-0.0067** **(-6.421)**
$\Delta STSIR$	0.0008 (0.9301)	-0.0004 (-0.873)	-0.0006 (-1.030)	**-0.0027** **(-6.369)**	**-0.0019** **(-3.271)**	**-0.0040** **(-3.98)**
$\Delta VDAX$	2.3E-06 (0.058)	1.2E-05 (0.572)	9.2E-06 (0.348)	9.6E-06 (0.508)	-2.7E-06 (-0.110)	3.1E-05 (0.726)
$Adj\ R^2$	0.1252	0.4336	0.3285	0.5582	0.4942	0.5372
SSR	0.0001	3.41E-05	5.10E-05	2.65E-05	1.76E-05	2.42E-06

Explaining the changes in the Implicit Loss Function of each Covered Bond issuer using changes in market variables; HIPC-linked inflation Index, Eurostoxx 50 Index, the level and slope of the term structure of interes rates and implied volatility of the DAX Index. All parameters are obtained by a SURE estimation. T-statistics are reported below the coefficient values. Bold type shows significant variables of 5% of significant level. * shows significant variables of 5% of significant level.

Table 8. Wald Test for Table 7

Null Hipótesis	Chi-square Stat.	*P*-value
$\beta^{CB}_{1,2}=\beta^{CB}_{2,2}=\beta^{CB}_{3,2}=\beta^{CB}_{4,2}=\beta^{CB}_{5,2}=\beta^{CB}_{6,2}$	28.11	0.0000
$\beta^{CB}_{1,2}=\beta^{CB}_{2,2}=\beta^{CB}_{3,2}$	11.63	0.0029
$\boldsymbol{\beta^{CB}_{4,2}=\beta^{CB}_{5,2}=\beta^{CB}_{6,2}}$	**3.43**	**0.1796**
$\boldsymbol{\beta^{CB}_{5,3}=\beta^{CB}_{6,3}}$	**0.29**	**0.5885**
$\boldsymbol{\beta^{v}_{1,4}=\beta^{CB}_{2,4}=\beta^{CB}_{3,4}=\beta^{CB}_{4,4}=\beta^{CB}_{5,4}=\beta^{CB}_{6,4}}$	**2.34**	**0.7999**
$\boldsymbol{\beta^{CB}_{4,5}=\beta^{CB}_{5,5}=\beta^{CB}_{6,5}}$	**4.01**	**0.1352**

Bold type shows that we cannot reject the null hypothesis significant variables of 5% of significant level.

Table 9. Descriptive Statistics for the Implicit Loss Function Ratio

	$ILFR_{DP}$	$ILFR_{BHV}$	$ILFR_{MH}$	$ILFR_{CM}$	$ILFR_{CC}$	$ILFR_{CG}$
Mean	0.6988	0.2623	0.5629	2.4278	0.2664	0.2333
Median	0.6834	0.2133	0.2163	0.8946	0.3462	0.2335
Maximum	2.1141	1.0635	10.449	11.958	0.6904	0.3367
Minimum	0.1420	0.0771	0.0143	0.1704	0.0122	0.1362
Std. Dev.	0.3570	0.1969	1.1540	2.9168	0.1537	0.0388

Table 10: ILF RATIOS						
	$\Delta ILFR_{DP}$	$\Delta ILFR_{BVH}$	$\Delta ILFR_{MH}$	$\Delta ILFR_{CM}$	$\Delta ILFR_{CC}$	$\Delta ILFR_{CG}$
K	0.0006 (0.343)	-0.0013 (-0.312)	-0.0069 (-0.174)	-0.0407 (-0.628)	-0.0003 (-0.165)	0.0009 (0.223)
Δ*HIPCLI*	0.1022 (1.446)	**0.6528** **(3.823)**	-1.8119 (-1.162)	-2.2371 (-0.881)	**0.5282** **(5.721)**	**0.7675** **(3.564)**
Δ*ESTX*	-1.2E-05 (-0.212)	0.0001 (1.018)	-0.0001 (-0.094)	-0.0028 (-1.391)	4.2E-05 (0.638)	0.0002 (1.807)
Δ*LTSIR*	**-0.1996** **(-3.106)**	-0.2160 (-1.392)	0.6871 (0.484)	**9.6017** **(4.161)**	**-0.7391** **(-9.009)**	**-0.9764** **(-4.638)**
Δ*STSIR*	0.0501 (0.639)	-0.0925 (-0.489)	-2.1935 (-1.269)	-3.2464 (-1.153)	**-0.2852** **(-2.873)**	**-0.7278** **(-3.535)**
Δ*VDAX*	-0.0026 (-0.789)	-0.0001 (-0.023)	-0.0003 (-0.004)	-0.0819 (-0.004)	-0.0014 (-0.671)	0.0073 (-0.338)
Adj R^2	0.0202	0.0215	0.0083	0.0350	0.2781	0.4404
SSR	0.812	4.753	394.737	1048.226	0.468	0.096

Explaining the changes in the Implicit Loss Function Ratio between Covered Bonds and Bonds from the same issuer using changes in market variables; HIPC-linked inflation Index, Eurostoxx 50 Index, the level and slope of the term structure of interes rates and implied volatility of the DAX Index. All parameters are obtained by a SURE estimation. T-statistics are reported below the coefficient values. Bold type shows significant variables of 5% of significant level.

Table 11: Kolmogorov-Smirnov Test							
	DP	*BHV*	*MH*	*CM*	*CC*	*CG*	Critical-values
Z1	**4,05**	**18,45**	**9,49**	**11,99**	1,28	0,34	1.64 (10%) 1.96 (5%)
Z2	**46,94**	**18,45**	**10,67**	**14,60**	**5,92**	0,34	2 (10%) 2,24 (5%)

The table shows the test statistics of Ferreira and Gil (2004) for the null hypothesis of an Implicit Loss Function Ratio between Bonds and Covered Bonds equal of a proportional constant. Bold type shows that we cannot reject the null hypothesis.