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IMPACTO DEL RIESGO DE REFINANCIAMIENTO Y DEL EFECTIVO DISPONIBLE SOBRE LOS SPREADS DE BONOS CORPORATIVOS

MEMORIA PARA OPTAR AL TÍTULO DE INGENIERO CIVIL INDUSTRIAL

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RESUMEN DE LA MEMORIA
PARA OPTAR AL TÍTULO DE
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IMPACTO DEL RIESGO DE REFINANCIAMIENTO Y DEL EFECTIVO DISPONIBLE SOBRE LOS SPREADS DE BONOS CORPORATIVOS

Conforme a la literatura existente sobre el riesgo de crédito corporativo, los principales determinantes de los *spreads* crediticio son el riesgo de incumplimiento y el riesgo de liquidez. Sin embargo, la reciente crisis de 2007-2009 destacó la importancia del riesgo de refinanciamiento y del efectivo disponible como factores importantes a considerar en la valorización de bonos corporativos. Recientes investigaciones presentan que mayor proporción de deuda de corto plazo incrementa los *spreads* de bonos corporativos a través del riesgo de refinanciamiento (Valenzuela (2013); Gopalan, Song, and Yerramilli (2013)). Además, existe evidencia de una correlación positiva y estadísticamente significativa entre el efectivo disponible y los *spreads* de bonos corporativos, lo cual es consistente con la hipótesis precautoria de ahorrar dinero, pero no con un efecto causal del efectivo disponible al spread.

Usando una base de datos a nivel de bonos, con datos trimestrales, para el periodo de enero 2004 a junio 2009, este estudio explora el impacto de la estructura del vencimiento de la deuda de las firmas sobre los *spreads* de créditos y si este efecto se atenúa en firmas con un mayor ratio de efectivo disponible sobre el total de la deuda. Los principales hallazgos de este trabajo es que el efectivo disponible reduce el impacto del riesgo de refinanciamiento de los *spreads* de bonos corporativos. Específicamente, este estudio muestra que el efecto de la proporción de la deuda de corto plazo sobre los *spreads* de bonos corporativos es positivo en firmas que presentan un nivel de efectivo disponible menor a 0.685. Sin embargo, este efecto desaparece o incluso llega a hacer negativo en firmas con mayor nivel de efectivo disponible.

Los principales resultados de este trabajo son significativos incluso después de controlar directamente por los determinantes estándar de *spreads* de bonos corporativos de acuerdo a los modelos de riesgo de crédito estructurales (Merton, 1974). Además, estos resultados son robustos al controlar por efectos fijos por bonos, país-tiempo y rating de la firma; y a diferentes sub-muestras, es decir, sub-muestras de las firmas con bajo nivel de efectivo disponible y por una sub-muestras que sólo considera el periodo de inestabilidad financiera.

Este *paper* contribuye a la literatura sobre los determinantes de los *spreads* de bonos corporativos en diversas dimensiones. Primero, explora los determinantes estándar de los *spreads* de bonos corporativos usando una nueva base de datos de bonos emitidos en mercados internacionales. Segundo, explora los efectos del riesgo de refinanciamiento y efectivo disponible sobre los *spreads* de bonos corporativos. Tercero, examina la interacción entre la estructura del vencimiento de la deuda de las firmas y el efectivo disponible; y hasta ahora los estudios recientes han tratado estas variables como determinantes independientes de los *spreads* de bonos corporativos.

Los principales resultados de este trabajo son útiles para inversores, directores de empresas y para los responsables de las políticas públicas. Además, los resultados mejoran el entendimiento del riesgo de refinanciamiento y del efectivo disponible sobre los *spreads* de bonos corporativos.

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IMPACT OF ROLLOVER RISK AND CASH HOLDINGS ON CORPORATE BOND SPREADS

According to the literature on corporate credit risk, the principal determinants of credit spreads are default and liquidity risks. However, the recent financial crisis of 2007-09 highlighted the importance of rollover risk and cash holdings as significant factors for consideration in the pricing of corporate bonds. Recent academic papers find that a higher proportion of short-term debt increases corporate bond spreads through a rollover risk channel (Valenzuela, 2013; Gopalan, Song, and Yerramilli, 2013). Additionally, there is evidence of a positive and statistically significant correlation between cash holdings and corporate bond spreads, which is consistent with a precautionary hypothesis but not with a causal effect.

Using a novel bond-level dataset with quarterly data for the period from January 2004 to June 2009, this paper explores the impact of the firm´s maturity debt structure on credit spreads and whether this effect is attenuated in firms with a higher ratio of cash holdings to total debt. The major´s finding of this paper is that indeed cash holdings reduce the impact of rollover risk on corporate bond spreads. Specifically, this paper shows that the effect of the proportion of short-term debt on corporate bond spreads is positive in firms with levels of cash holdings to total debt smaller than 0.685. However, this effect vanishes or even becomes negative in firms with higher levels of cash holdings.

The key findings in this paper are significant even after directly controlling for the standard determinants of corporate bonds spreads according to structural credit risk models (Merton, 1974). The results are also robust to controlling by bond, country-time, and rating fixed effects, and to different sub-samples (i.e., a subsample of firms with low levels of cash holdings and to sub-sample only considering the period of financial distress).

This paper contributes to the literature on the determinants of corporate bond spreads in several ways. First, it explores the standard determinants of corporate bond spreads using a new database of bond issued in international markets. Second, it explores the effect of both rollover risk and cash holdings on corporate bond spreads. Third, it examines the interaction between the maturity debt structure and cash holdings. Recent studies have generally treated these variables as independent determinants of corporate bond spreads.

The main findings in this thesis are helpful for investors, firm managers, and policymakers. Furthermore, this thesis improves the understanding of the rollover risk and levels of cash holdings on corporate bond spreads.

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1 Introduction

Several factors influence corporate bond spreads according to the literature on corporate credit risk. The principal determinants of credit spreads are default and liquidity risks. However, the recent financial crisis of 2007-09 highlighted the importance of rollover risk and cash holdings as significant factors for consideration in the pricing of corporate bonds. Often intuition suggests that firms with higher cash holdings exhibit lower bond spreads. If firms have higher liquidity, they should have a lower probability of default and lower cost of financing. Thereby, these variables are negatively related. Nonetheless, Acharya, Davydenko and Strebulaev (2012) show that sometimes the correlation between cash holdings and corporate bond spreads is robustly positive and greater for lower credit ratings. This study concludes that the model considered shows endogeneity and the results are strongly related by the precautionary motive for saving cash, hence, can be deduced that relation between the cash holdings and spreads is not strict way.

Moreover, firms with higher cash holdings, i.e. with more liquid financial assets over total debt, are able to take charge of their debt, hence it is not direct seek refinancing. This suggests a negative relation between the cash holdings and rollover risk, considering rollover risk as short-term debt over total debt. Nevertheless, if it is observed rollover risk from firms level, it is likely that intuition is not same. Firms with high rollover risk appreciate conserve greater cash holdings on the short term. An empirical study by Harford, Klasa and Maxwell (2013) presents that firms mitigate refinancing risk by increasing their cash holdings and saving cash from cash flows. Hence, this shows a positive correlation between both variables what reinforces the above, and further the study indicates that rollover risk proves to be a key determinant to cash holdings.

Valenzuela (2013) in an empirical study shows that the impact of market illiquidity on corporate bond spreads are exacerbated by a higher proportion of short-term debt. The major finding is consistent with predictions of structural models of credit risk, arguing that a higher proportion of short-term debt increases the exposure of the firm to market illiquidity through a 'rollover risk' channel. Furthermore, He and Xiong (2012) in a theoretical study show that the market illiquidity increases corporate bond spread. They argue that this effect is exacerbated with higher proportion of short-term debt over total debt. The studies suggest that rollover risk is a significant determinant on corporate bond spreads. However, it has so far only appreciated that in times of crisis firms show a cost of rollover, and when it is assessed the rollover risk there a positive correlation with cash holdings of the firms.

In brief, given the absence of papers linking these findings or them study the impact and significance of cash holdings and rollover risk on corporate bonds spreads, and particularly on corporate bond option-adjusted spreads, arises motivation of study the impact of both variables on corporate bonds OAS in sample period from January 2004 to June 2009. This includes periods of stability and financial instability. For this study is used a linear regression model through a panel data model, this considers fixed effects by bonds and country-time. Bond fixed effects

capture the particular effects of time-invariant characteristics, and country-time fixed effects capture macroeconomics invariant characteristic. Moreover, it is analyzed if this model needs to incorporate the credit rating variable as other explanatory variable, or as fixed effect (the reason for this is presented throughout this document). Thereby, confirm the hypothesis, i.e. that rollover risk and cash holdings are statistically significant variables on corporate bond spreads and both have explanatory power on the regressions model proposed.

The paper is organized as follows. Section 2 presents the literature review. In Section 3 shows the theoretical framework that supports the empirical tests conducted in this paper. Section 4 describes the characteristics of the data and sample. Section 5 shows the methodology and empirical model. Section 6 presents the main results. Section 7 shows the additional results. Section 8 concludes the study.

2 Literature review

Existing literature shows that options theory has important implications for modelling corporate debt. Black and Scholes (1973) and Merton (1974) applied options models to the valuation of default premium on corporate bonds. Mainly Merton (1974) gave origin the literature on determinants of corporate bond spreads, who lays the foundation of the basic credit risk structural models, allowing the study of bond spreads in different contexts.

Cavallo and Valenzuela (2010) study the determinants of corporate bond spreads in emerging markets economics using option-adjusted spreads. This method allows them to compare bonds with different cash flow characteristics on a more equitable basis. Furthermore, they implement an empirical methodology based on panel data techniques that enable them to take full advantage of the cross-sectional and time-series dimensions of our data set while reducing the risk of bias arising from endogeneity or unobserved fixed effects.

Collin-Dufresne, Goldstein and Martin (2001) study the determinants of corporate bond spreads changes using bonds data by the industrial sector. They conclude that structural models cannot explain by alone the corporate bond spreads changes, using the U.S. Treasury bonds as proxy.

Covitz and Downing (2007) study the determinants of very short term corporate bond spreads, employing a comprehensive database on transactions of commercial paper issued by domestic U.S. nonfinancial corporations from 1998 to 2003. They analyze the liquidity effect and control by credit rating and maturity. They find that liquidity plays a role in the determination of bond spreads. However, credit rating plays a more important role, even at bonds with short-term horizons.

Acharya, Davydenko and Strebulaev (2012) study cash holdings and credit risk, they show that sometimes the correlation between cash holdings and corporate bond spread is robustly positive and greater for lower credit ratings. They conclude that the model considered shows endogeneity and the results are strongly related with the precautionary motive for saving cash.

Cossin and Hricko (2004) study the benefits of cash holdings using the real options approach. They present that companies need to decide on the optimal amounts of cash to hold. They describe that cash holdings allow for optimal timing of an investment and avoid the underpricing issue. However, cash holdings excessive does not necessarily is make good business sense. Therefore, financial managers need to understand the determinants of cash holdings in a corporation.

Harford, Klasa and Maxwell (2013) study the refinancing risk and cash holdings. They find that firms mitigate refinancing risk by increasing their cash holdings and saving cash from cash flows. On the other hand, the maturity of firms' long-term debt has shortened markedly, and this shortening explains a large fraction of the increase in cash holdings over time. Consistent with the inference that cash reserves are particularly valuable for firms with refinancing risk, they document that the value of these reserves is higher for such firms and that these mitigate underinvestment problems. They conclude that refinancing risk is a key determinant of cash holdings and highlight the interdependence of a firm's financial policy decisions.

Valenzuela (2013) study rollover risk and corporate bond spreads using an option-adjusted spreads. He shows that the impact of market illiquidity on corporate bond spreads are exacerbated by a higher proportion of short-term debt, being higher in speculative-grade bonds. The major finding is consistent with predictions of structural models of credit risk, arguing that a higher proportion of short-term debt increases the exposure of the firm to market illiquidity through a channel 'rollover risk'.

These work mainly focus on the corporate bond spreads, cash holdings and/or rollover risk problem from different views, taking different variables and trying to complement the model presented by Merton in 1974. These studies comprise the theoretical and empirical base that sustains and supports the development of this study.

3 Theoretical framework

This section presents the main theoretical framework to understand the empirical methodologies conducted in this study. Moreover, Appendix A presents the theoretical framework associated with linear regression model, least squares method, model's goodness fit, cross-section regression model and time series regression model.

Panel Data

Panel data is a panel that contains a sample of individuals (companies, bonds, and another) for a given period of time, i.e. a temporal dimension combines with another cross (see Hsiao (2003) and Baltagi (2008)).

Panel data have several benefits: First, this can efficiently control by Individual Heterogeneity. Unlike the time series and cross-section studies, panel data suggest that individuals, companies,

countries, among others are heterogeneous. Controlling for this heterogeneity, it avoids the risk biased results. Second, panel data shows more informative data, more variability, less collinearity among variables, more degrees of freedom and greater efficiency. Time series studies usually have multicollinearity issues, obtaining biased estimations and results. Third, panel data are better able to study the dynamics of adjustment. Time series and cross-section analysis cannot identify adjusting dynamics over time. On the other hand, panel data are better able to identify and measure effects that are not simply detectable with a cross section alone or a single time series

Panel data regression model

Regression model that combines a temporal dimension with another cross, the regression is as follows:

$$Y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it}$$

Where Y_{it} is called dependent variable, X_{it} are called independent or explanatory variables, α_i is called intercept or individual effect, β coefficient, ϵ_{it} is errors, as noted above, and $i\ and\ t$ are the indices of individual and time.

Fixed effects

It uses fixed-effects (FE) whenever there is interest in analyzing the impact of variables that vary over time (see Hsiao (2003)).

FE explores the relationship between dependent and independent variables within an entity (country, person, company, bonds, and another). Each entity has its own individual characteristics that may or may not influence the predictor (explanatory) variables. When using FE, it assumes that something within the individual may impact or bias the explanatory or dependent variables, hence it needs to control for this. This is the rationale behind the assumption of the correlation between entity's error term and explanatory variables. Fixed effects remove the effect of those time-invariant characteristics, and thereby it can assess the net effect of the explanatory variables on the dependent variable.

The regression model is presented considering fixed effects, showing the various components of the error

$$Y_{ijt} = \alpha + \beta X_{ijt} + u_{ijt}$$

$$Y_{ijt} = \alpha + \beta X_{ijt} + \underbrace{A_i + A_j + \epsilon_{ijt}}_{u_{ijt}}$$

Where the errors term u_{ijt} is the sum of the terms A_i, A_j and ϵ_{ijt}. The term A_i and A_j correspond to *fixed effects* by i and j entities (country, corporate, bonds, or another), respectively.

Using the methodology of fixed effect can be overcome typical problems of using panel data; the idea of serial correlation of errors, endogeneity and omitted variables by constants in the error.

4 Data

This section describes the data and variables used in this study. The dataset was obtained from Bloomberg Professional. It contains investment-grade and speculative-grade corporate bond placed in international markets by developed and emerging market borrowers. The period under study is from January 2004 to June 2009. The dataset consists of month-end data, and considers all fixed-rate bonds that are denominated in U.S dollars and available to Bloomberg in June 2009, with exception of bonds issued by corporate located in the U.S and England. That mainly to exclude the economies in which the financial instability incubated, and thereby the study reduces potential endogeneity problems on corporate bond spread.

It is important to highlight that international debt denominated in US dollars have become a significant financing source for firm (see Allen, Qian, Carletti and Valenzuela, 2012). On the other hand, Gozzi et al. (2010) show that 35% of the capital raised through debt issues was higher in international markets over the period 1991 - 2005.

The sample included 677 corporate bonds from 241 firms from 35 different countries[1], and the distribution of issuers by sector is: industrial (52%), bank (21%), financial (8%), telephone (8%), utility (6.7%), transportation (2.3%), and gas (2%). Furthermore, the data are restricted to bonds issued by firms with a Standard & Poor's credit rating between AAA and B-. Additionally, to reduce potential coding error, it is cleaned the data with the same method used by Valenzuela (2013).

The sample contains 21.359 bond-month observations, of which 16.528 correspond to investment-grade bonds and 4.831 correspond to speculative-grade bonds. Moreover, the variables considered are firm-specific variables, bond characteristics, and corporate bonds option-adjusted spread (OAS). The latter corresponds to the dependent variable in the model, and it is observed at the monthly frequency. However, some firm-specific variables correspond to balance sheet information, and are only available quarterly. This introduces correlations in regression residual. Hence, the study just considers quarterly data, and by clustering regression residuals at the bond level, too. Thereby, the final sample contains 7.302 bonds-quarter observations, of which 5.641 pertain to investment-grade bonds and 1.661 to speculative-grade bonds.

The empirical study is focused on corporate bonds option-adjusted spread, dependent variable of the model as noted above. Model spreads explained by the independent variables, and these are bond maturity, equity volatility, leverage, total assets (in log), short-term debt to total debt ratio (rollover risk), cash holdings ratio. The first four variables based on the Merton (1974) model,

[1] The countries included in the final simple are Argentina, Australia, Austria, Belgium, Brazil, British Virgin, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Liberia, Malaysia, Marshall Island, Mexico, Neth. Antilles, Netherlands, New Zealand, Norway, Panama, Peru, Philippines, Puerto Rico, Singapore, South Korea, Spain, Sweden, Switzerland, Thailand, and United Arab Emirates.

and these latter two are the relevant variables on the model, because throughout of the study is tested the impact of the cash holdings and rollover risk over corporate bonds OAS.

Additionally, the study consider firm's credit rating from Standard & Poor's but two different ways: as another independent variable, or as fixed effect (dummy variable). The main reason for this is that the variable might be over fitting the model. Therefore, the study shows different results analyzing both cases. Below is each variable that noted above and the main descriptive statistic.

4.1 Corporate bond spreads

The dependent variable is the corporate bond option-adjusted spread (OAS) from Bloomberg Professional, and its unit of measurement is basis points. The mean spread is 282 basis points, and the median is 189 basis points. Spreads are higher for speculative-grade bonds (534 basis points average), and for investment-grade bonds is 207 basis points average, hence spread is higher for lower credit rating. If it is observed bank and financial sectors, these account 230 basis points average (these sectors account 29% of the sample) and industrial sector contains 283 basis points average (this account 52% of the sample). Another sectors account 19% of the sample and their spread is 259 basis points average.

OAS represents the spread over an issuer's spot rate curve (i.e, the theoretical yield on a zero-coupon U.S treasury security). On other hand, it accounts the impact that an option has on the valuation and pricing of a corporate bond. A higher corporate bond spreads means that the cost of the financing for a firm is higher.

The use of the OAS in this study is important[2], because in general the corporate bonds contain embedded options, in this sample 57% of the bonds contain call or put features. This method allows comparing bonds with different cash flow characteristics on a more equitable basis.

4.2 Firm-level variables

The firm-level variables of the empirical study are: Equity volatility, this is the standard deviation of the day-to-day logarithmic price changes. A previous day's 180-day price volatility equals the annualized standard deviation of the relative price change of the most recent trading day's closing price, expressed in a percentage.

Then, study includes the logarithm of total assets to control for all influences that the firm's size may exert on debt spreads. The mean total assets is 10.38 million of US$ (in logarithm), and the median is 10 million of US$ (in logarithm). Besides, another variable is leverage ratio; this is

[2] Other studies using option-adjusted spreads (OAS) are, for instance, Cavallo and Valenzuela (2010), and Pedrosa and Roll (1998).

estimated as total debt divided by total assets. The mean leverage ratio is 0.33, and the median is 0.30. Total debt to total assets is higher for speculative-grade bonds (the average value is 0.36), and for investment-grade bonds is 0.32 average. Therefore, leverage ratio is higher for lower credit rating. Whether observed by sectors, bank has a ratio 0.41, and financial sector is 0.36. Both sectors have a leverage ratio average 0.39 (remember that these sectors account 29% of the sample), which is above average. If it is analyzed industrial sector, this has a total debt to total assets ratio average 0.28 (this account 52% of the sample), below average.

Continuing with the firm's credit rating, this is considered from Standard & Poor's agency, who express the views of the agency on the ability and willingness of an issuer, whether a company, state or local government to comply in a timely manner its financial obligations. Rating also refers to the credit quality of an individual debt issue, such as a corporate bond, and the relative likelihood that such issuance may default on payment.

Each agency applies its own methodology for measuring creditworthiness and uses a specific rating scale to publish their ratings opinions. In This case, Standard & Poor's, Rating is expressed as letter grades in that range, for example, the 'AAA' to 'D' to communicate the agency's opinion on the relative level of credit risk. Nevertheless, as noted above, the data are restricted to bonds issued by firms with credit rating between AAA and B-. Appendix B shows the numerical assignment of ratings, this method has already addressed in other studies involving ratings (see Valenzuela (2013)).

Observed the sample, 86 firms contain low credit rating (rating from BB+ to B-), and 181 firms have high credit rating (rating from BBB- to AAA). On the other hand, 168 corporate bonds have low credit rating, from a total 677 bond in the sample. It is noteworthy that 26 firms change their credit rating during the study period[3].

The short-term debt to total debt -Rollover risk- is constructed using accounting data from Bloomberg and is calculated as the ratio of short-term debt over total debt. This data set is in balanced sheet information, and it is only available quarterly (in the regression each observation of a liquidity ratio is used in four different months; 3, 6, 9, and 12 month).

Cash holdings ratio corresponds to liquidity ratio, which is constructed with liquid financial assets divided by total debt. The mean cash holdings ratio is 0.18, and the median is 0.08. The speculative-grade bonds (low credit rating bonds) have 0.27 in average, and investment-grade bonds have cash holdings ratio average 0.17. This means, the sample with low credit rating presents higher cash holdings ratio than the sample with high credit rating.

[3] 23 firms change their credit rating during the study period; 18 firms pertain to industrial sector, 3 to utility sector, 2 bank sector, 1 financial sector, 1 transportation, and 1 gas sector.

4.3 Bond-level variable

The explanatory variable related to bond characteristics is bond maturity. Its unit of measurement is years, and the mean years to maturity are 6.08 years. Whether the sample is fitted to maturity intervals from 0 to 3 years, 3 to 7 years, and 7 to 15 years; OAS variable take value 389.28 basis points, 276.85 and 249.33 basis points, respectively as seen on Figure 4 (i.e. at higher maturity intervals, lower is corporate bonds spreads). However, if observed each maturity intervals over time, these have similar behavior about corporate bond OAS as seen on Figure 5.

Finally, the descriptive statistics, and description of variables are shown on Appendix C and D, respectively.

5 Methodology

This section explains the methodology used in order to study the impact of rollover risk and cash holdings on corporate bond spreads. To construct the dataset, it reviews external databases; in this case Bloomberg Professional is used in order to establish a consolidated *panel data*. Mainly because the study uses a *linear regression model* through panel data. As noted above, Panel data has several advantages when analyzing a heterogeneous dataset, and also to reduce potential endogeneity problems. For these potential problems *fixed effects* are used by bond and by country-time. Thereby the study controls for all invariant corporate bond characteristics and invariant country-time characteristics.

To estimate regression coefficients is used *least squares method*, explained in the theoretical framework section. This method is the most widely used in the literature (i.e. see Acharya, Davydenko and Strebulaev (2012), and Valenzuela (2013)).

Below is the empirical models used in this study, in order to understand how they work, what are important variables considered in the study, what is the scope of the study, and on what methods are the results estimated.

Empirical model

This section describes a regression model of corporate bond spreads with its main explanatory variables. The main goal is to show the impact of rollover risk and cash holdings on corporate bond spread. Overall, the empirical model is as follows:

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + \beta_7 (CH_{fct}\, x\, RR_{fct}) + A_b + A_{ct} + \varepsilon_{bfct}\,, \quad (1)$$

where

OAS_{bfct} is option-adjusted spreads of bond b of firm f of country c in month t.

Mat_{bfct} is bond maturity of bond b of firm f of country c in month t.

Vol_{fct} is equity volatility of firm f of country c in month t.

Lev_{fct} is leverage ratio of firm f of country c in month t.

TA_{fct} is total assets of firm f of country c in month t.

CH_{fct} is cash holdings ratio of firm f of country c in month t.

RR_{fct} is rollover risk ratio of firm f of country c in month t.

A_b is bond fixed effect.

A_{ct} is country-time fixed effect.

Where OAS is corporate bond option-adjusted spreads the dependent variables. The Maturity variable is a bond characteristic. The Equity volatility, Leverage ratio, and Total assets are variables firm characteristics. The Cash holdings and Rollover risk are the relevant variables of the model, where the first is a measure of liquidity of the company, and the second is a measure of debt of the firm, both are obtained of balance sheet information of the enterprise. The last variable considered on the model is the interaction between Cash holdings x Rollover risk, which analyzes the magnitude of the impact of refinancing risk on spread through changes in the liquidity of the firm, Cash holdings.

The relevant variables of the model are Cash holdings, Rollover risk, and their Interaction. These are defined below:

Cash holdings: is constructed with liquid financial assets divided by total debt.

$$CH = \frac{liquid\ financial\ assets}{Total\ debt} \tag{2}$$

Rollover risk: is constructed as the ratio of short-term debt divided by total debt.

$$RR = \frac{Short - term\ debt}{Total\ debt} \tag{3}$$

Interaction Cash holdings *x* Rollover risk:

$$CH\ x\ RR = \frac{liquid\ financial\ assets}{Total\ debt}\ x\ \frac{Short - term\ debt}{Total\ debt} \tag{4}$$

On the other hand, fixed effects are considered. These correspond to dummy variables, and these capture the fixed effects by bond and country-time. As noted above (section theoretical framework), this method helps to capture the effects invariant. Fixed effects by bonds helps to reduce selection bias, and by country-time helps to control all macroeconomics invariant characteristics. Therefore, fixed effects applying to the model allows capturing the real effect of each explanatory variable on corporate bond spreads.

To estimate the unknown parameter β_k, it uses ordinary least squares method (OLS), through the minimization of error is calculated β_k (see Appendix A, ordinary least squares method (OLS)). The *standard error* of the coefficients is adjusted by applying robustness and cluster at bonds level, in each of the regressions considered. The cluster option produces robust standard error estimates for linear panel models to disturbances being heteroscedastic and autocorrelated.

The study considers 5 cases to analyze the impact of the relevant variables of the model. The main idea is compare each one case and see how the relevant variables are behaved in each case. Below are these:

1. The first regression presents 4 explanatory variables bases: Maturity of the bond, Equity Volatility, Leverage, Total assets. These variables are based on the Merton (1974) model, and this regression just allows observing the effect of these four variables on the model.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + A_b + A_{ct} + \varepsilon_{bfct}. \quad (5)$$

2. The second regression presents 5 explanatory variables; the four variables noted above more *Cash Holdings* variable, thereby this regression allows observing the effect of incorporate the Cash Holdings in the model. Below is this:

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + A_b + A_{ct} + \varepsilon_{bfct}. \quad (6)$$

3. The third regression presents 5 explanatory variables; the four variables noted in the first case more *Rollover Risk* variable. This regression is similar to point 2, but it studies the effects generated by the Rollover Risk in the model.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 RR_{fct} + A_b + A_{ct} + \varepsilon_{bfct}. \quad (7)$$

4. The fourth regression presents 6 explanatory variables; the four variables noted in regression n° (5) more cash holdings and rollover risk variables. In this case, the study aims to observe the impact controlling for both relevant variables at once.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + A_b + A_{ct} + \varepsilon_{bfct}. \quad (8)$$

5. The fifth regression presents the variables considered in before point more the *interaction* between Cash Holdings and Rollover Risk. This is baseline regression indicated at the beginning of the empirical model, i.e. regression (1).

In addition, it analyzes two other options about the model (see Appendix E). First, Whether the model has to include the *firm's credit rating* as another explanatory variable, and second if the model has to include the credit rating as a fixed effects. It is analyzed these options because the credit rating is a variable that it is built with many information of the firm. It is likely that this information is not being considered in principal model variables. Two important points, the firm's credit rating could capture the company invariant characteristics, or it could be over fitting the model. Therefore, it is key to analyze the model's results, and to study what is the effect to control by credit rating as explanatory variable or as fixed effects.

In brief, it replicates all regressions models noted above, i.e. (1), (5), (6), (7) and (8), including credit rating as an independent variable (i.e. regressions (9), (10), (11), (12), (13) raised in Appendix E), and then the first five cases are replicated adding the credit rating as fixed effects (i.e. regressions (14), (15), (16), (17), (18) raised in Appendix E).

6 Results

In this section is shown the results of regression models raised above. The coefficient estimates of the regressions are reported in the Tables section. At the end of each table is seen number of observations, the indicator of goodness of fit and if regressions include fixed effects per bond and/or country-time and/or credit rating.

Table 1 presents the results of the regressions (1), (5), (6), (7) and (8). These have 7.302 observations for the whole period of study. These are presented without fixed effects. As expected, the four variables considered by Merton (1974) model are significant for the model. The Equity volatility and Leverage ratio have positive effect over corporate bond option-adjusted spreads (OAS), i.e. higher equity volatility higher is corporate bond OAS, and same with leverage ratio. Nevertheless, Bond maturity and Total assets have negative effect over OAS, i.e. higher total assets lower is OAS, and same with bond maturity (see Figure 4.)

As regards rollover risk, it is significant and has larger coefficient for higher OAS. However, the cash holdings and interaction variable between cash holdings and rollover risk are not significant for the model, and also model's goodness fit is low. Accordingly, the explanatory power of variables on regression model is low. This can explain because there are invariant characteristics

of bonds, firms and country-time than absorb large proportion of the explanatory power of some independent variables. Given that, it justifies the use of fixed effects on the model in table 3 onwards.

Table 2 shows the results of the replicate regressions adding credit rating as an independent variable. These regressions have 7.302 observations for the whole period of study, and these are presented without fixed effects, too. However, these include credit rating in the independent variables. Therefore, it can be seen that equity volatility and bond maturity show same behavior that Table 1. On the other hand, it is perceived the effects generated by credit rating over leverage ratio and total assets variables, both variables lost explanatory power on the corporate bond OAS (they change their significance and sign), and this happens because credit rating variable is explained by various business risk characteristics and financial risk characteristics of the firms, including liquidity, cash flow stability, profitability, leverage, and others. It is important emphasis that Standard & Poor's do not have any predetermined weights for these categories, and the significance of specific factors varies from situation to situation (see Standard & Poor's (2009)). Although, it is easy see that credit rating affects significantly to leverage ratio and total assets on this model. As regards the relevant variables, in the Table 2, it is observed the credit rating does not have problem of over fitting on those, this mainly because these do not present bigger change on coefficients and their significance.

Looking at the Table 3 presents the baseline regressions model, i.e. regressions (1), (5), (6), (7) and (8). This table includes fixed effects by bonds and country-time. Regressions have an adjusted R^2 equal to 0.785; hence the fixed effects help to explain better the model and the variables considered have explanatory power on dependent variable, corporate bond OAS. The study focuses in relevant variables' results and as the fixed effects influence on significance of these variables on the model. Columns (3) - (5) show that rollover risk ratio is statistically significant. This is positively related to corporate bond spreads and this effect is stronger when regression include interaction variable.

On the other hand, Cash holding is negatively related to corporate bond OAS. This is statistically significant when regression considers as rollover risk as cash holdings (see Column (4), Table 3) since only liquidity variable is not significant in regression, see Column (2). However, its sign is consistent with expected. Column (5) contains interaction variable, *cash holdings x rollover risk*. The results show rollover risk is conditioned to cash holdings value, i.e. rollover risk is positively related to corporate bond spreads when cash holdings is lower than 0.553 but whether cash holdings is higher than 0.553 the rollover risk is negatively related to corporate bond spreads. This last does not go in the same direction with the intuition presented in the introduction section, since higher debt imply higher bond spreads. In this case, although rollover risk rises the effect will be negative on OAS if liquidity is higher than 0.553. Hence, there is an inflection point. As noted above in data section, the mean cash holdings is 0.18, and whether it considers ± 2 standard deviation, where standard deviation is 0.26, the upper level is 0.7. Thereby, the conditional value of cash holdings over rollover risk is within of range. Nevertheless, the above should be

considered if cash holding has a normal distribution (see Figure 7). As this is not case, it is better to see the *interquartile range*, in its upper quartile and this is 0.237 (75% of sample).

It is observed Table 4; this includes credit rating as explanatory variable and fixed effects by bonds and country-time. The results are similar to table 3; rollover risk is statistically significant and is positively related on OAS. But in this case, this effect is stronger than results of table 3, with significance to 5% and 1%. Broadly, Cash holdings has same sign but loss its significance, and this is because credit rating variable is over fitting since this is considering as explanatory variable. Consequently, table 5 shows a replicate of the regressions model including credit rating as fixed effects.

Columns (2) – (5) study the relevant variables, and this case cash holdings and rollover risk are statistically significant, and both keep their sign respective. Rollover risk and Interaction variable keep on same behavior of Table 3 and 4. However, cash holdings present an effect stronger than other Tables aforementioned. This is mainly due to credit rating because this is considered as fixed effect, and this controls all firms' invariant characteristics over time.

Observed interaction variable in these results (see Column (5) Table 5.), the inflection point between cash holdings and rollover risk is 0.685. This is obtained from the regression (1) adding the credit rating as a fixed effect. Therefore partial effect is given by:

$$\frac{\partial OAS_{bfct}}{\partial RR_{fct}} = \beta_6 + \beta_7 CH_{fct}$$

The marginal effect of rollover risk ratio over corporate bond spread OAS is conditioned to cash holdings values, i.e. rollover risk impact positively to corporate bond OAS if cash holdings is lower than 0.685 and this impact negatively whether companies have liquidity higher than 0.685. This last result seems interesting to analyze because it is not consistent with the intuition, and it is not known if this sample's part is representative or if it is significant by itself in the regression.

Given these results, the regressions of table 5 are considered as the principal results (i.e. the regressions model including credit rating as fixed effect. See the regressions (14), (15), (16), (17) and (18) in Appendix E). Mainly because the relevant variables present a higher effect on corporate bond OAS than other cases, and this due to the different considerations raised. The next section presents this additional result plus other regression model but this considers just period of financial instability.

7 Additional results

In this section is presented additional results that complement the section above. In table 6 show the regressions (1), (5), (6), (7) and (8) adding the credit rating as fixed effect. Furthermore, It is considered two news regressions. These regressions allow observing the two parts of the inflection point, i.e. all data that present cash holdings ratio lower than 0.685 and all the other part. By observe this a new variable is created in the database. This is a dummy variable, $D_{cash\ holding}$, that take value 1 if cash holdings value is lower 0.685 and 0 if not (i.e. this is higher than 0.685). This is done to assess the real significance of the interaction variable (cash holdings ratio x rollover risk ratio). Done this, they are created two news interactions. The first interaction is:

$$CH_{fct}\ x\ RR_{fct}\ x\ D_{cash\ holding}$$

This new explanatory variable comprises all data that present cash holdings lower than 0,685, i.e. 5.582 observations. It represents to 76.4% of the sample, hence this new interaction contain a representative sample. On the other hand, second interaction created is:

$$CH_{fct}\ x\ RR_{fct}\ x\ (1 - D_{cash\ holding})$$

This interaction considers 273 observations, and it represents to 3.7% of the sample. Said that, the news two regressions are follows:

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + \beta_7 (CH_{fct}\ x\ RR_{fct}\ x\ D_{cash\ holding}) + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (19)$$

And another,

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + \beta_7 (CH_{fct}\ x\ RR_{fct}\ x\ (1 - D_{cash\ holding})) + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (20)$$

Given that, Table 6 presents the results of the two new regressions, also it considers the five principal regressions of the Table 5. Observed the results, Column (6) shows that rollover risk and interaction variable keep their statistic significance and sign, and cash holdings change its significance. Hence, cash holdings is statistically significant when regression model consider rollover risk and a new interaction variable (*cash holdings x rollover risk ratio x Dummy*$_{cash\ holdings}$). Whether it is sought a new inflection point to cash holdings, this is 0.675 and it represents just to 10 observations. Therefore, the coefficient estimate of this interaction is very representative of the sample, thereby it is not necessary study a new turnning point.

In brief, the column's results (6) (regression (19)) show that rollover risk is positively related with corporate bond OAS, and when it is observed cash holdings lower than 0.685 the marginal

effect of rollover risk ratio is positive over OAS, being a representative result over the sample. Thereby, the sample have a behavior expected.

On the other hand, Column (7) show the results of regression (20), this represent just 273 observations accordingly this result is not representative. Analized this sample, this contains 226 observations of Industrial sector and 41 observations of Bank and financial sector. Therefore, this sample correspond in a 83% to industrial sector.

Then, it is performed a robustness check given the sample period, i.e. January 2004 to June 2009. Mainly it is observed the subprime crisis, i.e. year 2008 and 2009 (financial instability period). Table 7 shows that the results are robust in financial instability period (For this they are considered regressions of Table 5). This sample contain 2787 observations what represent to 38% of the sample. Cash holdings, rollover risk and interaction variable keep their significance and sign, respectively. In conclusion, the results are consistent in financial instability period.

Furthermore, it is studied regression model according to sectors. It is important remember that industrial sector correspond to 52%, bank and financial sector to 29% and other sectors 19%. It is proceed to observe the industrial sector, this result is presented in Table 8. The main difference is the interaction variable (cash holdings x rollover risk) is not statistically significant on corporate bond spreads, OAS (see Column (5) in Table 8). To observe better behavior this sample, it is divided in financial stability and financial instability period, and it is analyzed the results's robustness.

Table 9 shows the coefficient estimates as financial stability (Columns (1) – (5)) as financial instability period (Columns (6) – (10)). Columns (1) – (5) show the results are not consistent with mentioned above. This is could explain with Figure 11, it shows there are fluctuations in corporate bonds spreads belonging to the industrial sector, thereby the high variance in sample (in financial stability period) leading to relevant variables without statistical significance or different sign. While in financial instability period, i.e. Columns (6) – (10), the results are consistent[4], rollover risk, cash holdings and interaction variable (cash holdings ratio x rollover risk ratio) keep their sign and rises their significance. Moreover, the inflection point of cash holdings is 0.683, which similar to got above. However, bond maturity variable shows a strange behavior, i.e. this presents positive relation with corporate bonds OAS. This behavior in subsample is explained with Figure 5.1 since in financial instability period the dependent variable (OAS) shows similar behavior by different maturity intervals, opposed to the financial stability period (see Figure 5.2).

8 Conclusions

This paper explores the impact of rollover risk and cash holdings ratio on corporate bonds option-adjusted spreads during January 2004 to June 2009. Using fixed effects by bonds, country-time

[4] This subsample contain 1325 observations, and adjusted R^2 of 0.825 average.

and credit rating; the results confirm that rollover risk and cash holdings are variables significant and that impact on corporate bonds OAS.

Part of the analysis is focused in observe if credit rating should be considered an explanatory variable or a fixed effect, or if no have to be contemplated in regression model. The first answer was the credit rating has to be considered in the model because this variable is built by business risk characteristics and financial risk characteristics, as noted above. Many of these features explain to enterprises, and given that the dependent variable is related with bonds and their issuers (corporates), it is important take into account this. Said that and other points, noted in an above section, the credit rating has to be contemplated as fixed effect, to control invariant characteristics over time of the firms, and to help to explain other factors and features are not included. Furthermore, the results show that include credit rating as a fixed effect helps to better explain the model, and collaborates with the impact of rollover risk ratio and cash holdings ratio on OAS. The goodness fit of the principal model according the results, i.e. regressions considering credit rating as fixed effect, show an explanatory power of the independent variables equal to 0.806 (Table 5), which is in upper bound of adjusted R^2.

On the other hand, the results show that rollover risk on corporate bond OAS is conditioned to cash holdings value, i.e. rollover risk ratio impact positively to corporate bond OAS if cash holdings ratio is lower than inflection point found, and otherwise this impact negatively whether firms have liquidity higher than this same point. The first part is according to common behavior of rollover risk over OAS, since higher short-term debt to total debt imply higher financing cost, hence, higher corporate bonds OAS. However the other part of inflection point, i.e. when cash holdings take a value over 0.685, said that a higher rollover risk impact negatively to dependent variable whether firms have liquidity ratio higher, which is strange behavior may be difficult to interpret because these can be specific measures of each firms. Nevertheless, this sub-sample contains just 273 observations, it represents to 3.7%, and hence it is not a representative sample. Moreover, 226 observations correspond to industrial sector and 41 observations of bank and financial sector. Therefore, this sub-sample is biased with an 83% corresponding to industrial sector. Furthermore, given the subsamples number, it is likely this is a noise of the sample or part of mistakes in database's cleaning. In brief, considered the total sample, these 273 observations are not representative and these do not impact on corporate bond OAS (see Table 6, Column (7)).

As regards financial instability period, the relevant variables impact strongly on spreads, improving their significance. Mainly because these variables are balance sheet information, and these were very affected in the sub-prime crisis.

The results are robust according to different restrictions on the regressions. Therefore, it is concluded that the rollover risk and cash holdings impact heavily on the corporate bonds OAS; rollover risk impacts positively and cash holdings ratio impact negatively on the dependent variable. Other behaviors are minimum sample cases, and might correspond to errors in sample cleaning, or lack of balancing this.

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Appendix A

Theoretical framework

Linear Regression model

Linear regression is a statistical process for estimating the relationships among variables. This is an approach for modeling the relationship between a *dependent variable* Y and one or more *independent or explanatory variables* X. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regressions. The critical assumption of the model is that the conditional mean function is linear:

$$Y = \alpha + \beta X$$

In most problems, more than one explanatory variable will be available. This leads to the following "multiple regression" mean function:

$$Y = \alpha + \beta_1 X_1 + \cdots + \beta_n X_n + \epsilon,$$

where α is called the *intercept*, the β_j are called *slopes* or *coefficients*, and ϵ is called *error or residual*.

It can pack all dependent values for all observations into a n-dimensional vector called the *dependent vector*:

$$Y = \begin{pmatrix} Y_1 \\ Y_2 \\ \cdots \\ \cdots \\ \cdots \\ Y_n \end{pmatrix}$$

The same with all independent variables into a $n\ x\ p + 1$ matrix called the *explanatory matrix*:

$$X = \begin{pmatrix} 1 & X_{11} & X_{12} & \cdots & X_{1p} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 1 & X_{n1} & X_{n2} & \cdots & X_{np} \end{pmatrix}$$

It can pack the intercepts and slopes into a $(p + 1)$-dimensional vector called the *slope vector*, denoted β :

$$\beta = \begin{pmatrix} \alpha \\ \beta_1 \\ \cdots \\ \cdots \\ \cdots \\ \beta_p \end{pmatrix}$$

Finally, it can pack all the errors terms into an n-dimensional vector called the *error vector*:

$$\epsilon = \begin{pmatrix} \epsilon_1 \\ \epsilon_2 \\ \cdots \\ \cdots \\ \cdots \\ \epsilon_n \end{pmatrix}$$

Using linear algebra notation, the model

$$Y_i = \alpha + \beta_1 X_{i,1} + \cdots + \beta_p X_{i,p} + \epsilon_i$$

Can be compactly written:

$$Y = X\beta + \epsilon ,$$

where $X\beta$ is the matrix-vector product.

In the simple linear regression model there are three parameters to be estimated: the coefficients of the linear regression α and β_j; and the variance of the normal distribution σ^2.

Calculating estimates for these parameters can be done by different methods, the most common being the *least squares method.*

Least squares method

From estimators $\hat{\alpha}$ and $\widehat{\beta_j}$, can be calculated predictions for the sample observation, given by,

$$\hat{Y}_i = \hat{\alpha} + \hat{\beta}_1 X_i \quad i = 1,2, \dots, n.$$

Or, in matrix form,

$$\hat{Y} = \hat{\alpha}\vec{1} + \hat{\beta}_1 \vec{X}$$

where $\hat{Y}_i = (\hat{y}_1, \hat{y}_2, \dots, \hat{y}_n)$. Now residual are defined as

$$\epsilon_i = y_i - \hat{Y}_i \qquad i = 1, 2, \dots, n.$$

In matrix form,

$$\vec{\epsilon} = \vec{Y} - \hat{Y}, \qquad \text{with } \vec{\epsilon} = (\epsilon_1, \dots, \epsilon_n)$$

Least squares estimators are obtained by minimizing the sum of squared residuals, that is, minimizing the following function

$$\Psi(\alpha, \beta_1) = \sum_{i=1}^{n} \epsilon_i^2 = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 = \sum_{i=1}^{n} (y_i - (\alpha + \beta_1 x_i))^2 ,$$

deriving and equal to zero and the following equations are obtained , called canonical equations,

$$\left\{\begin{array}{l} \sum_{i=1}^{n}(y_i-(\alpha+\beta_1 x_i))=\sum_{i=1}^{n}\epsilon_i=0 \\ \sum_{i=1}^{n}(y_i-(\alpha+\beta_1 x_i))x_i=\sum_{i=1}^{n}\epsilon_i x_i=0 \end{array}\right\}$$

$$\left\{\begin{array}{l} \sum_{i=1}^{n} y_i = \hat{\alpha}n+\hat{\beta}_1\sum_{i=1}^{n}x_i \\ \sum_{i=1}^{n} y_i\,x_i = \hat{\alpha}\sum_{i=1}^{n}x_i+\hat{\beta}_1\sum_{i=1}^{n}x_i{}^2 \end{array}\right\}$$

$$\left\{\begin{array}{l} \bar{y}=\hat{\alpha}+\hat{\beta}_1\bar{x} \\ \overline{xy}=\hat{\alpha}\bar{x}+\hat{\beta}_1\overline{x^2} \end{array}\right\}$$

where the Following Minimum quadratic estimators of the parameters of the regression are deduced

$$\hat{\alpha}_{mc}=\bar{y}-\hat{\beta}_{1,mc}\bar{x}$$

$$\hat{\beta}_{1,mc}=\frac{S_{XY}}{S_x^2}$$

It is important to emphasis that estimator $\hat{\beta}_1$ is slope of the regression line, is called *regression coefficient* and has a simple interpretation indicates growth (or decline) of the dependent variable Y associated with a unit increase in the independent variable X.

If this is apply to regression model of this study to estimate the unknown parameter β_k. It can be interpreted as:

$$\beta_k=\frac{\partial OAS_{bfct}}{\partial X_{bfctk}}$$

This represents the effect of the explanatory variable on the dependent variable, i.e. effects generated one more unit of X_{bfct} on the dependent variable OAS_{bfct} where, X_{bfct} represents the explanatory variables. Both variables explained in section 5.

Model's goodness fit

To evaluate the fit of the model can be used R^2 statistic or coefficient of determination expressed by

$$R^2 = \frac{SC_{Reg}}{SC_{total}}$$

$$R^2 = \frac{\sum_{i=1}^{n}(\hat{Y}_i - \bar{Y})^2}{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}$$

which measures the proportion of the total variability explained by the regression model proposed, or the proportion of the total is due to regression. It is expected that this ratio is high and close to 100% (range between $0 < R^2 < 1$) and only a small part is due to error. The interpretation of R^2 depends on the number of data:

- If the number of data is high, the coefficient is decreased.
- If the number of data is not enough, the coefficient is increased.

Advantages / Limitations of Linear Regression Model:

First, linear regression implements a statistical model that, when relationships between the independent variables and the dependent variable are almost linear, shows optimal results. On the other hand, linear regression is often inappropriately used to model non-linear relationships. Furthermore, linear regression is limited to predicting numeric output, and a lack of explanation about what has been learned can be a problem.

Cross-section data

This is a type data collected by observing many subjects (such as individuals, firms, countries, or regions) at the same point of time, or without regard to differences in time (see Greene (2002)).

Cross-section regression model

It is a linear regression model that includes only one cross dimension. Regression is as follows:

$$Y_i = \alpha + \beta X_i + \epsilon_i$$

Where Y_{it} is called dependent variable, X_{it} are called independent or explanatory variables, α and β coefficients, and ϵ_i is errors, as noted above.

Time series data

Time series data is a sequence of data points, typically consisting of successive measurements made over a time interval (see Greene (2002)).

Time series regression model

Time series processes are often described by multiple linear regression models of the form:

$$Y_t = \alpha + \beta X_t + \epsilon_t$$

Where Y_t is a dependent variable and X_t includes columns for explanatory variables (predictors). The partial regression coefficients in β represent the marginal contributions of individual predictors to the variation in Y_t when all of the other predictors are held fixed. The term ϵ_t is a catch-all for differences between predicted and observed values of Y_t.

Appendix B

Standard and Poor's credit rating

This table lists the categories of credit ratings. These are 21 categories each of these is assigned a number, 21 corresponds to AAA and go down to 1, which corresponds to SD / D.

Definition	Rating	Numerical assignment
STABLE INVESTMENT RATING		
The highest quality	AAA	21
High quality	AA+	20
	AA	19
	AA-	18
Strong ability to pay	A+	17
	A	16
	A-	15
Adequate ability to pay	BBB+	14
	BBB	13
	BBB-	12
SPECULATIVE INVESTMENT RATING		
It is still likely to pay their obligations	BB+	11
	BB	10
	BB-	9
Vulnerable to nonpayment	B+	8
	B	7
	B-	6
Currently vulnerable to nonpayment	CCC+	5
	CCC	4
	CCC-	3
Highly vulnerable to nonpayment	CC/C	2
Default	SD/D	1

Appendix C

Descriptive statistics

Variables	*Mean*	*Median*	*Moda*	*St. Dev*	*Min.*	*Max.*	*N*
Dependent variables							
OAS (basis points)	282,03	189,68	304,19	307,36	25,29	2671,42	7302
Explanatory variables							
Maturity (years)	6,08	6,06	8,88	2,65	0,09	14,97	7302
Equity Volatility (percent)	38,60	30,89	43,78	23,65	7,61	142,75	7302
Leverage (ratio)	0,33	0,30	0,65	0,17	0,00	0,93	7302
Total asset (in log, Millions of US$)	10,36	10,00	13,72	1,86	5,38	15,11	7302
Relevant variables							
Rollover risk (ratio)	0,26	0,17	0,00	0,26	0,00	1,00	7302
Cash holding (ratio)	0,18	0,08	0,00	0,26	0,00	2,26	7302
Interation Cash holding x Rollover risk (ratio)	0,03	0,01	0,00	0,06	0,00	1,05	7302

Appendix D

Description of Variables

This table describes the variables used in the empirical model, presenting the variables names, descriptions, units, and sources.

Name	Description	Unit of Measurement	Data Source
Dependent variables			
Corporate bond spread	Option-adjusted spread	Basis points	Bloomberg
Explanatory variables			
Bond Maturity	Years to maturity	Years	Bloomberg
Equity Volatility	Volatility is the standard deviation of the day-to-day logarithmic price changes. A previous day's 180-day price volatility equals the annualized standard deviation of the relative price change of the most recent trading day's closing price, expressed in a percentage for the day prior to the current.	Percent	Bloomberg
Leverage	Total debt divided by total assets	Ratio	Bloomberg
Credit Rating	Standard and Poor's firm rating, long-term debt, foreign currency	(1=D,…,21=AAA)	Standard & Poor's
Total Asset	Total assets	Millions of US$ (in log)	Bloomberg
Rollover Risk	Short-term debt divided by total debt	Ratio	Bloomberg
Ratio Cash holding	Liquid financial assets divided by total debt	Ratio	Bloomberg

Appendix E

The first five linear regressions are replicated ((1), (5), (6), (7), (8)) adding the credit rating as an independent variable. The new regressions are as follows:

1. The first regression presents 5 explanatory variables bases: *Maturity of the bond, Equity Volatility, Leverage, Total assets and Credit rating*.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 Credit\ rating_{fct} + A_b + A_{ct} + \varepsilon_{bfct} \quad (9)$$

2. The second regression presents 6 explanatory variables; the five variables noted above (regression n° 9) more Cash Holdings variable, thereby this regression allows observing the effect of incorporate the Cash Holdings in the model, including credit rating:

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 Credit\ rating_{fct} + \beta_6 CH_{fct} + A_b + A_{ct} + \varepsilon_{bfct} \quad (10)$$

3. The third regression presents 6 explanatory variables; the five variables noted in regression n° (9) more Rollover Risk variable. This regression is similar to point 2, but it studies the effect generated by the Rollover Risk in the model, including credit rating too.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 Credit\ rating_{fct} + \beta_6 RR_{fct} + A_b + A_{ct} + \varepsilon_{bfct} \quad (11)$$

4. The fourth regression presents 7 explanatory variables; the five variables noted regression n° (9) more cash holdings and rollover risk variables. In this case, the study aims to observe the impact controlling for both relevant variables at once.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 Credit\ rating_{fct} + \beta_6 CH_{fct} + \beta_7 RR_{fct} + A_b + A_{ct} + \varepsilon_{bfct} \quad (12)$$

5. The fifth regression presents the variables considered in before point more the interaction between Cash Holdings and Rollover Risk. The latter is compared with the baseline regression, regression n° (1) :

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 Credit\ rating_{fct} + \beta_6 CH_{fct} + \beta_7 RR_{fct} + \beta_8 (CH_{fct}\ x\ RR_{fct}) + A_b + A_{ct} + \varepsilon_{bfct} \quad (13)$$

Finally, the first five linear regressions are replicated again, however this time, adding the *credit rating* as *fixed effects*. Below is the model:

1. The first regression presents 4 explanatory variables bases: *Maturity of the bond, Equity Volatility, Leverage, Total assets*, and fixed effects by bond, country-time and *credit rating:*

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (14)$$

2. The second regression presents 5 explanatory variables; the four variables and the fixed effects noted above more Cash Holdings variable, thereby this regression allows observing the effect of incorporate the Cash Holdings in the model. Below is that:

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (15)$$

3. The third regression presents 5 explanatory variables; the four variables noted in regression n° 14 case more *Rollover Risk* variable. This regression is similar to point 2 (regression n° 15), but it studies the effects generated by the *Rollover Risk* in the model, included fixed effects by bond, country-time and credit rating, too.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 RR_{fct} + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (16)$$

4. The fourth regression presents 6 explanatory variables; the four variables more the fixed effects, noted in the first case (regression n° 14), more cash holdings and rollover risk variables. In this case, the study aims to observe the impact controlling for both relevant variables at once.

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (17)$$

5. The fifth regression presents the variables considered in before point more the *interaction* between Cash Holdings and Rollover Risk. The latter is compared with the baseline regression (regression n° (1)):

$$OAS_{bfct} = \alpha + \beta_1 Mat_{bfct} + \beta_2 Vol_{fct} + \beta_3 Lev_{fct} + \beta_4 TA_{fct} + \beta_5 CH_{fct} + \beta_6 RR_{fct} + \beta_7 (CH_{fct}\, x\, RR_{fct}) + A_b + A_{ct} + A_{rating} + \varepsilon_{bfct} \quad (18)$$

TABLE 1
OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) presented in methodology section. All regressions do not consider fixed effects. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Bond corporate OAS					
Explanatory variables					
Bond Maturity	-6.077***	-6.199***	-6.070***	-6.124***	-6.128***
	(2.245)	(2.246)	(2.249)	(2.250)	(2.246)
Equity Volatility	6.950***	6.956***	6.920***	6.924***	6.923***
	(0.337)	(0.339)	(0.337)	(0.339)	(0.339)
Leverage	85.864**	76.466**	83.347**	79.199**	79.000**
	(34.416)	(35.837)	(34.657)	(36.178)	(36.726)
Total Asset	-50.584***	-50.973***	-58.144***	-58.219***	-58.241***
	(3.246)	(3.290)	(4.788)	(4.802)	(4.818)
Relevant variables					
Rollover Risk ST			84.575***	83.490***	84.252***
			(28.061)	(27.943)	(29.186)
Ratio Cash holding		-16.424		-7.305	-6.401
		(18.088)		(17.922)	(23.261)
Interation Cash x Rollover ST					-6.826
					(78.965)
Bond FE	No	No	No	No	No
Country-time FE	No	No	No	No	No
Observations	7,302	7,302	7,302	7,302	7,302
Adjusted R-squared	0.385	0.385	0.388	0.388	0.388

TABLE 2

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as an independent variable in each regression (These equations are regressions (9), (10), (11), (12) and (13) presented in Appendix E). They do not consider fixed effects. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Bond corporate OAS	(1)	(2)	(3)	(4)	(5)
Explanatory variables					
Bond Maturity	-7.398***	-7.538***	-7.428***	-7.473***	-7.439***
	(1.907)	(1.911)	(1.911)	(1.917)	(1.911)
Equity Volatility	6.200***	6.207***	6.136***	6.139***	6.143***
	(0.290)	(0.292)	(0.289)	(0.290)	(0.291)
Credit Rating	-39.253***	-39.272***	-40.431***	-40.428***	-40.511***
	(3.478)	(3.481)	(3.677)	(3.677)	(3.673)
Leverage	9.530	-1.286	3.703	0.287	2.219
	(28.923)	(29.815)	(28.882)	(29.683)	(29.711)
Total Asset	6.098	5.679	-2.826	-2.892	-2.550
	(5.174)	(5.168)	(5.269)	(5.279)	(5.356)
Relevant variables					
Rollover Risk ST			118.864***	117.966***	110.041***
			(26.466)	(26.483)	(28.911)
Ratio Cash holding		-18.842		-6.027	-15.506
		(15.776)		(15.717)	(18.880)
Interation Cash x Rollover ST					71.634
					(89.024)
Bond FE	No	No	No	No	No
Country-time FE	No	No	No	No	No
Observations	7,302	7,302	7,302	7,302	7,302
Adjusted R-squared	0.442	0.442	0.447	0.447	0.447

TABLE 3

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) presented in methodology section. All regressions consider fixed effects by bonds and country-time. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Bond corporate OAS					
Explanatory variables					
Bond Maturity	14.322	12.403	15.786	13.852	20.042
	(23.155)	(22.802)	(23.298)	(22.930)	(23.402)
Equity Volatility	2.493***	2.477***	2.469***	2.452***	2.509***
	(0.679)	(0.675)	(0.672)	(0.668)	(0.670)
Leverage	238.436**	212.521**	226.700**	200.308**	173.937*
	(107.079)	(101.565)	(101.625)	(96.817)	(96.112)
Total Asset	9.599	6.160	3.394	-0.147	5.797
	(39.462)	(38.737)	(38.754)	(38.188)	(38.432)
Relevant variables					
Rollover Risk ST			89.303*	90.066*	178.998***
			(51.007)	(50.679)	(66.753)
Ratio Cash holding		-35.785		-36.305*	3.897
		(21.840)		(21.616)	(22.790)
Interation Cash x Rollover ST					-323.534***
					(108.629)
Bond FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes
Observations	7,302	7,302	7,302	7,302	7,302
Adjusted R-squared	0.785	0.785	0.785	0.786	0.786

TABLE 4

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as an independent variable in each regression (These equations are regressions (9), (10), (11), (12) and (13) presented in Appendix E). All regressions consider fixed effects by bonds and country-time. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Bond corporate OAS					
Explanatory variables					
Bond Maturity	6.461	5.159	8.052	6.730	11.654
	(20.141)	(19.863)	(20.292)	(20.006)	(20.432)
Equity Volatility	2.009***	2.000***	1.981***	1.972***	2.021***
	(0.560)	(0.557)	(0.552)	(0.550)	(0.553)
Credit Rating	-70.130***	-69.854***	-70.388***	-70.108***	-69.473***
	(11.269)	(11.348)	(11.256)	(11.333)	(11.338)
Leverage	65.395	48.071	51.777	34.013	14.814
	(104.966)	(100.130)	(100.430)	(96.303)	(95.440)
Total Asset	41.716	39.201	34.972	32.369	36.742
	(33.590)	(33.029)	(32.922)	(32.520)	(32.738)
Relevant variables					
Rollover Risk ST			98.764**	99.260**	168.999***
			(49.860)	(49.659)	(64.641)
Ratio Cash holding		-24.861		-25.394	6.070
		(19.886)		(19.688)	(19.664)
Interation Cash x Rollover ST					-254.012***
					(97.644)
Bond FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes
Observations	7,302	7,302	7,302	7,302	7,302
Adjusted R-squared	0.799	0.799	0.799	0.799	0.800

TABLE 5

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as a fixed effect in each regression (These equations are (14), (15), (16), (17) and (18) presented in Appendix E). All regressions consider fixed effects by bonds, country-time and credit rating. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Bond corporate OAS	(1)	(2)	(3)	(4)	(5)
Explanatory variables					
Bond Maturity	12.810	10.362	13.360	10.907	14.565
	(17.920)	(17.531)	(18.010)	(17.626)	(17.863)
Equity Volatility	1.899***	1.880***	1.876***	1.857***	1.896***
	(0.545)	(0.539)	(0.537)	(0.532)	(0.536)
Leverage	23.141	-6.752	10.687	-19.309	-33.919
	(109.602)	(104.945)	(104.726)	(100.754)	(99.688)
Total Asset	41.966	38.116	35.617	31.743	35.240
	(29.131)	(28.284)	(28.141)	(27.489)	(27.644)
Relevant variables					
Rollover Risk ST			83.052*	83.245*	139.331**
			(49.096)	(48.495)	(63.937)
Ratio Cash holding		-42.466**		-42.571**	-17.192
		(19.109)		(18.839)	(18.594)
Interation Cash x Rollover ST					-203.386**
					(99.001)
Bond FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes
Observations	7,302	7,302	7,302	7,302	7,302
Adjusted R-squared	0.806	0.806	0.806	0.806	0.807

TABLE 6

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as a fixed effect in each regression model (These equations are (14), (15), (16), (17) and (18) presented in Appendix E). Furthermore, the regressions (19) and (20). All regressions consider fixed effects by bonds, country-time and credit rating. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Whole sample					Sample with Cash holding ratio lower than 0.685	Sample with Cash holding ratio higher than 0.685
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Corporate bond OAS							
Explanatory variables							
Bond Maturity	12.810	10.362	13.360	10.907	14.565	-14.084	-12.566
	(17.920)	(17.531)	(18.010)	(17.626)	(17.863)	(18.948)	(35.573)
Equity Volatility	1.899***	1.880***	1.876***	1.857***	1.896***	4.033***	2.585*
	(0.545)	(0.539)	(0.537)	(0.532)	(0.536)	(0.725)	(1.501)
Leverage	23.141	-6.752	10.687	-19.309	-33.919	91.105	-231.275
	(109.602)	(104.945)	(104.726)	(100.754)	(99.688)	(106.596)	(251.263)
Total Asset	41.966	38.116	35.617	31.743	35.240	12.707	48.372
	(29.131)	(28.284)	(28.141)	(27.489)	(27.644)	(29.793)	(60.270)
Relevant variables							
Rollover Risk ST			83.052*	83.245*	139.331**	159.621**	-69.003
			(49.096)	(48.495)	(63.937)	(72.691)	(80.420)
Cash holding ratio		-42.466**		-42.571**	-17.192	-39.686**	0.402
		(19.109)		(18.839)	(18.594)	(16.192)	(22.693)
Interaction Cash x Rollover ST					-203.386**		
					(99.001)		
Interaction Cash x Rollover ST x Dummy						-236.546*	
						(120.857)	
Interaction Cash x Rollover ST x (1 - Dummy)							23.916
							(66.672)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,302	7,302	7,302	7,302	7,302	5,582	273
Adjusted R-squared	0.806	0.806	0.806	0.806	0.807	0.818	0.978

TABLE 7

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below, differentiating by financial instability period, i.e. from January 2008 to June 2009. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as a fixed effect in each regression (These equations are (14), (15), (16), (17) and (18) presented in Appendix E). All regressions consider fixed effects by bonds, country-time and credit rating. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Financial Instability				
	(1)	(2)	(3)	(4)	(5)
Bond corporate OAS					
Explanatory variables					
Bond Maturity	14.648	7.029	28.481	20.668	8.051
	(29.198)	(30.599)	(25.996)	(27.530)	(28.075)
Equity Volatility	2.085***	2.038***	1.877**	1.840**	1.918**
	(0.774)	(0.768)	(0.743)	(0.743)	(0.761)
Leverage	-110.938	-155.230	-213.112	-251.230	-254.300
	(349.484)	(336.439)	(304.508)	(298.003)	(297.646)
Total Asset	139.443	99.165	98.780	62.026	69.283
	(136.198)	(124.585)	(117.884)	(109.822)	(109.988)
Relevant variables					
Rollover Risk ST			291.009*	279.367*	359.905**
			(161.713)	(157.706)	(174.277)
Ratio Cash holding		-165.636**		-157.834**	-102.037
		(66.513)		(63.662)	(66.537)
Interation Cash x Rollover ST					-429.905*
					(241.731)
Bond FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes
Observations	2,787	2,787	2,787	2,787	2,787
Adjusted R-squared	0.792	0.793	0.794	0.795	0.795

TABLE 8

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below, differentiated by industrial sector. These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as a fixed effect in each regression (These equations are (14), (15), (16), (17) and (18) presented in Appendix E). All regressions consider fixed effects by bonds, country-time and credit rating. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Industrial sector				
	(1)	(2)	(3)	(4)	(5)
Corporate bond OAS					
Explanatory variables					
Bond Maturity	-73.562	-76.909	-84.081	-87.050	-77.131
	(66.004)	(66.045)	(65.006)	(65.142)	(66.991)
Equity Volatility	5.040***	5.015***	5.004***	4.981***	4.982***
	(1.006)	(0.997)	(0.977)	(0.970)	(0.971)
Leverage	150.727	111.330	129.705	93.408	76.707
	(142.834)	(139.298)	(136.618)	(134.468)	(133.834)
Total Asset	-3.281	-8.520	-24.357	-28.941	-25.340
	(35.203)	(34.723)	(33.756)	(33.601)	(34.282)
Relevant variables					
Rollover Risk ST			204.730***	202.022***	265.144**
			(73.270)	(72.687)	(109.064)
Ratio Cash holding		-39.167**		-36.362**	-13.317
		(18.442)		(18.137)	(21.686)
Interaction Cash x Rollover ST					-198.036
					(154.948)
Bond FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes	Yes
Observations	3,773	3,773	3,773	3,773	3,773
Adjusted R-squared	0.827	0.828	0.829	0.830	0.830

TABLE 9

OLS Regression of corporate bonds option-adjusted spreads (OAS)

This table reports estimates from a panel regression of corporate bonds option-adjusted spreads against the variables listed below, differentiated by industrial sector, and this subsample by period of stability (from January 2004 to December 2007) and financial instability (from January 2008 to June 2009). These equations are regressions (1), (5), (6), (7) and (8) more the credit rating as a fixed effect in each regression (These equations are (14), (15), (16), (17) and (18) presented in Appendix E). All regressions consider fixed effects by bonds, country-time and credit rating. The panel data consist of 667 corporate bonds, 241 firms covering the period from January 2004 to June 2009. The sample considers data quarterly. Robust standard errors are clustered at the bond level and shown in parentheses below each coefficient estimate. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Industrial sector									
	Financial stability					Financial Instability				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Corporate bond OAS										
Explanatory variables										
Bond Maturity	-14.451***	-14.459***	-14.366***	-14.377***	-16.209***	14.983	24.707	55.790**	53.956**	68.414***
	(5.041)	(5.029)	(5.052)	(5.038)	(4.895)	(14.793)	(22.205)	(24.113)	(24.135)	(25.480)
Equity Volatility	2.804**	2.820**	2.815**	2.830**	2.831**	5.686***	5.642***	5.386***	5.362***	5.208***
	(1.100)	(1.106)	(1.104)	(1.110)	(1.103)	(1.640)	(1.636)	(1.595)	(1.599)	(1.562)
Leverage	210.122***	202.734***	209.117***	201.935***	217.706***	503.093	473.502	-37.587	-41.091	-3.330
	(55.420)	(53.337)	(54.822)	(52.840)	(53.393)	(470.963)	(456.452)	(372.807)	(369.832)	(365.748)
Total Asset	-2.640	-2.656	-3.827	-3.795	-6.477	121.872	60.829	47.714	2.073	36.079
	(13.797)	(13.716)	(13.901)	(13.837)	(13.916)	(152.163)	(145.235)	(131.406)	(129.268)	(130.872)
Relevant variables										
Rollover Risk ST			11.927	11.461	-36.722			703.387***	677.439***	958.771***
			(20.527)	(20.451)	(29.398)			(217.017)	(218.473)	(249.793)
Ratio Cash holding		-6.622		-6.472	-22.619*		-156.933**		-124.369**	16.136
		(8.053)		(7.965)	(13.141)		(62.440)		(60.540)	(74.103)
Interation Cash x Rollover ST					133.522**					-1,401.949***
					(64.153)					(518.627)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,448	2,448	2,448	2,448	2,448	1,325	1,325	1,325	1,325	1,325
Adjusted R-squared	0.849	0.849	0.849	0.849	0.850	0.816	0.818	0.824	0.825	0.828

FIGURES

Figure 1: Historical evolution of corporate bonds OAS. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

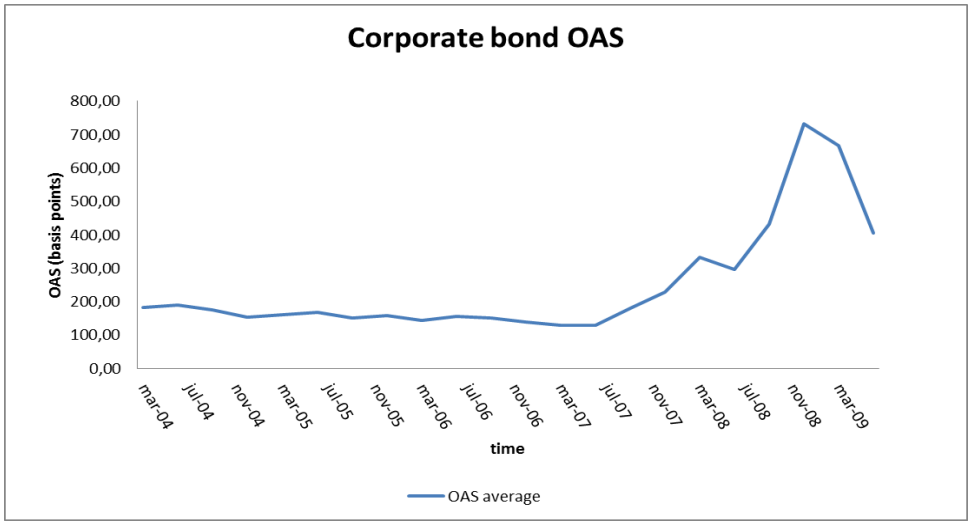

Figure 2: Historical evolution of corporate bonds OAS by different sectors. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

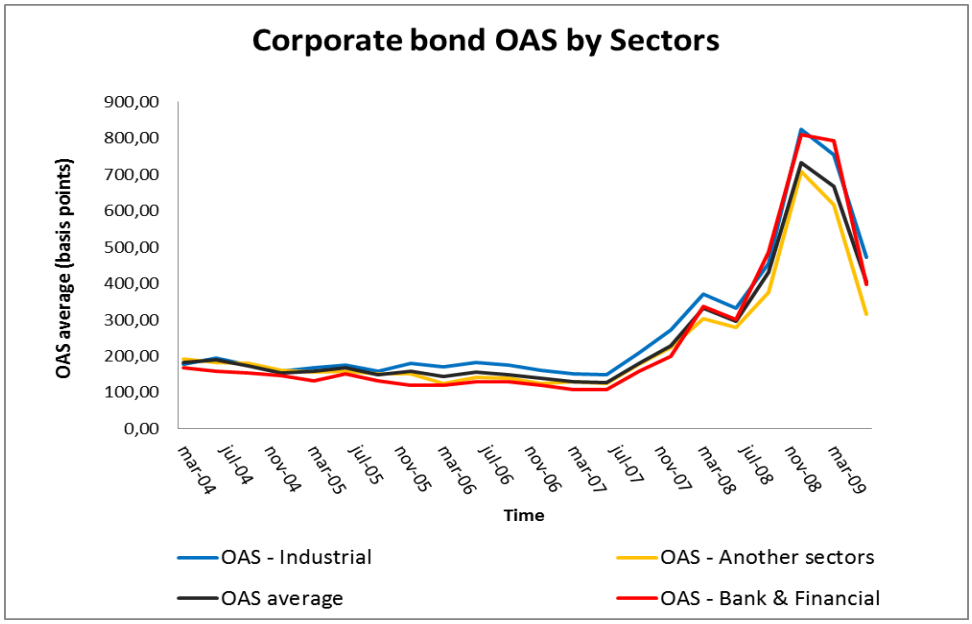

Figure 3: Historical evolution of corporate bonds OAS by types bonds. It is considered investment grade bonds (AAA – BBB credit rating) and speculative grade bonds (BB+ - B+ credit rating). Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

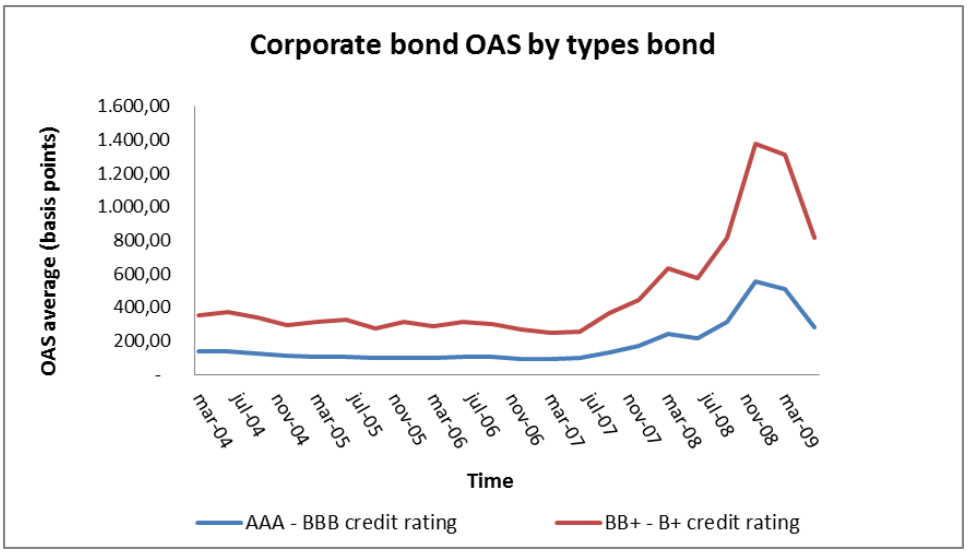

Figure 4: Corporate bonds OAS by Maturity intervals. They are considered three intervals: Maturity of 0 to 3 years, maturity 3 to 7 years, maturity 7-15 years. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

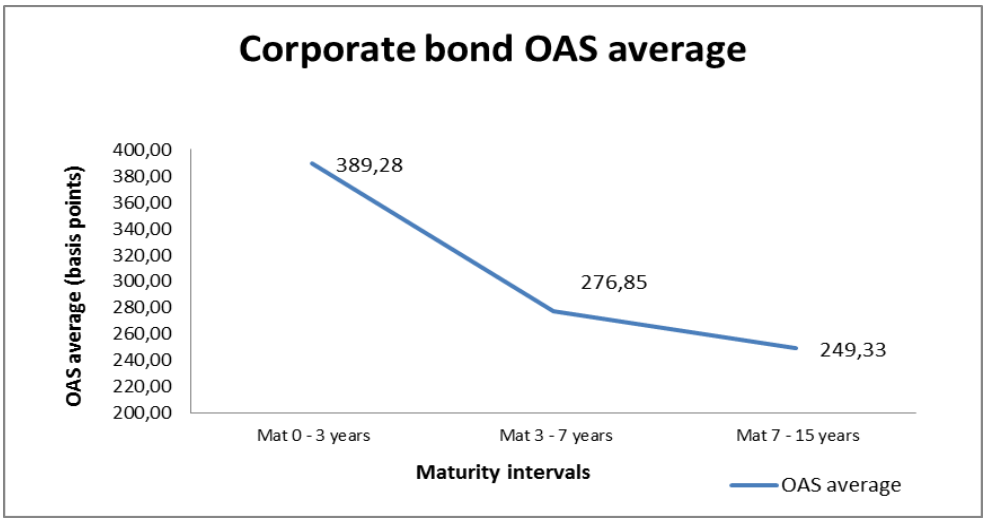

Figure 5: Historical evolution of corporate bonds OAS by Maturity intervals. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

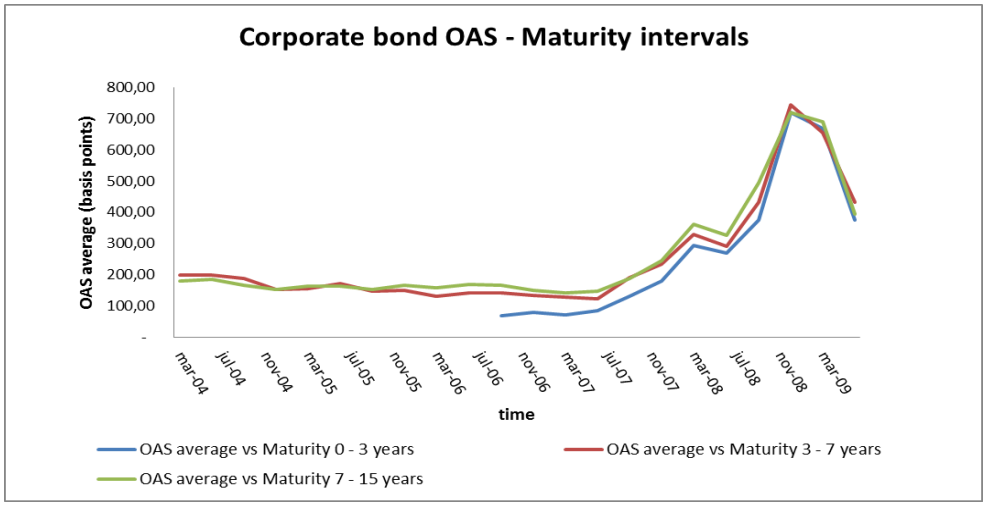

Figure 5.1: Historical evolution of corporate bonds OAS by Maturity intervals in financial instability period. Period of the sample March 2008 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

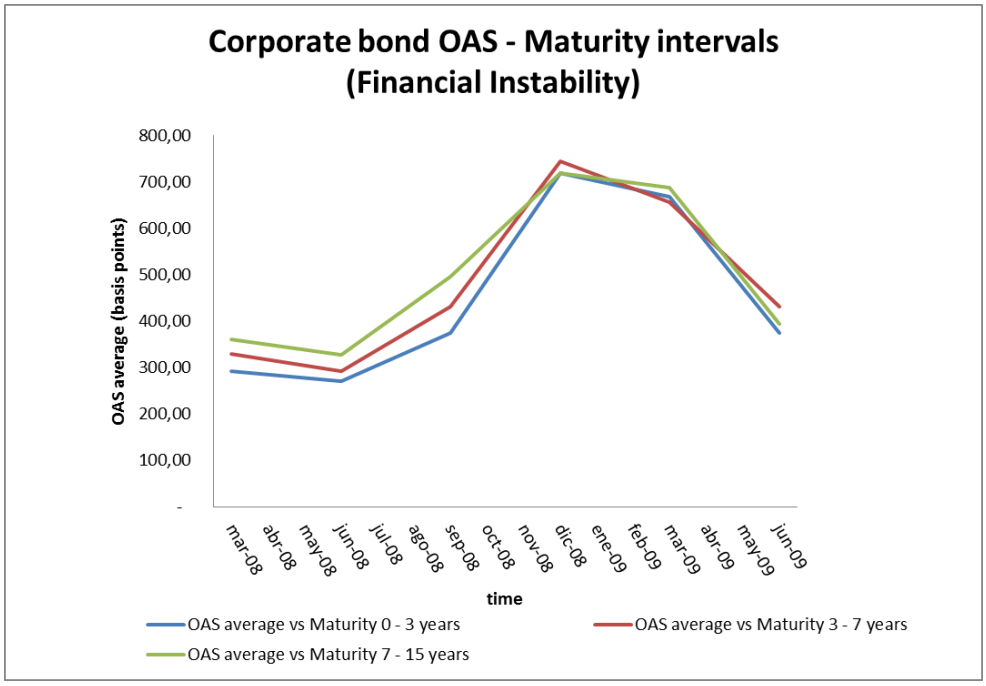

Figure 5.2: Historical evolution of corporate bonds OAS by Maturity intervals in financial stability period. Period of the sample January 2004 to December 2007, it corresponds to quarterly data. Source: Bloomberg Professional.

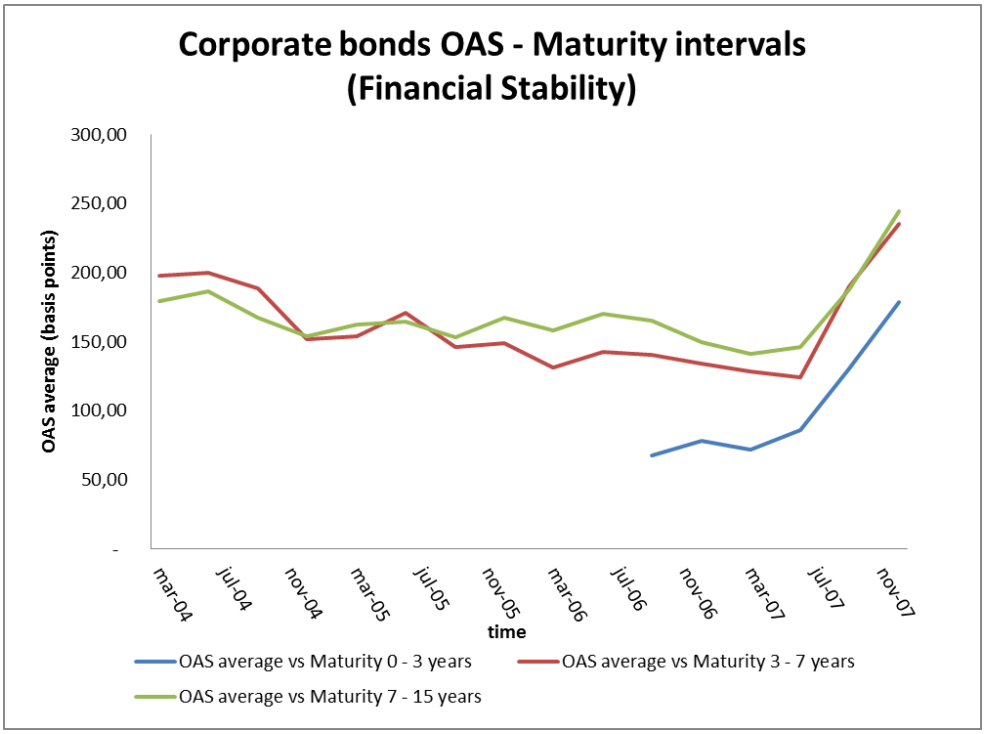

Figure 6: Maturity behavior in time by whole sample and by different sectors. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

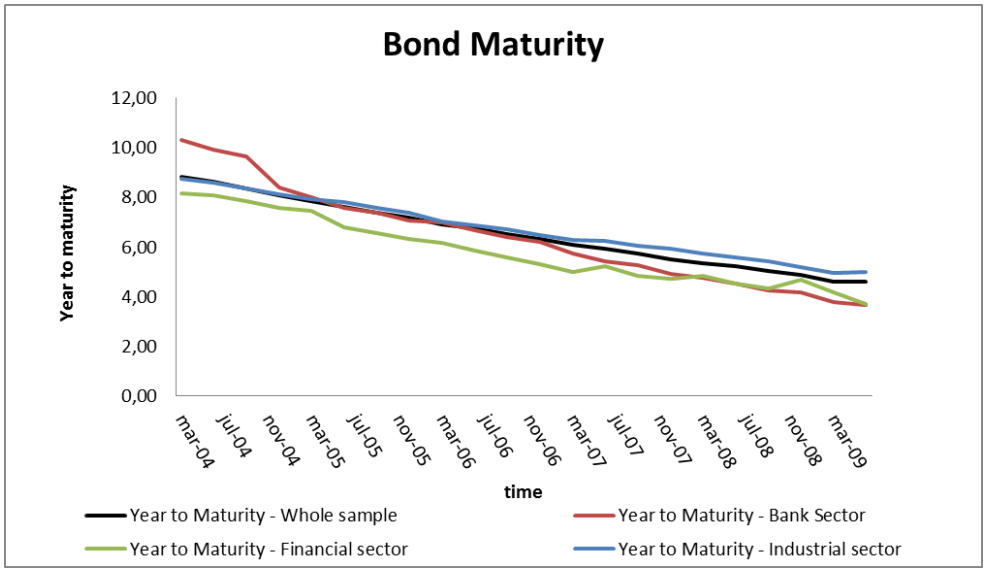

Figure 7: Historical evolution of Cash holdings ratio. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

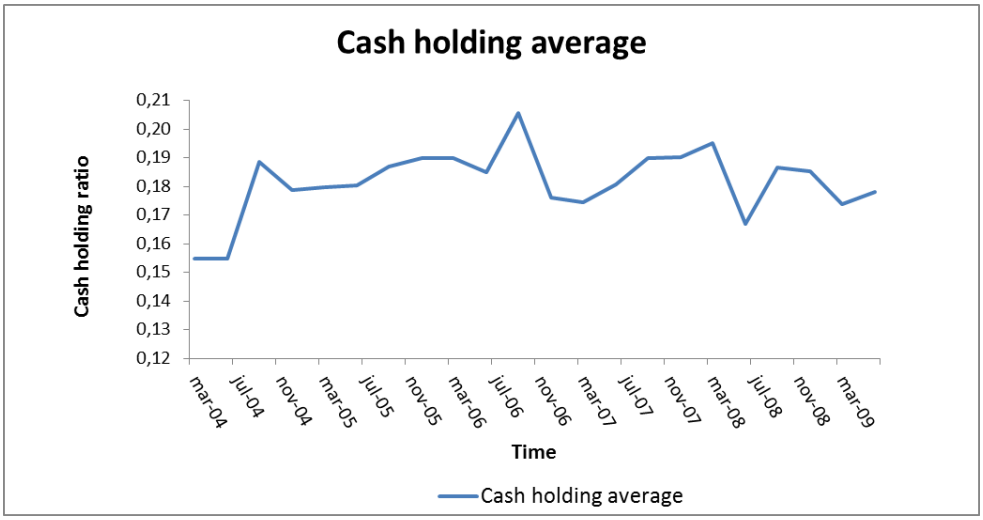

Figure 8: Historical evolution of Cash holdings ratio by different sectors. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

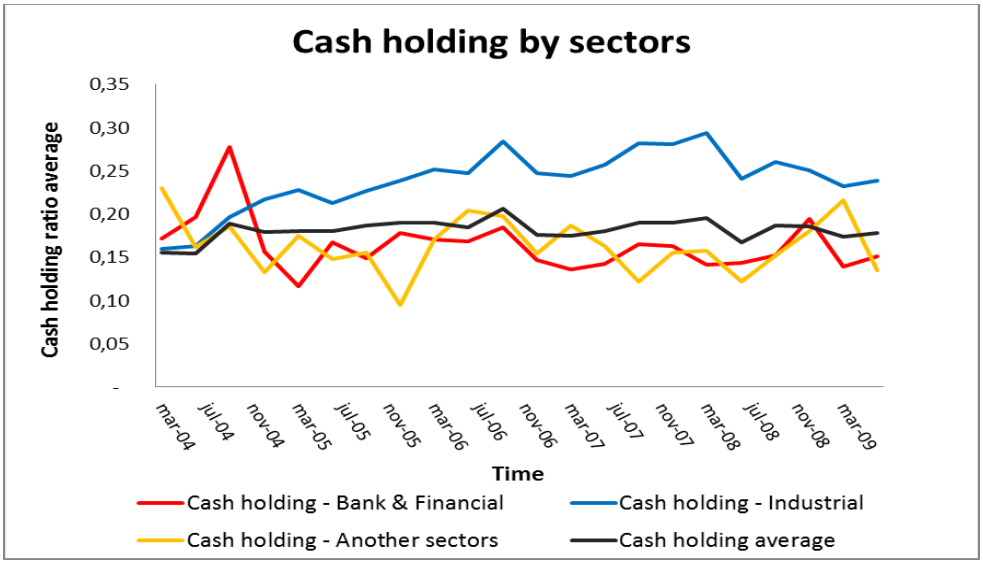

Figure 9: Cash holdings ratio by credit rating. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

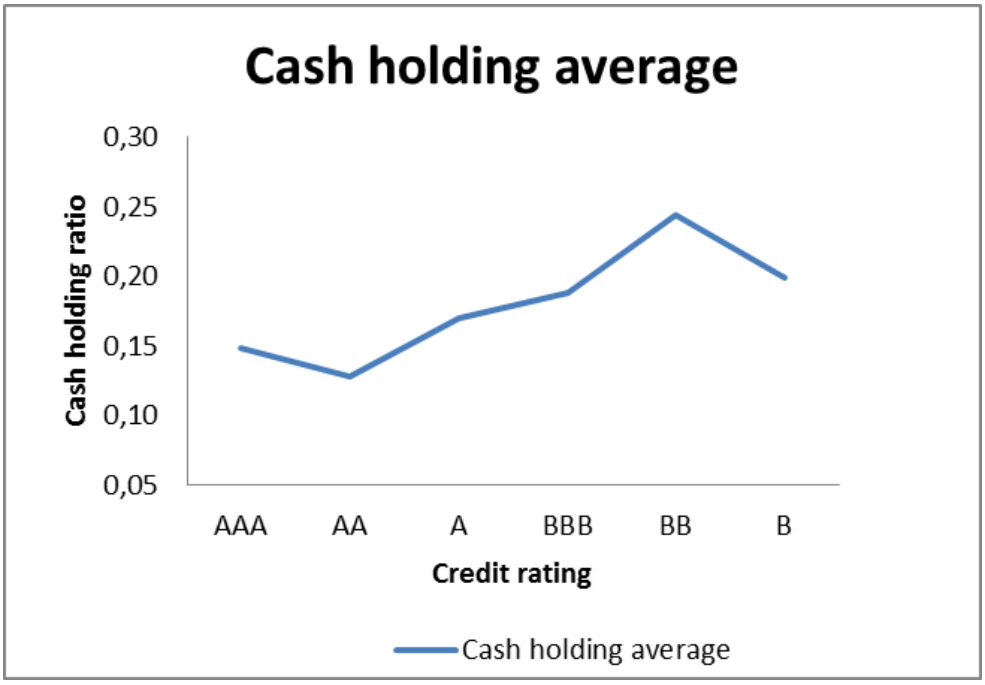

Figure 10: Historical evolution of Total assets average. Period of the sample January 2004 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.

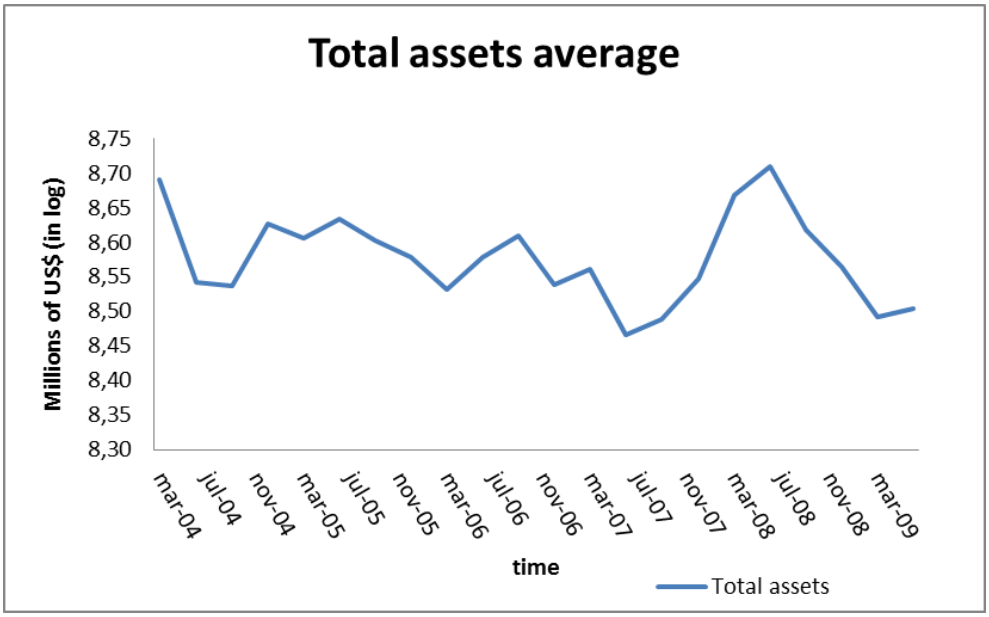

Figure 11: Historical evolution of corporate bonds OAS by industrial sector in financial stability period. Period of the sample January 2004 to December 2007, it corresponds to quarterly data. Source: Bloomberg Professional.

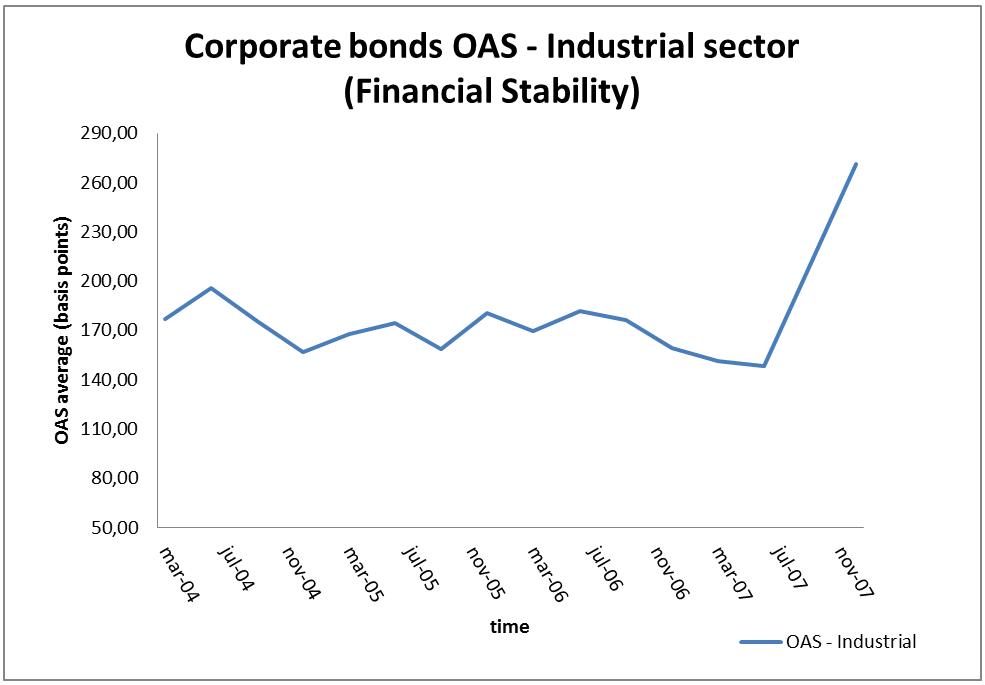

Figure 12: Historical evolution of corporate bonds OAS by industrial sector in financial instability period. Period of the sample March 2008 to June 2009, it corresponds to quarterly data. Source: Bloomberg Professional.