Rollover Risk and Corporate Bond Spreads

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ABSTRACT

This paper examines whether rollover risk is priced on corporate bond spreads. Using a novel data set and new proxies for firm-specific rollover risk and market illiquidity, the empirical analysis developed reveals that market illiquidity affects corporate bond spreads beyond a liquidity premium through a "rollover risk channel". This effect is statistically significant and financially important during episodes of market illiquidity, as in the recent U.S. subprime crisis, with speculative bonds and bonds issued by financial corporations being among the most affected. The results are significant even after controlling by a powerful set of variables and non-linear effects (e.g. flight to quality and too-big-to-fail), are robust to alternative proxies of market illiquidity, bond and time-fixed effects and potential endogeneity bias, and are unlikely to be driven by sample selection bias. This paper has important implications for the literature on the modeling of corporate bond spreads in periods of financial distress and in the current debate regarding the effects of financial crises and the regulation of financial corporations.

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KEY WORDS: CREDIT SPREADS; ROLLOVER RISK; MARKET LIQUIDITY; DEFAULT RISK; FINANCIAL CRISES

The U.S. subprime crisis hit international corporate bond markets hard, producing a significant widening of investment grade and speculative grade corporate bond spreads. The main potential factors that may have affected corporate bond spreads during the U.S. subprime crisis are default risk, liquidity premium, and rollover risk. Although there is a rich literature studying the influence of default risk and liquidity premium on corporate bond spreads (e.g., Merton (1974), Collin-Dufresne et al. (2001), Campbell and Taksler (2003), Chen, Lesmond and Wei (2007), Covitz and Downing (2007)), the literature studying the role of rollover risk on corporate debt markets is flourishing (e.g., Acharya, Gale and Yorulmzer (2009), Morris and Shin (2009), He and Xiong (2009, 2010)) and, in particular, the impact of rollover risk on corporate bond spreads still remains an empirical question. This paper comprehensively explores the impact of firm-specific rollover risk on spreads of corporate bonds placed on international markets by developed and emerging market borrowers during the last half decade.

Throughout the paper, I define rollover risk as the possibility that a firm will default due to high rollover losses originated by episodes of market illiquidity. During an episode of market illiquidity, as in the recent U.S. subprime crisis, rollover risk becomes

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particularly relevant: Firms with high short-term debt to total debt ratios and without access to new capital at reasonable cost may incur in substantial rollover losses that increase their default probabilities. Therefore, rollover risk may provide an additional explanation of why firms may default and a potential determinant of corporate bond spreads.

The U.S. subprime crisis, as shown in Figure 1, had a higher impact on corporate bonds with lower credit rating quality, and this impact was heterogeneous across sectors with banks and financial corporations being among the most affected. [1] A potential reason for the divergence on corporate bond spreads across sectors is the mentioned rollover risk, as banks and financial corporations are more prone to rollover losses given their high levels of short-term debt relative to total debt: In the final sample used in this paper, the ratio of short-term debt to total debt is 63% in the banking sector, 22% in the financial sector, and 14% in the industrial sector. Moreover, during episodes of market illiquidity the impact of rollover losses on corporate bond spreads seems to be particularly important in financial corporations that do not have, in principle, the support of a lender of last resort, as they are not depositary/regulated institutions.

This paper shows that rollover risk is indeed priced on corporate bond spreads. Using a new data set for the academic literature, spanning the period from December 2004 to June 2009, and using new proxies for firm-specific rollover risk and market illiquidity, the main results in this paper suggest that rollover risk is priced in both investment grade and speculative grade bonds and that its impact on corporate bond spreads is higher in speculative bonds and in bonds issued by financial corporations. The results are significant even after controlling by a powerful set of controls and non-linear effects, and are robust to alternative proxies of market illiquidity, bond and time-fixed effects and potential endogeneity bias. In addition, the main results are consistent with first passage structural credit risk models, such as the one introduced by He and Xiong (2010) on the relationship between rollover losses, credit risk, and corporate bond spreads: The authors show theoretically that market illiquidity increases corporate bond spreads beyond a liquidity premium through a "rollover risk channel", where the influence of market illiquidity on rollover losses and thus on corporate bond spreads is exacerbated in firms with higher short-term debt to total debt ratios.

The magnitude of corporate bond spreads explained by rollover risk is financially important. For instance, during the episode of high market illiquidity at the end of 2008, rollover risk predicts a difference of around 300 basis points between the spread of speculative bonds issued by firms with short-term debt to total debt ratios at the 90^{th} and 10^{th} percentile. For investment grade bonds, this magnitude is around 120 basis points. For the same episode of market illiquidity, the average spreads of speculative grade and investment grade corporate bonds were around 1,290 basis points and 475 basis points respectively. So the magnitudes associated with rollover risk are high numbers.

This paper contributes to the finance literature in four ways: First, it contributes to the literature on the determinants of corporate bond spreads by exploring one of their important components i.e. the rollover risk. As the results show, ignoring the influence of market illiquidity on corporate bond spreads through a "rollover risk channel" and adhering to standard models on the pricing of corporate debt may be undesirable in times

[1] For simplicity, throughout this paper the term "financial corporations" will be used to refer to "non-bank financial corporations".

of market illiquidity. Second, this paper presents new insights concerning firms' specific vulnerabilities in episodes of financial distress. As observed in the recent U.S. subprime crisis, firms that rely heavily on short-term debt can be strongly affected by negative liquidity shocks. Third, given that a higher cost of capital decreases investment and reduces output, this paper present a channel through which financial crises propagate to the real sector, i.e. the cost of the capital for the private sector. Finally, in showing that financial corporations are more sensitive than banks to negative liquidity shocks, as they do not have the support of a lender of last resort, this paper contributes to the current debate regarding the regulation of financial corporations.

The remainder of the paper is organized as follows. Section I presents the theoretical framework that supports the empirical tests explored in this paper. Section II describes the data and the construction of new measures of firm-specific rollover risk and market illiquidity. Section III presents the main empirical results and Section IV reports the robustness checks. Finally, Section V concludes.

I. The Theoretical Framework

To motivate the empirical tests explored in Section III, this section presents a theoretical discussion of the "rollover risk channel" through which market illiquidity influences corporate bond spreads, i.e. specifically the relationship that I explore empirically in this paper. First-passage structural credit risk models, like the model introduced by He and Xion (2010), frame the most important issues.

Extending the Leland and Toft's structural credit risk model (1996), which considers illiquid bond markets and firms that finance their capital with equity, short-term and long-term debt, He and Xiong (2010) show that market illiquidity increases corporate bond spreads, this effect being exacerbated in firms with higher short-term debt to total debt ratios. Under the assumption that firms commit to a stationary debt structure, implying that when a bond matures firms replace it by issuing a new identical bond, the impact of rollover risk on corporate bond spreads is given by the following mechanism: A negative shock in market liquidity drives the prices of the firm's newly issued bonds down. If the value of the new issued debt goes below their principal values, firms incur rollover losses which are higher in firms with higher short-term debt to total debt ratios as short-term debt is rolled over at a higher frequency. Rollover losses reduce the equity value of the firm at a higher endogenous default boundary, increasing the probabilities of default, and thus the corporate bond spreads. In standard first-passage structural credit risk models, default occurs the first time that assets fall to a sufficiently low boundary, which may not be the face value of the debt as in classical credit risk model introduce by Merton (1974). Specifically, in the model presented by He and Xiong (2010) default occurs endogenously when assets fall to a low boundary at which equity value becomes zero.

Therefore credit risk models posit a theoretical channel of how rollover losses, and consequently corporate bond spreads, are influenced by market illiquidity and the firm's fraction of short-term debt over total debt. In short, credit risk models are able to generate predictions of the impact of market illiquidity on corporate bond spreads through a "rollover risk channel".

II. Sample Characteristics and Data Description

For the purposes of this paper and using Bloomberg Professional, I constructed a new data set on investment grade and speculative grade corporate bonds placed on international markets by developed and emerging market borrowers for the period running from December 2004 to June 2009. The data set consists of month-end data and considers all fixed-rate bonds denominated in U.S. dollars available in Bloomberg by June 2009, with the exception of bonds issued by firms located in the U.S. or Great Britain.[2] The objective of excluding the economies where the crisis was incubated is to reduce potential endogeneity problems in the causal impact of market liquidity on corporate bond spreads. Despite these exclusions, as I show below, the behavior of my data mimics the behavior of the total debt issued by corporations in U.S. dollars quite well. The data set contains bonds issued by publicly traded firms in the financial and non-financial sectors. Based in the Bloomberg issuer classification, the distribution of issuers by sector in the final sample is the following: Industrial (53.9%), Banking (17.1%), Financial (9.0%), Utility (8.6%), Telephone (7.8%), and Oil and gas (2.4%), and Transportation (1.2%).

According to the Bank of International Settlement (BIS), by June 2009 the outstanding debt by fixed-rate and U.S. denominated bonds represented about 65% and 36% of the total outstanding debt respectively. Therefore, my database should be adequately representative of international corporate debt markets. I use only bonds denominated in U.S. dollars to ensure that the spreads in my sample exclude currency risk. Moreover, most corporations in emerging markets issue international bonds in U.S. dollars due to the so-called original sin (Eichengreen and Hausmann (1999)). In fact, according to the BIS, about two-thirds of the outstanding international debt by emerging market borrowers is denominated in U.S. dollars.

To reduce potential error in the coding of the data, I eliminate the top and bottom 0.5% of the spreads from my analysis, I dropped the observations where any of the accounting variables exceeded the sample mean by more than five standard deviations, and I did not consider the bonds issued in countries where the total number of observations was smaller than 30.[3] In addition, I considered bonds issued by firms with S&P credit rating between AAA and B-. Thus, the final sample including all my control variables consists of 19,558 bond-month observations, 15,239 of which correspond to investment grade bonds and 4,319 to speculative grade bonds.

A. Option-Adjusted Spreads

The main dependent variable is the corporate *option-adjusted spread* (OAS) from Bloomberg. Basically, it is the spread over an issuer's spot rate curve (i.e. the theoretical yield on a zero-coupon Treasury security). It is derived by positing a distribution of

[2] The countries included in the final sample are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Peru, Philippines, Singapore, South Korea, Spain, Sweden, Switzerland, and Thailand.

[3] The bonds eliminated in this last cleaning of the data correspond to bonds issued in Bahamas, China, and Hong Kong.

millions of interest rate paths (using a one factor-arbitrage free binomial tree of normally distributed short rates) consistent with the current "riskless" Treasury term structure. Then, the bond's call schedule is examined and the interest rate paths are used to discount the cash flows from the corporate bonds to arrive at present values, with cash flows depending in the level of interest rates.[4] The present values are averaged to get an expected value, which can be viewed as the theoretical price of the bond. The OAS is the constant spread over the underlying Treasury term structure across each path that make the theoretical value of the bond equal to the market price of the bond. Mathematically, OAS is the spread that will satisfy the following condition:

$$Market\ \Pr ice = \frac{1}{S}\sum_{s=1}^{S}\sum_{t=1}^{T}\frac{c_t^s}{\prod_{i=1}^{t}(1+z_t^s+OAS)}$$

Where c_t^s is the cash flow for period t on path s, z_t^s is the simulated Treasury short-term rate for period t on path n, and OAS is the option-adjusted spread.

As emphasized by Fabozzi (2006), in this case, the OAS captures the credit spread, a liquidity premium, and any richness or cheapness of the bond after adjusting for the effects of any embedded options. In this study, the use of OAS is important given that corporate bonds in general contain embedded options. In fact, in my final sample, the 57% of the bonds contain contingent cash flows due to call, put, or sink features. [5]

In order to explore the extent to which my OAS data is representative of the whole market of bonds denominated in U.S. dollars, it is interesting to compare it with OAS indices widely used by investors. In Figure 2, I plot the average OAS from my data along with the OAS indices reported by Bank of America (BofA) Merrill Lynch for the period that goes from December 2004 to June 2009. I plot both series for each credit rating category and I reported their correlation. It is noteworthy that although there are small discrepancies between the two series, the indices constructed from my data set mimics quite well the behavior of the BofA Merrill Lynch OAS indices, which represent the universe of bonds given a set of characteristics such as credit rating, currency, amount issued, and time to maturity.[6] For all the credit rating categories reported, the correlation between both series are very close to one suggesting that the results presented below are unlikely to be driven by sample selection bias.

Table I summarizes the mean spread before and after the Lehman Brothers bankruptcy by S&P credit rating and years to maturity. For the two period samples and for the different years to maturity categories, the table shows that OASs increase as the

[4] For instance, the probability of occurrence of a cash flow prior to the call period is one hundred percent but the probability of occurrence of a cash flow occurring after the call period begins depends in the possible paths of interest rates up to the time of the cash flow.

[5] Other studies using OASs are, for example, Cavallo and Valenzuela (2010), Huang and Kong (2003), and Pedrosa and Roll (1998). A description in more detail of the OAS computation can be found in Cavallo and Valenzuela (2010), Fabozzi (2006), and Miller (2007).

[6] The BofA Merrill Lynch OAS indices correspond to weighted averages based on the outstanding amount of each bond. By data restrictions, the OAS weighted averages from my data are based in the issued amount. In addition, given that the U.S. Corporate BofA Merrill Lynch indices by credit rating are only available for bonds issued in investment grade country of risk, in the construction of my indices I do not consider the bonds issued in countries granted with a below investment grade credit rating. The index criteria used by BofA Merrill Lynch are available in http://www.mlindex.ml.com.

quality of the credit rating decreases. In addition, the table reports that OASs are considerably higher in the period of high market illiquidity post Lehman Brothers bankruptcy for all the categories presented.

B. Market Illiquidity

Although recent empirical literature on the determinants of corporate bond spread has explored the impact of bond-specific measures of liquidity, in this paper I focus on market illiquidity for three reasons. First, I want to focus my interest in the systematic implications of illiquidity. Second, according to Collin-Dufresne et al. (2001), most of the variation in corporate bond spreads can be explained by a factor common to all bonds. Third, to some extent I control by bond liquidity as there is a robust relationship between bond liquidity and bond characteristics and also between aggregated bond liquidity and market-wide variables of financial distress (Bao, Pan and Wang (2008)).

Using a methodology similar in spirit to those presented by Longstaff (2004) and Schwarz (2009),[7] I propose a new measure of market illiquidity in the bond market denominated in U.S. dollars, which I will use later to test my hypotheses. Taking into account that the U.S. Treasury and supranational bonds are traditionally considered as "safe havens" due to their negligible default risk, my market illiquidity measure of bonds denominated in U.S. dollars is the yield spread between supranational AAA bonds and Treasury bonds. Given that the debt of supranational organizations such as the European Investment Bank, the World Bank, the International Finance Corporation, the Inter-American Development Bank, the Asian Development Bank and the European Bank for Reconstruction and Development is considered at the top of the credit risk quality with negligible default risk, any difference between supranational AAA bonds and Treasury bonds should be driven mainly by liquidity premium. I constructed my market liquidity measure using bond yield indices from BofA Merrill Lynch. The yield indices considered include bonds with time to maturity between 1 and 3 years. The supranational AAA spread is shown in Figure 3.

The main assumption to obtain a clean measure of market illiquidity, particularly in a period of global financial distress, is that the probability of default of supranational AAA debt is highly correlated with the probability of default of the debt issued by the U.S. government. Although the opposite cannot be totally disregarded, there is no good reason to think that the significant jump in my market illiquidity measure during the U.S. subprime crisis was due to a higher deterioration of the creditworthiness of supranational institutions in comparison to the creditworthiness of the U.S. government, which suffered a considerable deterioration of its fiscal position in recent years .[8] In addition, as a check

[7] The methodology proposed by Longstaff (2004) measure Treasury market liquidity comparing Treasury bond yields with Refcorp bond yields. Refcorp is an U.S. agency which bonds are fully collateralized by the Treasury and Treasury bonds. Therefore any difference between Treasury and Refcorp bond yields should reflect liquidity premium. In the same line, Schwarz (2009) proposed a new measure of market liquidity in the German bond market. It consists of the comparison between German government bonds and KfW bonds, which are bonds with explicit guarantee of the German federal government.

[8] According to data from the World Economic Outlook from the International Monetary Fund, during the period of the U.S. subprime financial crisis the U.S. output growth rate was smaller than the World output growth rate. Additionally, the U.S. government showed, on average, the biggest fiscal deficit between the countries with available data.

on the validity of my illiquidity measure, I estimated the correlation between my market illiquidity measure and the measured proposed by Schwarz (2010). Although the supranational AAA spread corresponds to debt denominated in U.S. dollars and the KfW spread corresponds to debt denominated in euros, the correlation between both measures is 0.96 suggesting that the supranational AAA spread is also a good measure of market illiquidity.[9]

For robustness purposes, I also constructed a second measure of market illiquidity, which is the yield spread between U.S. agencies AAA bonds and Treasury bonds. The idea in the construction of this measure is that although most U.S. agencies included in the BofA Merry Lynch index are not backed by the full faith and credit of the U.S. government, the market has long believed that agency debt is "implicitly guaranteed" by the U.S. government given the importance of these agencies promoting public policy. Since the financial pressures experimented by Fannie Mae and Freddie Mac during the U.S. subprime crisis may have added some noise to this market illiquidity measure, despite the fact that these enterprises were placed under conservatorship of the Treasury in September 2008, I report my results utilizing only the supranational AAA spread. The results remain qualitatively unchanged regardless of the market liquidity measure used.

C. Rollover Risk

According to the theoretical framework introduced by He and Xiong (2010), and under the assumption of a stationary debt structure, rollover losses increase with market illiquidity and this effect is stronger for firms with higher short-term debt to total debt ratios. Market illiquidity shocks increase the liquidity premium, pushing bond prices down and increasing the cost of rolling over the maturating debt. This effect is amplified with a higher short-term debt to total debt ratio as the short-term debt has to be rolled over at a higher frequency. In Appendix A, I show that under some weak assumptions the rollover losses of firm *j*, in country *c*, at time *t* can be expressed by

$$Rollover\ Losses_{jct} = \phi + \alpha\ Illiquidity_t + \beta(Short\ Term\ Debt / Total\ Debt)_{jct}\ Illiquidity_t$$

Where ϕ>0, α>0, β>0 and $Illiquidity_t$ represents market illiquidity, with higher illiquidity values indicating higher liquidity premium. Therefore, to analyze whether rollover risk is priced on corporate bond spreads, I consider my measure of market illiquidity and its interaction with the short-term debt to total debt ratio as determinants of corporate bond spreads. While the impact of market illiquidity on corporate spreads can be explained by liquidity premium or rollover risk, the impact of the interaction term on corporate bonds spreads can only be justified theoretically by rollover risk. Bearing this in mind, I consider the interaction between the short-term debt to total debt ratio and market liquidity as a proxy for rollover risk. The short-term debt to total debt ratio is constructed using accounting data from Bloomberg and market illiquidity is measured by the supranational AAA spread mentioned above.

[9] I thank Krista Schwarz for access to one of her liquidity measures: the Two-year KfW over German Federal Bond Yield Spread. The correlation of 0.96 between both series was obtained using daily series for the period running from the 5th of May 2007 to the 15th of June 2009, period for which the KfW measure was available.

D. Other Corporate Bond Spread Determinants

To control for all variables that could affect corporate bond spreads directly, I control for bond characteristics, firm-specific performance indicators, business sector, sovereign credit rating and global factors in all the regressions. The choice of the control variables is mainly based in the literature on the determinants of corporate bond spreads. The description, unit, frequency and source of the variables are shown in Appendix B.

The three bond characteristics considered are time to maturity, issue size and coupon rate. Time to maturity and issue size control for bond liquidity and the coupon rate controls for the tax effect presented by Elton et al. (2001).

Regarding firm-specific performance indicators, I run all my regressions with Standard and Poor's (S&P) corporate credit rating. Furthermore, given that credit ratings mainly consider the long-term and structural component of default risk (Löffler (2004), Standard and Poor's (2001)); I also consider the issuer's equity volatility, as in Campbell and Taskler (2003), and a standard set of accounting variables. These variables are the operating income to sales, short-term debt to total debt, total debt to assets, and firm size.[10] Since balance sheet variables are reported quarterly, following Collin-Dufresne et al. (2001), I estimate monthly observations using linear interpolation.

To control for all the operating risks facing a firm in a given business sector that are time-invariant but specific to an industry, I include industry fixed effects. And, given that my data set contains bond information for a large set of countries, I include the S&P sovereign credit rating. This variable captures a broad range of country-time risk factors correlated with sovereign risk that may affect the credit risk of private firms.

Global variables affecting all bonds are also considered. In order to control for the relation between Treasury bond and corporate bond spreads presented by Duffee (1998), I consider the 10-year Treasury rate and the difference between the 10-year and 2-year Treasury rate. Table II characterizes the variables considered in my final sample of bonds for each year.

III. Regression Analysis

A. Corporate Bond Spreads and Rollover Risk

The central question of this study is to explore the impact of rollover risk on corporate bond spreads. Thus, the baseline specification is:

$$\begin{aligned} Bond\ Spread_{ijct} = {} & \eta_0 + \eta_1\, Maturity_{ijct} + \eta_2\, Issue\ Size_{ijct} + \eta_3\, Coupon_{ijct} + \eta_4\, Equity\ Volatility_{jct} \\ & + \eta_5\, Credit\ Rating_{jct} + \eta_6\, Operating\ Income/Sales_{jct} + \eta_7\, ST\ Debt/Debt_{jct} \\ & + \eta_8\, Debt/Assets_{jct} + \eta_9\, Size_{ct} + \eta_{10}\, Sovereign\ Credit\ Rating_{ct} + \eta_{11}\, Treasury\ Rate_t \\ & + \eta_{12}\, 10yr\text{-}2yr\ Treasury\ Rate_t + \eta_{13}\, Illiquidity_t + \eta_{14}\, Credit\ Rating_{jct}\ x\ Illiquidity_t \\ & + \eta_{15}\, (ST\ Debt/Total\ Debt)_{jct}\ x\ Illiquidity_t + \eta_{16\ldots24}\, Sector\ Dummies + \varepsilon_{ijct} \end{aligned}$$

[10] Although my main results are robust to the inclusion the pretax interest coverage, I exclude this variable in my baseline regression given that my sample size drops considerably when it is added.

where the subscript *"ijct"* refers to bond *i*, firm *j*, country of risk *c*, and time *t*. The interaction between *"Corporate Rating"* and *"Illiquidity"* controls by the "flight to quality" effect presents in periods of financial distress. The parameters of interests in this estimation are η_{13} , η_{14}, and η_{15}.

Although recent literature has interpreted the impact of liquidity on corporate bond spreads as liquidity premium, as emphasized by He and Xiong (2010) market illiquidity can also increase corporate bond spreads through a "rollover risk channel". Although a feature of my specification is that market illiquidity may be capturing both liquidity premium and rollover risk, the only economic reason to expect that the impact of market illiquidity on corporate bond spreads is exacerbated with higher short-term debt to total debt ratios is the rollover risk channel. For this reason, a statistically significant sign on the parameter η_{15} is considered as strong evidence that rollover risk is priced on corporate bonds.

Table III reports my main results when estimating my baseline regression by ordinary least squares. Models 1 and 3 report the results of my baseline specification for my investment grade and speculative grade bond samples, respectively. Given that the U.S. subprime crisis had a global impact, in Models 2 and 4 I take a more agnostic view and include month dummies to control for any time-specific effect.

Three findings are notable. First, I find that my market illiquidity measure is positively related to corporate bond spreads, the spreads of speculative bonds being more sensitive to market illiquidity than the spread of investment grade bonds. The coefficients are significant at the 1% level for both investment grade and speculative grade bonds. These results are in line with recent literature, which shows that aggregate and bond-specific liquidity is priced in the corporate bond spreads (Collin-Dufresne et al. (2001), Campbell and Taskler (2003), Chen et al. (2007), Covitz and Downing (2007)).

Second, the results are consistent with a "flight to quality" effect. Models 1 to 4 show that the coefficients associated with the interaction between corporate credit rating and market illiquidity are negative and highly statistically significant. These results suggest that less risky bonds (in terms of credit rating quality) are relatively strongly less affected by episodes of market illiquidity. Therefore, in times of financial distress, standard models that omit the investors' "flight to quality" may bias the results.

Third, the main finding is that rollover risk matters to the pricing of corporate bond spreads, its impact being higher in speculative bonds. Consistent with the theoretical framework introduced by He and Xiong (2010), the results suggest that a higher proportion of short-term debt to total debt exacerbates the impact of market illiquidity on corporate bond spreads through a "rollover risk channel".

In times of market illiquidity, the magnitude of corporate bond spreads that can be explained by rollover risk is financially important. One way to get a sense of the magnitude of the rollover risk on corporate bond spreads is as follows: considering a supranational AAA spread of 150 basis points as at the end of 2008, the coefficients estimated from model 4 in Table III predicts that the spreads of speculative bonds issued by firms with short-term to total debt ratios at the 90^{th} percentile are around 300 basis points higher than the spreads of speculative bonds issued by firms with short-term to total debt ratios at the 10^{th} percentile. On the other hand, the coefficients estimated from model 2 in Table III predict that this magnitude is around 120 basis points in the investment grade sample. For the same period of market illiquidity, the spread of

speculative grade and investment grade corporate bonds were, on average, around 1,290 basis points and 475 basis points respectively. So the magnitudes explained by market illiquidity through a "rollover risk channel" are high numbers.

Finally, it is noteworthy that most control variables have strong explanatory power in the expected directions. For example, in the investment grade bond sample the results indicate that years to maturity, coupon rate, equity volatility, short-term debt to total debt and total debt to assets are positively related to corporate bond spreads. On the other hand, the results also suggest that issue size, corporate credit rating, operating income to sales, size, sovereign credit rating, treasury rate and the difference between the 10-year and 2-year Treasury rate are negatively related to corporate bond spreads.

B. Banks versus Financial Corporations

The main business in the banking and financial sectors consists in borrowing short to invest long. Therefore, in times of market illiquidity, banks and financial corporations may have higher rollover losses given their high levels of short-term debt over total debt. Moreover, financial corporations do not have, in principle, a lender of last resort since they are not depositary institutions. Consequently, I would expect them to be more vulnerable to episodes of market illiquidity and thus more sensitive to rollover risk than banks.

Table IV explores whether the impact of rollover risk on corporate bond spreads differs across sectors. The empirical strategy to explore this issue is to augment my baseline regressions with two interaction terms. The first term is an interaction between the rollover risk measure and a financial corporation dummy variable and the second term is the interaction between the rollover risk measure and a bank dummy variable. As expected, the results indicate that financial corporations were the most affected by each unit of rollover risk while the effect on banks was the smallest. Nevertheless it is important to keep in mind that as banks have the highest levels of short-term debt, they were highly exposed to market illiquidity.

C. Periods of Financial Stability versus Periods of Financial Distress

In this section I explore whether the impact of market illiquidity and rollover risk differs between periods of financial distress, as in the recent U.S. subprime crisis, and periods of financial stability. Table V reports the results of the same specifications estimated in Table III but splitting the sample in two periods: one period of financial stability (December 2004 to December 2006) and one period of financial distress (January 2007 to June 2009). The results show that during periods of financial stability the sign of the coefficients associated to market illiquidity, investors' flight to quality, and rollover risk remain qualitatively unchanged but they are all insignificant in the investment grade sample. In the speculative grade sample, although all the previous mentioned coefficients have the expected sign, only the coefficient associated to rollover risk are significant at standard levels. For the financial distress period, all my main results are virtually unchanged from the estimates in Table III.

The previous results together with the fact that most previous studies on the determinants of corporate bond spreads have been done using investment grade data in periods of financial stability are a potential reason why the impact of market illiquidity on

corporate bonds spreads through a "rollover risk channel" has been ignored in the literature on the modeling of corporate bond spreads. However, adhering to standard models on the pricing of corporate debt may be undesirable in periods of financial distress and market illiquidity.

IV. Robustness Checks

A. Bond Fixed-Effects Regressions

In my previous results I have shown that corporate bond spreads vary directly with rollover risk across bonds. In order to remove the cross bond effect, in the specifications reported in Table VI, I apply fixed effects to each of my 493 investment grade bonds and 166 speculative grade bonds. In this way, I control for the fact that a small set of firms may dominate the bond market and, in addition, for the fact that bonds may differ in seniority. Applying bond fixed-effects, all my previous findings remain qualitatively unchanged. All the coefficients associated to market illiquidity, investors' flight to quality, and rollover risk have the expected sign and remain highly significant.

B. Does my Rollover Risk Measure Proxy for Something Else?

Until now I have demonstrated that my measures of rollover risk help to predict corporate bond spreads. However, given that my rollover measure is constructed as the interaction between the short-term to total debt ratio and my measure of market illiquidity, there exists the possibility that the short-term to total debt ratio or my market illiquidity measure proxy for something else.

The first possibility is that the short-term debt to total debt ratio may pick up other contemporaneous variables. Table VII reports the results from more explicit testing of this possibility by including a number of other interaction terms. The five new terms correspond to the interaction of equity volatility, total debt to total assets, size of the firm, years to maturity, and issue size of the bond with my measure of market illiquidity respectively. Table VII shows that my main results remain practically unchanged and the coefficients associated to my new interaction terms have the expected sign and are highly significant for investment grade and speculative grade bonds. On the one hand, the new coefficients suggest that corporate bond spreads of bonds with higher issue amount and issued by firms with higher equity volatility and higher total debt to total assets are more affected by market illiquidity. The last two findings are consistent with the structural credit risk models initiated by Merton (1974). For example, as shown by Campbell and Taksler (2003), firms with higher idiosyncratic equity volatility are more likely to reach the condition of default where the firm equity value becomes zero. And, according to my results, this is particularly true in periods of market illiquidity characterized by negative shocks in the equity value of the firm.

On the other hand, spreads of corporate bonds issued by larger firms and with more years to maturity are less affected by episodes of market illiquidity.[11] The negative coefficient of "*Size x Supranational AAA spread*" is consistent with the Too-Big-to-Fail hypothesis: it argues that inventors could perceive that the largest firms are so large that a government

[11] The positive sign in the interaction between size and market illiquidity for my speculative grade bond sample is given by the fact that corporate ratings are highly correlated with size. Once that I include only the component of the credit rating unrelated to size, the coefficient becomes also negative.

cannot allow them to declare bankruptcy. In this case, larger firms would be less vulnerables to periods of market illiquidity.

Regarding to the maturity of the bond, both the positive coefficient of "*Years to maturity*" and the negative coefficient of "*Years to maturity x Supranational AAA spread*" indicate that in periods of financial stability a longer time to maturity is associated with more credit risk, but that in times of financial distress a shorter time to maturity is associated with more credit risk. Finally, it is noteworthy that all results remain unchanged even when all the interactions terms are included at the same time (columns 6 and 12).

Another possibility is that my market illiquidity variable may pick up other contemporaneous variables. To rule out this possibility, I augment my baseline regression with three variables of financial distress. The first variable is the 3-month Libor-OIS spread, which is the difference between the London inter-bank offer rate and the overnight index swap rate. The second variable is the 3-month TED spread that is the difference between the interest rate on inter-bank loans and the "T-bills" rate. The third variable is the VIX index that is a measure of the implied volatility of the S&P500 index options. While the spreads in the money market reflect both credit risk and liquidity premium, the VIX index reflects financial instability. [12] I add these variables to my baseline specification, both with and without an interaction with the short-term to total debt ratio.

To account for the fact that these three indicators are closely related to market illiquidity, I include only the part of these measures that is unrelated to market liquidity. For this purpose, I first regress each of the measures on my market liquidity variable and then I use the residual from that equation in my baseline regression. The resulting residual still contains all of the financial information other than market liquidity (e.g., credit risk in the cases of the Libor-OIS and TED spreads). Table VIII reports the results of my augmented regressions. Once again, my main results remain qualitatively unchanged.

C. Generalized Method of Moments IV Estimation

Since firms may choose their debt structure in order to balance the smaller borrowing costs with the rollover losses associated with short-term borrowing and according their credit profile,[13] endogeneity problems cannot be ruled out from my previous results without some further testing. To control by the potential endogeneity problems in my rollover risk measure, I replicate my baseline specifications using a two-step efficient GMM estimator.

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[12] Empirical works that have decomposed money market spreads on market liquidity and credit risk are Taylor and Williams (2009) and Schwarz (2009). In particular, Schwarz (2009) finds that market liquidity effects explain more than two-thirds of the widening of euro Libor-OIS spreads. Regarding to the relationship between the VIX index and market illiquidity, Bao, Pan and Wang (2008) show that monthly changes in aggregate liquidity are stronly related to changes in the *VIX* Index.

[13] For instance, as Diamond (1991) argues, 'Firms with high credit ratings issue short-term debt directly to investors. Firms with lower credit ratings issue long-term bonds or borrow through financial intermediaries such as banks. The lower rated borrowers' bank loans are relatively short term. Borrower who rely heavily on short-term debt are a mix of the very high and low rated borrowers, with the middle rated borrowers using long-term debt'. (p. 709)

Although firms may anticipate that short-term debt may exacerbate rollover losses in episodes of market illiquidity and plan accordingly, leverage ratios and debt structure appear to be stationary. Previous empirical studies support the existence of a pre-established target in leverage and short-term debt to total debt ratios (Antoniou et. al (2006), Jalilvand and Harris (1984), Opler and Titman (1997), Rataporn et. al (2009)). In the theoretical side, Collin-Dufresne and Goldstein (2001) propose a structural model of model with stochastic interest rates that captures the previously mentioned mean reversion and generate more consistent credit spreads (i.e. larger credit spread for low-leverage firms) than the traditional structural credit risk models. The final data used in this study is consistent with the mentioned facts: in fact, firm-fixed effects explain 90% of the total variance of the short-term debt to total debt ratios in investment grade and speculative grade bonds. Exploiting this information, I instrument rollover risk with the 2- and 4-month lags of the interaction between market illiquidity and the firm-fixed effects from a regression of the short-term debt to total debt on firm dummies.

Table IX presents the results from the second-stage of the two-step efficient GMM IV estimator for the same set of regressions reported in columns 1 and 3 in Table III. The efficiency gains of this estimator relative to the traditional IV/2SLS estimator derive from the use of the optimal weighting matrix, the over-identification restrictions of the model, and the relaxation of the identical and independently distributed assumption. The results reported in Table IX remain largely unchanged. The table also presents the R-squared of excluded instruments and the p-value of the Hansen J test of over-identifying restrictions. The joint null hypothesis of the Hansen J test is that the instruments are orthogonal to the error term, and that the excluded instruments are correctly excluded from the estimated equation (Baum, Schaffer, and Stillman (2003)). As shown by the results, I cannot reject the null hypothesis at standard confidence levels in any of these regressions. Thus, this suggests that the baseline results are unlikely to be driven by an endogeneity bias.

V. Conclusions

In this paper, I employ a new bond-level data set and new proxies for firm-specific rollover risk and market illiquidity to empirically examine the impact of market illiquidity on corporate bond spreads through a "rollover risk channel". I find a statistically significant and financially important effect of rollover risk on corporate bond spreads in both investment grade and speculative grade bonds. I also find that the impact of rollover risk on corporate bond spread is stronger for speculative bonds and for bonds issued by financial corporations. In particular, I argue that the "rollover risk channel" operates through the firms' level of short-term debt to total debt, where the exposure to rollover losses during episodes of market illiquidity is higher in firms with higher short-term debt to total debt ratios. The results are statistically significant even after controlling for bond-specific characteristics, firm-level performance indicators, sovereign credit rating, global factors and a broad set of non-linear impact effects. Moreover, they are robust to alternative proxies for market illiquidity, issuer and time fixed effects, and potential endogeneity bias.

The results in this paper are a contribution to the empirical literature on the modeling of corporate bond spreads during periods of financial distress and in the current debate regarding the effects of financial crises and the regulation of financial corporations

by means of the examination of a novel channel through which market illiquidity affects corporate bond markets. Although the impact of market illiquidity on corporate bonds spreads through a “rollover risk channel” seems to be important, this channel has been ignored in prior empirical studies. In addition, this paper presents preliminary evidence of other bond- and firm-specific vulnerabilities as well as the presence of an investor flight-to-quality effect during periods of financial distress. Future research on these issues is needed in order to improve our understanding of the determinants of corporate bond spreads.

Appendix A: Rollover Losses

In the theoretical framework introduced by He and Xiong (2010), rollover losses of the firm *j*, in country *c*, at time *t* are given by

$$Rollover\ Losses_{jct} = -\sum_{k}\left[d_{k}\left(Illiquidity_{t}\right) - p_{k}\right]$$

where $d_k(Illiquidity_t)$ is the market value of the newly issued bonds with maturity, m_k, and principal, p_k. $Illiquidity_t$ represents market illiquidity, where higher illiquidity values indicate higher liquidity premium. Under the assumption that the expiration of each k^{th} class of debt is uniformly spread out across time, rollover losses can be written as function of the fraction of the k^{th} class debt (λ_k), the total debt (D), and the total debt principal (P).

$$Rollover\ Losses_{jct} = -\sum_{k}\lambda_{k}\left[\frac{D\left(Illiquidity_{t}\right) - P}{m_{k}}\right]$$

Expanding the previous equation for two classes of debt with maturities m_1 and m_2, with $m_1 < m_2$, and expressing rollover losses as function of the fraction of short-term debt, rollover losses are given by

$$Rollover\ Losses_{jct} = \left[\frac{1}{m_{2}} + \frac{\lambda_{1}\left(m_{2} - m_{1}\right)}{m_{1}}\right]P - \frac{1}{m_{2}}D\left(Illiquidity_{t}\right) - \lambda_{1}\frac{\left(m_{2} - m_{1}\right)}{m_{1}m_{2}}D\left(Illiquidity_{t}\right)$$

Finally, assuming a negative lineal relationship between market illiquidity and the market value of the new bonds, rollover losses are a function of market illiquidity and of its interaction with the short-term debt to total debt ratio as follow

$$Rollover\ Losses_{jct} = \phi + \alpha\ Illiquidity_{t} + \beta\lambda_{1}\ Illiquidity_{t}$$

Where $\phi > 0$, $\alpha > 0$, $\beta > 0$, and $\lambda_1 > 0$.

Appendix B: Variables description

Name	Description	Unit	Source
Dependent Variable			
Bond spread	Option-adjusted spread	Basis points	Bloomberg
Bond characteristics			
Years to maturity	Years to maturity	Years	Bloomberg
Issue size	Amount issued	Millions of US$ (in *log*)	Bloomberg
Coupon rate	Coupon bond	Basis points	Bloomberg
Firm Specific			
Equity volatity	Volatility is the standard deviation of the day to day logarithmic price changes. A previous day 180-day price volatility equals the annualized standard deviation of relative price change of the most recent trading days' closing price, expressed in a percentage for the day prior to the current.	Percent	Bloomberg
Credit rating	Standard and Poor's firm rating, long term debt, foreign currency	(1=D, …, 21=AAA)	S&P
Operating income to sales	Operating income divided by net sales.	Ratio	Bloomberg
ST debt to total debt	Short term debt divided by total debt.	Ratio	Bloomberg
Total debt to assets	Total debt divided by total assets.	Ratio	Bloomberg
Size	Total assets	Millions of US$ (in *log*)	Bloomberg
Country Risk			
Sovereign credit rating	Standard and Poor's sovereign rating, long term debt, foreign currency	(1=D, …, 21=AAA)	S&P
Market illiquidity			
Supranational AAA spread	Difference between the Supranational AAA 1-3 years yield index and the Treasury 1-3 years yield index	Basis points	DataStream
U.S. Agencies AAA spread	Difference between the U.S. Agencies AAA 1-3 years yield index and the Treasury 1-3 years yield index	Basis points	DataStream
Global factors			
Treasury Rate	10-year Treasury rate	Basis points	U.S. Treasury
10Yr-2Yr Treasury Rate	Difference between the 10-year and 2-year Treasury rate	Basis points	U.S. Treasury
Libor-OIS spread	Spread between the three-month OIS rates and LIBOR rates	Basis points	Bloomberg
Ted spread	Difference between the three-month U.S. treasury bill rate and the three-month London Interbank Borrowing Rate (LIBOR)	Basis points	Bloomberg
VIX	Chicago Board Options Exchange Volatility Index	Percentage points	CBOE

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Table I
Average Corporate Option-Adjusted Spreads

Using panel data between December 2004 and June 2009, this table reports corporate option-adjusted spreads, in basis points, by credit rating and years to maturity. All the bonds are denominates in U.S. dollars. The table reports option-adjusted spreads for the periods before and after the Lehman Brother bankruptcy.

	S&P Credit Rating							
Corporate bond spreads (bps)	AAA	AA	A	BBB	BB	B	All ratings	N
				January 2004 to August 2009				
Short maturity (0-3 years)	83	108	151	226	438	694	207	1396
Medium maturity (3-7 years)	48	106	122	161	324	478	187	7671
Long maturity (7-15 years)	73	100	117	165	337	572	191	6012
All maturities (0-15 years)	60	104	123	168	335	521	191	15079
N	121	2589	4117	4860	2654	738	15079	
				September 2009 to June 2010				
Short maturity (0-3 years)	259	326	358	636	1009	1398	570	1367
Medium maturity (3-7 years)	189	324	419	550	1045	1294	589	2067
Long maturity (7-15 years)		368	419	555	1006	1554	600	1045
All maturities (0-15 years)	245	334	400	576	1027	1388	586	4479
N	25	864	1333	1330	706	221	4479	

Table II
Sample Characterization

Using panel data between December 2004 and June 2009, this table reports simple averages by year of the variables considered in the empirical model. N corresponds to the total number of observations for each year.

Variables	2004	2005	2006	2007	2008	2009	2004-2009
Bond Spreads (OAS)	150.65	156.36	146.81	158.88	406.22	574.75	281.19
Years to maturity	8.13	7.59	6.68	5.86	5.18	4.65	5.94
Issue size	19.28	19.29	19.17	19.20	19.29	19.32	19.25
Coupon rate	674.98	663.68	646.93	640.12	643.72	635.87	645.67
Equity volatility	26.08	25.89	27.96	27.90	44.98	72.92	38.44
Credit rating	13.58	13.55	13.94	14.33	14.24	14.22	14.10
Operating income to sales	0.16	0.18	0.17	0.15	0.12	0.08	0.14
ST debt to total debt	0.20	0.21	0.24	0.27	0.27	0.25	0.25
Total debt to asset	0.30	0.31	0.33	0.34	0.33	0.33	0.33
Size	9.86	9.86	10.15	10.47	10.59	10.58	10.36
Sovereign credit rating	19.17	19.03	19.07	19.10	19.14	19.10	19.10
10 year Treasury rate	423.00	429.63	479.29	462.01	366.89	301.29	411.99
10yr.-2 yr. Treasury rate	122.00	41.19	-2.65	29.16	166.05	205.40	87.65
Supranational AAA spread	19.20	17.07	17.27	29.82	84.19	92.74	49.06
N	197	2869	3778	4625	5444	2645	19558

Table III
Corporate Bond Spreads and Rollover Risk

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds		Speculative Grade Bonds	
	(1)	(2)	(3)	(4)
Bond Characteristc				
Years to maturity	4.720***	4.851***	11.106***	11.830***
	(0.423)	(0.431)	(1.912)	(1.891)
Issue size	-5.227***	-5.242***	66.184***	71.912***
	(0.575)	(0.568)	(8.575)	(8.448)
Coupon rate	0.100***	0.097***	0.314***	0.346***
	(0.009)	(0.009)	(0.033)	(0.032)
Firm Specific				
Equity volatility	2.462***	1.923***	4.155***	3.050***
	(0.151)	(0.173)	(0.293)	(0.325)
Credit rating	7.764***	6.573***	-2.619	-7.751*
	(1.421)	(1.446)	(4.504)	(4.443)
Operating income to sales	-59.171***	-58.242***	-269.410***	-251.900***
	(15.547)	(15.224)	(34.872)	(34.414)
ST debt to total debt	67.581***	56.657***	-34.552	10.421
	(9.507)	(9.565)	(50.286)	(49.228)
Total debt to asset	9.808	12.958*	229.714***	217.829***
	(7.851)	(7.681)	(30.603)	(30.987)
Size	-1.981	-1.120	-1.040	2.922
	(1.309)	(1.287)	(4.234)	(4.178)
Country Risk				
Sovereign credit rating	-7.813***	-7.684***	3.491***	5.104***
	(0.655)	(0.643)	(1.140)	(1.091)
Global Factors				
10 year Treasury rate	-0.525***		-0.861***	
	(0.046)		(0.157)	
10yr.-2 yr. Treasury rate	-0.191***		-0.344***	
	(0.037)		(0.119)	
Market Illiquidity				
Supranational AAA spread	10.426***		16.270***	
	(0.501)		(1.268)	
Flight to Quality				
Credit rating x Supranational AAA spread	-0.539***	-0.532***	-1.059***	-1.069***
	(0.038)	(0.038)	(0.114)	(0.114)
Rollover Risk				
ST Debt/Debt x Supranational AAA spread	1.018***	1.310***	3.912***	3.287***
	(0.285)	(0.286)	(0.920)	(0.906)
Observations	15239	15239	4319	4319
Adjusted R-squared	0.623	0.633	0.718	0.736
Industry Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	No	Yes	No	Yes

Table IV
Banks versus Non-Bank Financial Institutions

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds		Speculative Grade Bonds	
	(1)	(2)	(3)	(4)
Bond Characteristc				
Years to maturity	4.982***	5.137***	10.482***	11.102***
	(0.406)	(0.411)	(1.915)	(1.886)
Issue size	-6.043***	-5.994***	59.817***	64.329***
	(0.612)	(0.603)	(8.662)	(8.517)
Coupon rate	0.105***	0.102***	0.318***	0.353***
	(0.009)	(0.008)	(0.033)	(0.032)
Firm Specific				
Equity volatility	2.485***	1.946***	4.027***	2.835***
	(0.149)	(0.174)	(0.296)	(0.328)
Credit rating	7.122***	6.001***	-4.425	-10.292**
	(1.366)	(1.386)	(4.523)	(4.455)
Operating income to sales	-62.415***	-61.456***	-250.219***	-226.485***
	(15.243)	(14.914)	(31.774)	(31.196)
ST debt to total debt	26.939**	18.529	-191.465***	-168.976***
	(13.722)	(13.776)	(57.580)	(56.263)
Total debt to asset	-3.235	0.279	194.569***	172.942***
	(7.725)	(7.524)	(30.715)	(31.636)
Size	-1.991	-1.129	-1.089	3.322
	(1.250)	(1.223)	(4.239)	(4.171)
Country Risk				
Sovereign credit rating	-7.519***	-7.418***	3.179***	4.822***
	(0.601)	(0.591)	(1.151)	(1.102)
Global Factors				
10 year Treasury rate	-0.529***		-0.888***	
	(0.046)		(0.155)	
10yr.-2 yr. Treasury rate	-0.195***		-0.344***	
	(0.037)		(0.119)	
Market Illiquidity				
Supranational AAA spread	10.217***		16.024***	
	(0.488)		(1.271)	
Flight to Quality				
Credit rating x Supranational AAA spread	-0.536***	-0.530***	-1.066***	-1.075***
	(0.037)	(0.038)	(0.114)	(0.114)
Rollover Risk				
ST Debt/Debt x Supranational AAA spread	2.020***	2.192***	6.104***	5.683***
	(0.616)	(0.616)	(1.177)	(1.163)
ST Debt/Debt x Supranational AAA spread x Bank	-1.122**	-1.004**	-3.846***	-4.290***
	(0.466)	(0.467)	(1.444)	(1.435)
ST Debt/Debt x Supranational AAA spread x Financial	1.803**	1.912**	6.514***	8.238***
	(0.839)	(0.832)	(2.325)	(2.158)
Observations	15239	15239	4319	4319
Adjusted R-squared	0.626	0.637	0.721	0.740
Industry Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	No	Yes	No	Yes

Table V
Periods of Financial Stability versus Periods of Financial Distress

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds				Speculative Grade Bonds			
	Dec. 2004 - Dec. 2006		Jan. 2007 - June 2009		Dec. 2004 - Dec. 2006		Jan. 2007 - June 2009	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bond Characteristc								
Years to maturity	3.045***	3.087***	5.259***	5.351***	15.281***	15.069***	5.073*	7.680***
	(0.218)	(0.219)	(0.599)	(0.588)	(1.252)	(1.228)	(2.814)	(2.696)
Issue size	-2.896***	-2.910***	-5.740***	-5.897***	-8.955*	-8.785*	114.138***	121.305***
	(0.320)	(0.319)	(0.831)	(0.818)	(4.905)	(4.807)	(13.305)	(13.144)
Coupon rate	0.055***	0.054***	0.120***	0.117***	0.222***	0.223***	0.305***	0.350***
	(0.005)	(0.005)	(0.014)	(0.013)	(0.025)	(0.024)	(0.048)	(0.048)
Firm Specific								
Equity volatility	0.199***	0.149**	2.438***	1.978***	2.176***	2.184***	3.907***	2.584***
	(0.073)	(0.073)	(0.164)	(0.186)	(0.396)	(0.398)	(0.366)	(0.414)
Credit rating	-5.099	-5.942*	13.743***	12.765***	-6.011	-5.778	-38.053***	-39.715***
	(3.400)	(3.427)	(2.376)	(2.400)	(13.312)	(13.223)	(8.424)	(8.456)
Operating income to sales	-6.012	-5.350	-62.016***	-59.932***	-136.714***	-134.148***	-308.593***	-286.920***
	(3.925)	(3.932)	(18.520)	(18.247)	(23.075)	(22.530)	(44.048)	(43.168)
ST debt to total debt	40.566*	40.213*	67.253***	52.177***	-161.235	-151.526	-233.219***	-175.900**
	(20.733)	(20.557)	(16.970)	(16.974)	(150.490)	(154.770)	(75.583)	(72.342)
Total debt to asset	-4.706	-4.381	18.625*	21.516**	109.163***	106.339***	262.998***	299.645***
	(3.160)	(3.150)	(10.471)	(10.275)	(24.176)	(24.414)	(53.643)	(53.296)
Size	-1.740*	-1.779*	-0.261	0.776	4.790	4.883	-1.583	4.067
	(0.988)	(0.988)	(2.043)	(2.007)	(3.734)	(3.699)	(6.741)	(6.759)
Country Risk								
Sovereign credit rating	-4.511***	-4.496***	-9.877***	-9.783***	1.922**	2.019**	2.322	5.034***
	(0.358)	(0.358)	(1.095)	(1.077)	(0.860)	(0.849)	(1.638)	(1.580)
Global Factors								
10 year Treasury rate	0.093***		-0.658***		-0.155		-0.869***	
	(0.026)		(0.062)		(0.099)		(0.229)	
10yr.-2 yr. Treasury rate	0.007		-0.183***		-0.158		-0.127	
	(0.026)		(0.044)		(0.105)		(0.141)	
Market Illiquidity								
Supranational AAA spread	3.091		11.059***		2.649		12.745***	
	(2.952)		(0.626)		(7.730)		(1.585)	
Flight to Quality								
Credit rating x Supranational AAA spread	-0.242	-0.202	-0.592***	-0.588***	-0.353	-0.370	-0.714***	-0.774***
	(0.205)	(0.206)	(0.046)	(0.047)	(0.748)	(0.743)	(0.140)	(0.141)
Rollover Risk								
ST Debt/Debt x Supranational AAA spread	0.400	0.469	1.106***	1.380***	16.722**	16.376*	5.811***	5.023***
	(1.185)	(1.174)	(0.353)	(0.353)	(8.358)	(8.591)	(1.155)	(1.120)
Observations	5212	5212	10027	10027	1632	1632	2687	2687
Adjusted R-squared	0.398	0.401	0.583	0.593	0.314	0.346	0.685	0.704
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	No	Yes	No	Yes	No	Yes	No	Yes

Table VI
Regressions with Bond Fixed Effects

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. Bond fixed effects are included. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds		Speculative Grade Bonds	
	(1)	(2)	(3)	(4)
Bond Characteristc				
Years to maturity	-4.513	-101.972***	3.486	-170.485***
	(4.364)	(10.414)	(10.514)	(20.564)
Firm Specific				
Equity volatility	2.837***	2.209***	5.913***	3.604***
	(0.361)	(0.463)	(0.769)	(0.938)
Credit rating	-6.190	-7.374	-27.649	-31.742*
	(6.405)	(6.461)	(17.070)	(18.134)
Operating income to sales	-38.244	-39.158	-429.079***	-385.013***
	(29.001)	(29.200)	(90.925)	(85.354)
ST debt to total debt	53.287*	40.663	-360.430***	-251.085**
	(30.651)	(30.733)	(108.327)	(104.890)
Total debt to asset	80.547	64.494	-24.321	-72.443
	(102.085)	(103.449)	(158.017)	(152.352)
Size	-37.458	-21.416	-58.898	27.735
	(25.087)	(25.046)	(49.887)	(49.551)
Country Risk				
Sovereign credit rating	-26.471**	-24.369*	-43.851***	-31.958***
	(13.374)	(13.204)	(13.088)	(12.253)
Global Factors				
10 year Treasury rate	-0.481***		-0.635***	
	(0.060)		(0.191)	
10yr.-2 yr. Treasury rate	-0.207***		-0.222*	
	(0.036)		(0.132)	
Market Illiquidity				
Supranational AAA spread	10.574***		13.942***	
	(1.024)		(2.171)	
Flight to Quality				
Credit rating x Supranational AAA spread	-0.567***	-0.563***	-0.877***	-0.969***
	(0.080)	(0.080)	(0.198)	(0.189)
Rollover Risk				
ST Debt/Debt x Supranational AAA spread	1.531**	1.812***	6.073***	4.824***
	(0.660)	(0.677)	(1.817)	(1.782)
Observations	15239	15239	4319	4319
Number of bonds	493	493	166	166
R-squared within	0.611	0.624	0.704	0.737
R-squared between	0.477	0.0228	0.484	0.150
R-squared overall	0.479	0.158	0.511	0.298
F	185.9	72.75	97.97	60.30
Issuer Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	No	Yes	No	Yes

Table VII
Alternative Non-Linear Effects of Market Illiquidity

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds						Speculative Grade Bonds					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Bond Characteristc												
Years to maturity	4.390***	4.730***	4.783***	8.363***	4.661***	7.721***	9.901***	10.839***	10.717***	21.268***	8.411***	20.740***
	(0.434)	(0.423)	(0.418)	(0.766)	(0.424)	(0.733)	(1.901)	(1.887)	(1.906)	(2.653)	(1.890)	(2.531)
Issue size	-5.112***	-4.957***	-5.044***	-5.074***	-9.051***	-9.165***	66.028***	66.380***	61.927***	69.813***	-55.827***	-47.442***
	(0.579)	(0.575)	(0.597)	(0.579)	(0.953)	(1.033)	(8.477)	(8.562)	(8.634)	(8.737)	(11.361)	(11.395)
Coupon rate	0.097***	0.100***	0.099***	0.102***	0.100***	0.099***	0.318***	0.311***	0.310***	0.324***	0.277***	0.291***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.032)
Firm Specific												
Equity volatility	1.489***	2.424***	2.501***	2.446***	2.463***	1.561***	1.752***	4.016***	4.026***	4.156***	3.575***	2.214***
	(0.235)	(0.148)	(0.156)	(0.150)	(0.151)	(0.232)	(0.591)	(0.300)	(0.297)	(0.293)	(0.289)	(0.562)
Credit rating	6.971***	7.779***	5.745***	8.114***	7.664***	3.324***	-9.730**	-4.574	5.492	-4.418	5.005	-0.237
	(1.347)	(1.419)	(1.211)	(1.441)	(1.411)	(1.074)	(4.618)	(4.596)	(4.641)	(4.484)	(4.568)	(4.688)
Operating income to sales	-57.974***	-62.290***	-60.252***	-60.073***	-61.552***	-66.579***	-266.104***	-262.139***	-272.580***	-266.027***	-261.509***	-252.762***
	(15.493)	(15.608)	(15.561)	(15.493)	(15.619)	(15.642)	(35.329)	(34.505)	(34.022)	(35.381)	(32.791)	(32.986)
ST debt to total debt	71.379***	71.047***	56.442***	68.354***	53.465***	35.905***	-60.010	-27.249	-30.650	-15.033	-145.503***	-124.630**
	(9.360)	(9.590)	(9.820)	(9.518)	(9.681)	(11.174)	(51.257)	(50.616)	(49.884)	(50.330)	(49.165)	(49.223)
Total debt to asset	10.365	-30.236**	7.839	10.581	11.742	-25.022*	197.581***	148.163***	228.269***	232.912***	241.224***	184.918***
	(7.897)	(14.067)	(7.784)	(7.879)	(7.997)	(14.310)	(32.290)	(36.406)	(30.436)	(30.621)	(30.713)	(37.528)
Size	*-2.392**	*-2.171*	*3.096**	*-1.578*	*-2.284**	*7.195****	-1.154	-0.805	-22.362***	-0.799	-1.448	-6.798
	(1.316)	*(1.327)*	*(1.756)*	*(1.308)*	*(1.316)*	*(1.966)*	(4.257)	(4.235)	(5.725)	(4.181)	(4.230)	(6.011)
Country Risk												
Sovereign credit rating	-7.847***	-7.793***	-7.772***	-7.783***	-7.825***	-7.737***	2.510**	3.538***	3.340***	3.746***	2.484**	2.314**
	(0.654)	(0.660)	(0.654)	(0.648)	(0.654)	(0.651)	(1.114)	(1.139)	(1.136)	(1.142)	(1.100)	(1.081)
Global Factors												
10 year Treasury rate	-0.496***	-0.522***	-0.526***	-0.508***	-0.525***	-0.480***	-0.762***	-0.881***	-0.886***	-0.816***	-0.923***	-0.825***
	(0.047)	(0.046)	(0.046)	(0.046)	(0.046)	(0.047)	(0.169)	(0.157)	(0.157)	(0.159)	(0.153)	(0.165)
10yr.-2 yr. Treasury rate	-0.097***	-0.188***	-0.196***	-0.179***	-0.189***	-0.093***	-0.102	-0.334***	-0.357***	-0.307**	-0.341***	-0.163
	(0.035)	(0.036)	(0.037)	(0.036)	(0.037)	(0.035)	(0.128)	(0.119)	(0.120)	(0.120)	(0.117)	(0.124)
Market Illiquidity												
Supranational AAA spread	9.741***	10.109***	10.872***	10.939***	8.819***	8.807***	13.336***	15.496***	13.921***	17.242***	-30.678***	-30.163***
	(0.441)	(0.487)	(0.592)	(0.564)	(0.621)	(0.646)	(1.405)	(1.306)	(1.503)	(1.323)	(5.844)	(6.076)
Flight to Quality												
Credit rating x Supranational AAA spread	-0.528***	-0.534***	-0.501***	-0.546***	-0.533***	-0.450***	-0.960***	-1.040***	-1.272***	-1.040***	-1.251***	-1.215***
	(0.037)	(0.038)	(0.035)	(0.039)	(0.037)	(0.032)	(0.117)	(0.115)	(0.128)	(0.114)	(0.116)	(0.129)
Rollover Risk												
ST Debt/Debt x Supranational AAA spread	0.867***	0.906***	1.223***	0.994***	1.286***	1.484***	4.010***	3.674***	3.573***	3.716***	5.319***	4.848***
	(0.271)	(0.289)	(0.323)	(0.283)	(0.322)	(0.377)	(0.939)	(0.944)	(0.906)	(0.921)	(0.901)	(0.913)
Other Interaction Effects												
Equity Volatility x Supranational AAA spread	0.012***					0.011***	0.033***					0.018**
	(0.003)					(0.003)	(0.009)					(0.009)
Total Debt to Asset x Supranational AAA spread		0.870***				0.754**		1.815*				0.945
		(0.321)				(0.326)		(1.099)				(1.109)
Size x Supranational AAA spread			-0.101**			-0.194***			0.525***			0.141
			(0.040)			(0.048)			(0.165)			(0.187)
Years to maturity x Supranational AAA spread				-0.069***		-0.062***				-0.195***		-0.251***
				(0.018)		(0.019)				(0.065)		(0.065)
Issue size x Supranational AAA spread					0.075***	0.093***					2.495***	2.397***
					(0.024)	(0.027)					(0.309)	(0.341)
Observations	15239	15239	15239	15239	15239	15239	4319	4319	4319	4319	4319	4319
Adjusted R-squared	0.624	0.623	0.623	0.624	0.623	0.626	0.720	0.718	0.719	0.719	0.728	0.731
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table VIII
Market Illiquidity versus Global Financial Distress

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

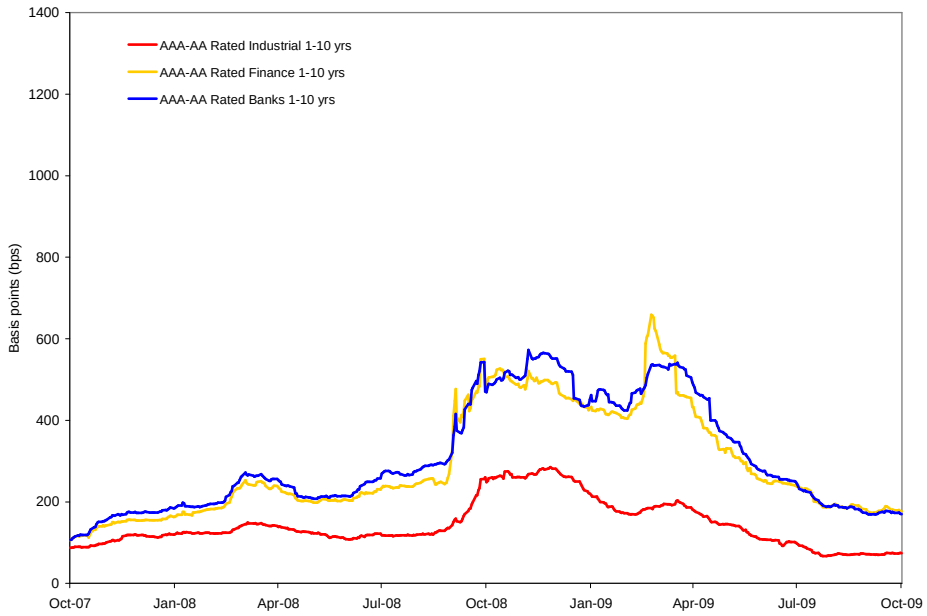
	Investment Grade Bonds			Speculative Grade Bonds		
	(1)	(2)	(3)	(4)	(5)	(6)
Bond Characteristc						
Years to maturity	4.732***	4.716***	4.599***	11.019***	11.136***	11.151***
	(0.423)	(0.423)	(0.418)	(1.905)	(1.909)	(1.849)
Issue size	-5.266***	-5.290***	-5.272***	65.810***	66.170***	69.944***
	(0.572)	(0.572)	(0.567)	(8.555)	(8.576)	(8.472)
Coupon rate	0.099***	0.098***	0.098***	0.311***	0.314***	0.331***
	(0.009)	(0.009)	(0.009)	(0.033)	(0.033)	(0.033)
Firm Specific						
Equity volatility	2.497***	2.449***	2.286***	4.278***	4.079***	3.892***
	(0.151)	(0.153)	(0.155)	(0.297)	(0.302)	(0.289)
Credit rating	7.790***	7.631***	7.363***	-2.500	-3.300	-3.730
	(1.425)	(1.428)	(1.419)	(4.521)	(4.529)	(4.449)
Operating income to sales	-58.849***	-58.927***	-57.280***	-265.380***	-263.163***	-260.652***
	(15.565)	(15.542)	(15.430)	(35.308)	(35.265)	(34.737)
ST debt to total debt	67.073***	65.064***	61.745***	-42.706	-46.529	-21.302
	(9.474)	(9.461)	(9.521)	(50.961)	(52.328)	(49.464)
Total debt to asset	9.261	9.054	10.018	227.356***	227.228***	232.103***
	(7.847)	(7.856)	(7.824)	(30.385)	(30.769)	(30.500)
Size	-1.946	-1.830	-1.399	-0.951	-0.591	1.205
	(1.311)	(1.312)	(1.291)	(4.252)	(4.240)	(4.276)
Country Risk						
Sovereign credit rating	-7.832***	-7.831***	-7.774***	3.411***	3.543***	4.130***
	(0.655)	(0.654)	(0.648)	(1.142)	(1.143)	(1.098)
Global Factors						
10 year Treasury rate	-0.545***	-0.493***	-0.629***	-0.978***	-0.825***	-1.155***
	(0.044)	(0.045)	(0.046)	(0.152)	(0.153)	(0.151)
10yr.-2 yr. Treasury rate	-0.203***	-0.185***	-0.217***	-0.381***	-0.321***	-0.434***
	(0.036)	(0.036)	(0.036)	(0.118)	(0.119)	(0.116)
Market Illiquidity						
Supranational AAA spread	10.418***	10.463***	10.319***	16.153***	16.297***	16.302***
	(0.501)	(0.501)	(0.499)	(1.272)	(1.276)	(1.263)
Flight to Quality						
Credit rating x Supranational AAA spread	-0.540***	-0.540***	-0.537***	-1.063***	-1.057***	-1.076***
	(0.038)	(0.038)	(0.038)	(0.114)	(0.114)	(0.114)
Rollover Risk						
ST Debt/Debt x Supranational AAA spread	1.018***	1.057***	1.124***	4.110***	4.053***	3.728***
	(0.283)	(0.283)	(0.286)	(0.926)	(0.926)	(0.906)
Other Interaction Effects						
Libor-OIS spread Residual	-0.040			-0.018		
	(0.053)			(0.199)		
ST Debt/Debt x Libor-OIS spread residual	0.351**			2.232**		
	(0.138)			(0.986)		
TED spread residual		-0.151***			-0.240*	
		(0.034)			(0.127)	
ST Debt/Debt x TED spread residual		0.325***			0.959	
		(0.087)			(0.600)	
VIX Residual			3.187***			8.431***
			(0.447)			(1.353)
ST Debt/Debt x VIX residual			0.147			12.229*
			(1.101)			(6.488)
Observations	15239	15239	15239	4319	4319	4319
Adjusted R-squared	0.623	0.623	0.628	0.719	0.718	0.731

Table IX
GMM IV Estimation

This table reports estimates from a panel regression of corporate option-adjusted spreads against the variables listed below. Rollover risk is instrumented with the 2- and 4-month lags of the interaction between market illiquidity and the firm-fixed effects from a regression of the short-term debt to total debt on firm dummies. The panel data consists of 659 corporate bonds covering the period running from December 2004 to June 2009. Robust standard errors are in parentheses ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	Investment Grade Bonds	Speculative Grade Bonds
	(1)	(2)
Bond Characteristc		
Years to maturity	5.318***	13.888***
	(0.456)	(2.063)
Issue size	-4.746***	72.570***
	(0.620)	(9.203)
Coupon rate	0.096***	0.338***
	(0.009)	(0.036)
Firm Specific		
Equity volatility	2.459***	4.138***
	(0.158)	(0.303)
Credit rating	9.200***	-8.200*
	(1.940)	(4.860)
Operating income to sales	-48.414***	-194.431***
	(17.049)	(35.977)
ST debt to total debt	39.269	-64.340
	(24.418)	(65.508)
Total debt to asset	8.923	213.417***
	(8.248)	(35.905)
Size	-2.186	3.121
	(1.406)	(4.665)
Country Risk		
Sovereign credit rating	-7.988***	5.871***
	(0.722)	(1.324)
Global Factors		
10 year Treasury rate	-0.549***	-0.638***
	(0.049)	(0.160)
10yr.-2 yr. Treasury rate	-0.190***	-0.281**
	(0.042)	(0.125)
Market Illiquidity		
Supranational AAA spread	10.306***	14.651***
	(0.532)	(1.396)
Flight to Quality		
Credit rating x Supranational AAA spread	-0.540***	-0.890***
	(0.042)	(0.120)
Rollover Risk		
ST Debt/Debt x Supranational AAA spread	1.447***	4.729***
	(0.464)	(1.243)
Observations	13310	3700
Adjusted R-squared	0.633	0.714
Partial R-squared of excluded instruments	0.291	0.490
p-value of Hansen J statistic	0.117	0.238
Industry Fixed Effect	Yes	Yes

Panel A: U.S. dollar denominated AAA-AA corporate debt



Panel B: U.S. dollar denominated A-BBB corporate debt

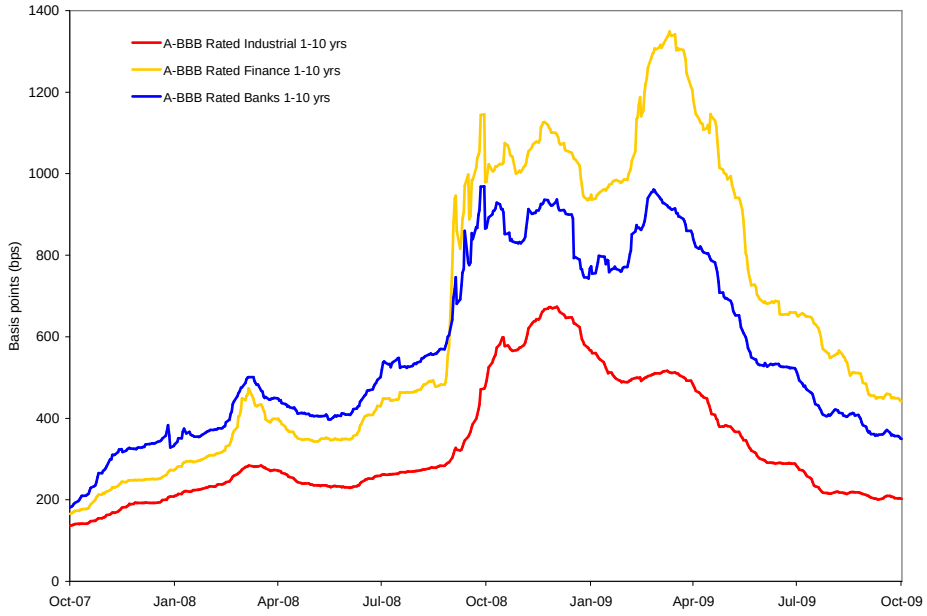


Figure 1. BofA Merrill Lynch Corporate Option-Adjusted Spreads by Sector. Panel A of the figure shows the option-adjusted spread indices of U.S. dollar denominated AAA-AA corporate debt publicly issued by corporations in the industrial, financial and banking sectors. Panel B of the figure shows the option-adjusted spread indices of U.S. dollar denominated A-BBB corporate debt publicly issued by corporations in the industrial, financial and banking sectors.

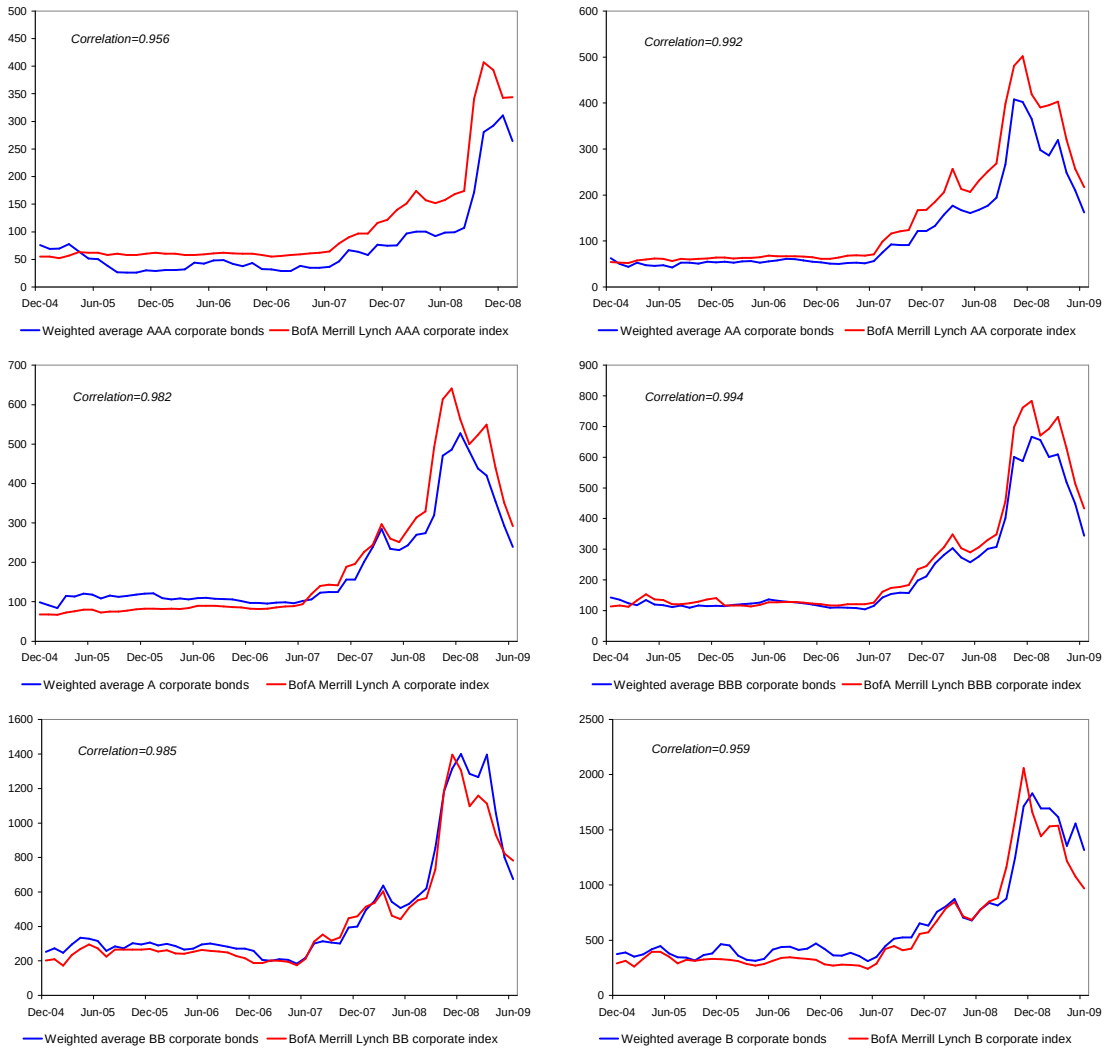


Figure 2. Corporate Option-Adjusted Spreads, 2004-2009. The panels in the figure show the weighted average option-adjusted spread from the bond-level data along with the BofA Merrill Lynch indices by credit rating category. The AAA, AA, A, and BBB U.S. Corporate Indices are a subset of The BofA Merrill Lynch U.S. Corporate Index, which include securities with an investment grade rating and an investment grade rated country of risk. The BB and B U.S. High Yield Indices are a subset of The BofA Merrill Lynch U.S. High Yield Index, which include securities with a below investment grade rating and an investment grade rated country of risk. For each credit rating category, simple correlations between both indices are reported.

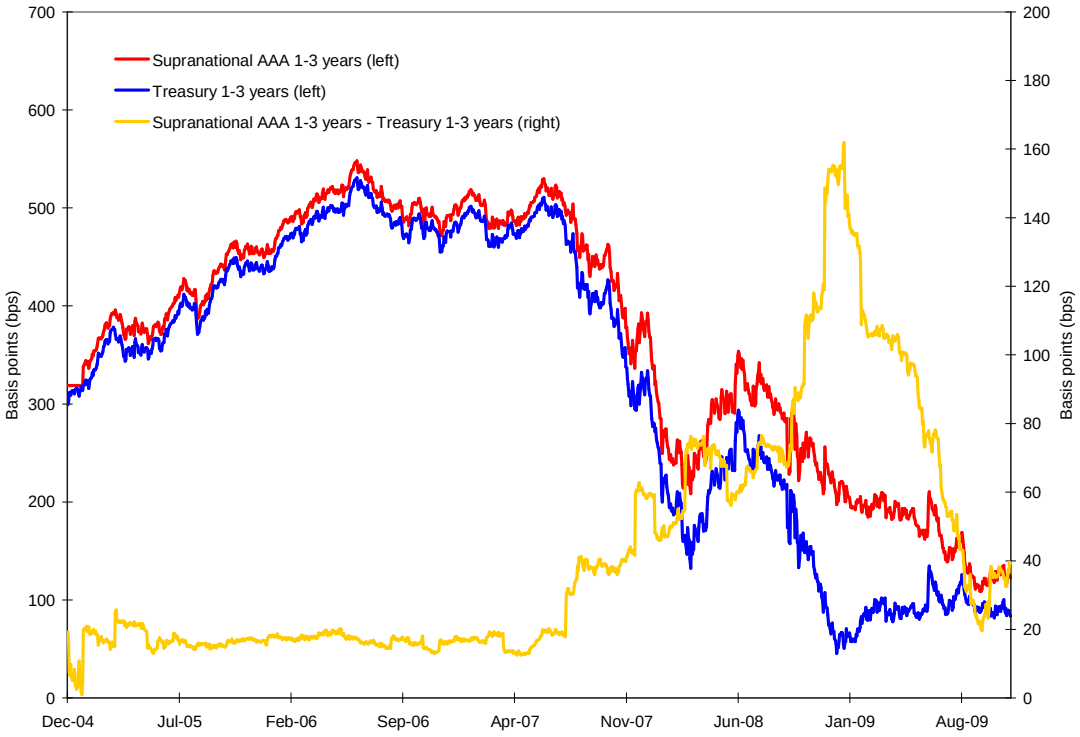


Figure 3. Supranational AAA 1-3 years spread. The figure shows the supranational AAA 1-3 years spread, which is the difference between the BofA Merrill Lynch supranational AAA 1-3 years yield index and the BofA Merrill Lynch U.S. 1-3 years Treasury yield index.