Network for Studies on Pensions, Aging and Retirement

Frank de Jong

Joost Driessen

Liquity risk premia in corporate bond markets

Discussion Papers 2005 – 023

November 2005

Liquidity Risk Premia in Corporate Bond Markets*

Frank de Jong
Tilburg University and University of Amsterdam

Joost Driessen
University of Amsterdam

November 14, 2005

Abstract

This paper explores the role of liquidity risk in the pricing of corporate bonds. We show that liquidity risk is a priced factor for the expected returns on corporate bonds. The exposures of corporate bond returns to fluctuations in treasury bond liquidity and equity market liquidity help to explain the credit spread puzzle. In terms of expected returns, the total estimated liquidity risk premium is around 0.45% for US long-maturity investment grade bonds. For speculative grade bonds, which have higher exposures to the liquidity factors, the liquidity risk premium is around 1%. We find very similar evidence for the liquidity risk exposure of corporate bonds using a sample of European corporate bond prices.

*We are grateful to Inquire Europe for financial support. We thank Ludovic Phalippou and Michael Fleming for comments on earlier drafts. Correspondence address: Frank de Jong, Finance Department, Tilburg University, P.O. Box 90153, 5000 LE, Tilburg, Netherlands. Phone: +31-12-4668040; Fax: +31-13-4662875 E-mail: f.dejong@uvt.nl. Joost Driessen, Finance Group, Faculty of Economics and Econometrics, University of Amsterdam. Roetersstraat 11, 1018 WB, Amsterdam, the Netherlands. E-mail: j.j.a.g.driessen@uva.nl.

Liquidity Risk Premia in Corporate Bond Markets

Abstract

This paper explores the role of liquidity risk in the pricing of corporate bonds. We show that liquidity risk is a priced factor for the expected returns on corporate bonds. The exposures of corporate bond returns to fluctuations in treasury bond liquidity and equity market liquidity help to explain the credit spread puzzle. In terms of expected returns, the total estimated liquidity risk premium is around 0.45% for US long-maturity investment grade bonds. For speculative grade bonds, which have higher exposures to the liquidity factors, the liquidity risk premium is around 1%. We find very similar evidence for the liquidity risk exposure of corporate bonds using a sample of European corporate bond prices.

1 Introduction

Corporate bond yield spreads pose a puzzle to academic researchers. The spread is a compensation for the possibility that the bond defaults, but the spreads are far wider than is justified by historical default losses.[1] This is particularly clear for high-rated bonds that have very small actual default probabilities. In contrast, credit spreads are quite large. Recently, several explanations for this 'credit spread puzzle' have been explored, such as tax effects and market risk premia (see the literature review in section 2). We contribute to this literature by studying in detail the pricing of liquidity risk in corporate bonds. It is well known by now that the liquidity of corporate bonds varies across bonds: several studies have documented a cross-sectional relation between liquidity proxies, such as amount issued and bond age, and the credit spread level. There is little direct evidence of the effect of liquidity on yield spreads, however. Likewise, little is known about the time variation in corporate bond liquidity and risk premia associated with changes in liquidity over time. In this paper we provide empirical evidence that corporate bonds are exposed to systematic liquidity shocks. In addition, we estimate the associated liquidity risk premia and show that these premia help to explain the credit spread puzzle.

Recent studies on equity market liquidity have shown that shocks to the liquidity of individual stocks contain a common component and that the (systematic) risk associated with this common component is priced in the cross-section of expected equity returns. In this paper we extend the literature on asset pricing and liquidity risk to corporate bonds. The corporate bond market seems a natural testing ground for the role of liquidity in asset pricing. A first reason is that the returns on corporate bonds are correlated with both the returns on the treasury bond market, and with returns on the stock market. Corporate bonds are thus a hybrid of default-free bonds and the firm's stock (Kwan, 1996), and we can expect them to be exposed to liquidity shocks in both stock and bond markets. Another reason why corporate bonds are a good testing ground for the theory is because the corporate bond yield, corrected for the expected loss, gives quite an accurate measure of the expected return on the bond (Campello, Chen, and Zhang, 2004). This is important given the problems associated with estimating expected returns using realized returns that plague the equity pricing literature.

[1] See, for example, Elton, Gruber, Agrawal, and Mann (2001).

We consider two types of liquidity risk, one originating from the equity market and one from the treasury bond market. To obtain a measure for equity market liquidity, we use the methodology proposed by Amihud (2002). His ILLIQ measure captures the price impact of trade, by relating volume to the size of absolute returns. We construct a measure for systematic liquidity as the cross-sectional median of the ILLIQ measure within a set of 1500 stocks. For the treasury market, we use the bid-ask spread of long-term US treasury bonds to measure liquidity. Fleming (2003) compares several proxies for Treasury market liquidity, and concludes that the quoted spread is the best commonly available measure to track changes in Treasury bond liquidity.

Our analysis is based on a linear multifactor asset pricing model, in which expected corporate bond returns are explained from their exposure to market risk and liquidity risk factors. We include two market risk factors: the return on an equity index, and the change in the option-implied index volatility. We estimate this model using US corporate bond price data for a 1993-2002 sample period. For measuring the corporate bond yields, we focus on portfolios that are constructed according to maturity and credit rating. We also perform a similar analysis to a recent sample of European bond data.

Our main empirical findings are as follows. First, our estimates of expected corporate bond returns are in line with existing results. Expected bond returns (in excess of government bond returns) are larger for lower-rated firms, and range from 0.52% for AAA-rated bonds to 2.56% for CCC-rated bonds. Second, using time-series regressions where we control for market risk using the stock market index return and the change in the implied equity index volatility, we provide evidence that corporate bond returns are positively related to changes in the equity and bond market liquidity measures. Importantly, the liquidity exposure is larger for lower-rated bonds. Because of this pattern in liquidity exposures, the cross-sectional regression of expected corporate bond returns on market and liquidity beta's renders significant premia on liquidity risk. The liquidity risk premia are economically important, as their contribution to the level of expected corporate bond returns is of similar size as the market risk premium. For long-maturity investment grade bonds, we estimate liquidity premia around 0.45% in terms of expected returns. For speculative grade bonds, the average liquidity premium is around 1%. We validate the results by replicating our analysis for the European corporate bond market. Similar to the US results, we find that European corporate bond returns have a significant exposure to liquidity risk, and that a liquidity risk premium helps to explain part of the credit spread puzzle.

The structure of this paper is as follows. In the next section we discuss how our paper is related to the existing literature on the credit spread puzzle, and to studies on equity and bond market liquidity. We set out the factor pricing model, the empirical methodology and the construction of expected returns and the liquidity measures in section 3. The empirical findings for the US market are presented in section 4. Section 5 presents results for the European bond market. Section 6 offers some conclusions.

2 Related Literature

In this paper we propose liquidity as an additional risk factor in the determination of corporate bond returns. There is by now a fairly substantial literature that relates liquidity to asset pricing. The early papers in this field build on the idea that investors require an additional return on securities that are illiquid, in order to compensate for the transaction cost incurred when trading the assets. Amihud and Mendelson (1986) show that this argument leads to transaction costs as an additional factor in expected returns, although the effect is not necessarily linear. For the equity market, the existence of liquidity effects on prices is well documented, see for example Brennan and Subrahmanyam (1996). Amihud (2002) shows evidence that equity returns are affected by both expected and unexpected liquidity. Acharya and Pedersen (2005) find that expected liquidity is an important determinant of expected returns in their model of liquidity and asset prices for US equities.

For the treasury bond market, Amihud and Mendelson (1991) find that less liquid treasury notes are cheaper than otherwise identical but more liquid treasury bills. This evidence is disputed, however, by Strebulaev (2002), who compares matching notes series. Elton and Green (1998) find small effects of liquidity differences on bond prices. Krishnamurthy (2002) and Goldreich, Hanke and Nath (2003) document differences in yields due to the liquidity difference of on-the-run and off-the run bond issues. One of the possible reasons why liquidity effects in the pricing of treasury bonds are relatively weak is that spreads are extremely narrow. Estimates in Chordia, Sarkar and Subrahmanyam (2003) and Fleming (2003) show that the bid-ask spread on the on-the-run 10 year Treasury note is typically around 2 or 3 basis points.

Bid-ask spreads in the corporate bond market are an order of magnitude higher than in the treasury market. In a recent study, Edwards, Harris and Piwowar (2004) report that bid-ask spreads on investment grade corporate bonds are around 25 basis points for a typical institutional trade size. For below investment grade bonds, the spreads are wider and vary from 35 to 50 basis points.[2] Houweling, Mentink and Vorst (2003) and Perraudin and Taylor (2003) show that the cross-sectional variation in credit spreads is partly explained by proxies for individual bond liquidity.[3] Longstaff, Mithal and Neis (2005) decompose corporate bond yield spreads in a default component (derived from CDS spreads) and a residual component. They show that the latter component is closely related to cross-sectional proxies for liquidity. Chen, Lesmond and Wei (2004) provide some direct evidence of the cross-sectional effect of liquidity on yields. Controlling for differences in credit rating and maturity, they show that credit spreads are strongly correlated with an estimate of the effective bid-ask spread. However, none of these studies investigates the time-variation in liquidity and the pricing of liquidity risk for corporate bonds, which constitutes the main contribution of this paper.

For the equity market, a number of recent studies have explored liquidity as an additional *risk* factor in asset pricing models. In this set-up, it is not (only) the level of transaction costs that determines asset prices, but (also) the exposure of returns to fluctuations in market wide liquidity. This literature is in part inspired by the findings of commonality in liquidity. Chordia, Roll and Subramanyam (2000) and Hasbrouck and Seppi (2001) show that there is a strong common component in liquidity of equities. Moreover, returns on stocks tend to be correlated with changes in liquidity. Chordia, Sarkar and Subrahmanyam (2003) show that liquidity in stock and treasury bond markets are correlated. These results motivate the investigation of liquidity as a priced risk factor. Important papers in this growing literature include Acharya and Pedersen (2005), Bekaert, Harvey, and Lundblad (2005), Pastor and Stambaugh (2003) and Sadka (2004), who all document the significance of liquidity risk for the expected returns on equities. The magnitude of the liquidity risk premium

[2]The spreads on corporate bonds are much smaller for large trades. These bid-ask spreads are smaller than the spreads typically estimated for equity trades. For example, Chordia, Roll and Subrahmanyam (2001) report effective bid-ask spreads between 50 and 100 basis points for NYSE stocks.

[3]Chakravarty and Sarkar (1999) show that these proxies are strongly correlated with the actual bid-ask spreads.

is economically significant. Acharya and Pedersen (2005) perform their analysis on 25 liquidity-based portfolios, sorted on a monthly ILLIQ measure. They also include expected liquidity as a determinant of returns. Their results imply a liquidity premium (difference between highest and lowest liquidity portfolio return, corrected for the other risk factors) of 4.6% per year, of which 3.5% is a compensation for expected liquidity and the remainder is related to liquidity risk. Pastor and Stambaugh's (2003) results show a much higher liquidity risk premium of 7.5% between the high liquidity-sensitive stock portfolio and the low liquidity-sensitive stock portfolio. One of the likely reasons for this higher estimate is the absence of an expected liquidity component in their model. Sadka (2004) uses price impact estimates based on intraday data as the measure of liquidity. He relates momentum effects and liquidity risk premia, but it is hard to back out the magnitude of the liquidity risk premium from his tables.

One of the debates present in this literature is about the most relevant measure of liquidity for asset pricing models. Amihud and Mendelson (1986) have in mind the bid-ask spread (cost of round trip trade) as a measure of illiquidity. Data requirements often make it difficult to get good estimates of effective bid-ask spreads, though. Hasbrouck (2003) shows that using daily price data, a generalization of Roll's estimator is the best proxy for the bid-ask spread. Chordia, Roll and Subramanyam (2000) and Hasbrouck (2003) look at depth, volume, and number of trades per day as measures of liquidity. Pastor and Stambaugh (2003, p.657) claim these measures are less useful to capture the time variation in liquidity, and hence less suited for asset pricing models.

Microstructure theory suggests that the transitory cost plus the price impact of a trade is a good measure of an asset's liquidity. Brennan and Subrahmanyam (1996) suggest the use of microstructure data to estimate these cost components, using the Glosten and Harris (1988) model. Sadka (2004) and Piqueira (2004) follow this approach and estimate time series of monthly illiquidity for individual assets from quote and transactions data using the TAQ database for the period 1993–2001. These are probably the most accurate measures of time-varying individual asset liquidity available. Based on these estimates, Sadka (2004) shows that the price impact component, rather than the transitory cost component, is the priced liquidity risk factor. In the absence of transactions data, the price impact may be difficult to estimate, however. As a proxy for the price impact, Amihud (2002) proposes the ILLIQ index, based on daily price and volume data. Hasbrouck (2003) shows that cross-sectionally, ILLIQ is highly correlated with transactions data based price impact estimates. Pastor and Stambaugh (2003) propose a measure similar to ILLIQ, based on a regression of daily returns on daily signed volume. To summarize, in the absence of estimates of bid-ask spreads or price impact based on intra-day data, the ILLIQ measure seems to be the best proxy for liquidity. We thus follow Acharya and Pedersen (2005) and construct an aggregate measure of equity market liquidity based on individual equities' ILLIQ measures.

Our paper also contributes to the literature on the credit spread puzzle. Elton, Gruber, Agrawal, and Mann (2001) and Campello, Chen and Zhang (2004) argue that the corporate bond spread may partly reflect additional risk factors, of the type typically used in equity pricing studies. For example, both papers include exposures to the stock market index, size, book-to-market and momentum factors. This approach is natural, as corporate bonds are exposed to the same fluctuations in the underlying firm value as the company's stock. Elton, Gruber, Agrawal, and Mann (2001) also note that corporate bond coupons are taxed at the state level, which may account for part of the credit spread puzzle. However, the size of the tax effect is under debate (Amato and Remolona (2004) and Liu, Qi, and Wu (2004)). Other reseachers have investigated whether jump risk premia can explain the credit spread puzzle (Amato and Remolona (2004), Collin-Dufresne, Goldstein, and Helwege (2003), Cremers, Driessen, Maenhout and Weinbaum (2005), and Driessen (2005)). In sum, these articles find that taxes, market risk premium and jump risk premia explain a reasonable part of the expected corporate bond returns and credit spreads, but explaining the full magnitudes remains difficult. Related to this conclusion is the recent work that compares spreads on credit default swaps (CDS) to corporate bond spreads (Blanco, Brennan, and Marsh (2004) and Longstaff, Mithal, and Neis (2004)). These authors find that CDS spreads are much lower than corporate bond spreads, and they attribute the difference to tax and liquidity effects. Our paper complements this work by providing direct evidence that corporate bond prices contain a liquidity risk premium. In addition, the existing work mainly focuses on investment-grade bonds, while we include the entire rating spectrum in our analysis, and provide evidence that speculative-grade bonds also exhibit large excess returns. A final contribution to existing work on the credit spread puzzle is that we also study a sample of European bond data, and show that a credit spread puzzle exists for European corporate bonds as well.

Finally, our paper is related to Campello, Chen, and Zhang (2004), who also use credit spread levels to construct expected returns. However, their focus is to obtain estimates for expected stock returns and they test the Fama and French (1993) three-factor asset pricing model using these expected stock returns. This procedure is related to Fama and French (2002) who advocate the use of dividend yields as a measure of expected returns for stocks, because these are less volatile than holding returns. For corporate bonds, this argument is even stronger as the yield is probably an even more accurate measure of expected bond returns than dividend yields are for expected stock returns. Campello, Chen, and Zhang also include an analysis of the relation between corporate bond yields and the Fama-French factors. They do not include liquidity in their analysis, though.

Upon completion of this paper, we became aware of recent independent work by Chacko (2005), Chen, Cheng, and Wu (2005) and Downing, Underwood, and Xing (2005), who also study the pricing of liquidity risk in credit markets. Chacko (2005) constructs a liquidity proxy that is based on the accessibility of a corporate bond, which is measured by the type of investors holding the bond (short-term versus long-term investors). He provides evidence that a portfolio that mimicks this liquidity measure carries a risk premium. Chen, Cheng, and Wu (2005) investigate liquidity effects for credit default swaps, using the quote updating frequency to proxy for liquidity. Applying a term structure approach, they provide some evidence for a liquidity risk premium . Downing, Underwood, and Xing (2005) use corporate bond transaction data to construct price impact measures, and show that a portfolio that mimicks illiquidity is priced in the cross-section of bond returns. Our work differs from these two papers in several dimensions. First, our liquidity risk factors represent systematic liquidity shocks in equity and government bond markets, which have been shown to carry a risk premium in these markets. Second, instead of using realized corporate bond returns, we use the credit spread level to construct expected bond returns. In section 3 we argue that this leads to more reliable estimates for expected returns. Third, we assess the implications of our results for the credit spread puzzle. Finally, we study both US and European markets.

3 Empirical Model and Data

Our empirical model follows the lines of Pastor and Stambaugh (2003), who estimate a linear model for equity returns with several factor mimicking returns, and shocks to a liquidity factor. Similarly, we assume a linear dependence of corporate bond returns on market risk factors and liquidity risk factors. For estimation, we employ a two-step procedure (similar to the traditional Black, Jensen and Scholes method). In the first step, factor loadings and liquidity beta's are estimated from an unrestricted multivariate regression of the excess holding returns of the corporate bonds on K_F market risk factors and K_L liquidity risk factors:

$$r_{it} = \alpha_i + \beta'_{F,i} F_t + \beta'_{L,i} \Delta L_t + e_{it}. \tag{1}$$

Here, r_{it} is the excess corporate bond return, α_i is a constant term, $\beta_{F,i}$ is a K_F vector containing the loadings on the market risk factors, and F_t is a K_F-dimensional vector with the market risk factors. Similarly, the model includes exposures $\beta_{L,i}$ (of dimension K_L) to changes in the liquidity factors ΔL_t. Finally, e_{it} represents a zero-expectation error term. In the second step, we run a cross-sectional regression of (estimates of) the expected excess returns on the estimated factor loadings:

$$\widehat{E}[r_{i,t}] = \widehat{\beta}_{F,i}\lambda_F + \widehat{\beta}_{L,i}\lambda_L + u_i, \quad i = 1, .., N \tag{2}$$

The K_L-dimensinal vector with regression coefficients λ_L represents the premia on liquidity risk in equity and government bond markets. Similarly, the K_F-dimensinal vector with regression coefficients λ_F represents the market risk premia.[4] In the next subsection, we describe how we obtain estimates for the expected excess returns in equation (2).[5] Standard errors are calculated using Shanken's (1992) formula based on the variance-covariance matrix of the estimated expected returns $\widehat{E}[r_{i,t}]$.

We include two market risk factors ($K_F = 2$), the equity market index return and the change in the implied volatility of equity index options, and two liquidity risk factors ($K_L = 2$), representing shocks to equity market and government bond market liquidity respectively. The choice of market factors is motivated by a theoretical

[4]Notice that, as in Pastor and Stambaugh (2003), this model does not include the liquidity level as a separate determinant of expected returns. Liquidity is only present as a risk factor.

[5]Pastor and Stambaugh (2003) use GMM for estimation. The main reason to use the two-step method in this paper, and not GMM, is that we do not use realized returns in the second step, but a credit spread-based estimate for expected returns.

firm value model. In the one-factor Merton (1974) model and subsequent extensions, the diffusive shocks in the firm values can be priced, and this effect is captured by including the equity index return as a risk factor. Note that in such a one-factor model equity index volatility varies over time, but this effect is fully driven by changes in the firm values. This is the so-called leverage effect. In these models, it suffices to include a single factor that captures changes in the firm value. It may however be that the firm value volatility is stochastic and driven by a second factor. In such a case, the equity index volatility will vary due to the leverage effect and due to the effect of the second factor, and corporate bond returns will have exposure to both factors. In particular, bond prices should decrease if firm value volatility increases. To capture the possible effect of the stochastic volatility factor, we include the change in the implied equity index volatility in our model. Including volatility is important for two reasons. First of all, changes in liquidity and volatility are often related, so that we need to control for volatility to estimate the effect of liquidity on prices. Second, several empirical studies on equity index options provide evidence that volatility risk is priced (Bakshi and Kapadia (2003)).

We now turn to a description of the data on corporate bond and equity returns, and the construction of the liquidity measures. The yield spread data that we use is measured at index level, grouped by credit rating and maturity, and not at the individual firm level. Under the assumption that shocks in market factors and liquidity equally affect corporate bonds with similar rating and maturity, this is as good as using individual bond data. If there is heterogeneity in the exposure to illiquidity and market factors, our beta estimates are averages of the effects within a category. The aggregation to the index level might remove some individual variation in exposures, but on the other hand will lead to much more reliable estimates of the beta's and hence less measurement error problems in the second stage regression (equation (2)). A drawback of the index-level data is that we cannot include expected liquidity in the model, because we don't have observations on corporate bond bid-ask spreads, turnover or other liquidity measures.

3.1 Constructing expected corporate bond returns

We focus on corporate bond data that are aggregated up to the rating and maturity level. To this end, we collect data from Datastream on Lehman corporate bond indices for US dollar denominated bonds. For the investment grade categories, which run from AAA to BBB, we use the 'intermediate maturity' indices and the 'long maturity' indices, which have average maturities of about 5 and 22 years, respectively. We also include three speculative grade indices, rated BB, B, and CCC. For these rating categories, we only use indices that cover the full maturity spectrum at once, because the 'Long Maturity' indices contain relatively few bond issues. The average maturities for bonds in these all-maturity indices are about 9 years (BB), 8 years (B), and 7 years (CCC). Finally, we also download information for intermediate-, long-, and all-maturity US Treasury bond indices.

For each index, we collect the following information: the yield-to-maturity (averaged across all issues in the index), the average maturity of all issues, and the number of issues in the given index. Our sample period runs from January 1993 until February 2002, and we use a monthly frequency for the data.[6] We construct a time series of credit spreads for each index by subtracting the appropriate government bond yield from the yield associated with the corporate bond index.

To construct estimates for expected corporate bond returns we adopt the following procedure. First, we approximate each corporate bond index by a discount bond that has the same duration as the corporate bond index.[7] Next, we use the following expression to calculate the expected return on a corporate discount bond with maturity τ

$$E[r_{t,\tau}] = [\pi_D(1-l) + (1-\pi_D)](1 + Y_{g,t} + S_t)^{\tau} - 1 \tag{3}$$

In equation (3), $r_{t,\tau}$ is the return on a corporate discount bond that matures at time $t+\tau$, π_D is the probability of default before time T, l is the loss rate in case of default, $Y_{g,t}$ is the time-t government discount rate with maturity date $t+\tau$, and S_t is the τ-maturity credit spread. Expression (3) assumes that default losses are incurred at maturity. Next, we annualize the expected return in equation (3) and subtract the annual expected return on a government discount bond (obtained by

[6] Before 1993, the speculative grade indices contain very few bond issues in some months.

[7] In order to calculate the duration of the corporate bond index, we assume that all issues in the bond index have the same maturity and coupon. Driessen (2004) reports an average coupon rate of 7.6% for a similar sample period. Using this coupon rate and the reported average maturity of each index, the durations can readily be calculated. On average, this results in durations of 4 years for the intermediate-maturity indices, 11 years for the long-maturity indices, and 6 years for the all-maturity indices.

setting the credit spread and default probability equal to zero in (3)). This gives us the annual expected corporate bond return in excess of the government bond return. Similar procedures for calculating expected corporate bond returns have been applied by Elton et al. (2001) and Campello et al. (2004).

We next describe how we use equation (3) to obtain empirical estimates of the expected excess corporate bond returns. First, we use S&P data on historical default rates to estimate the default probabilities π_D. These data are based on a 1985-2003 sample period. Table 1 shows these cumulative default rates for several maturities. This table illustrates the well-known stylized fact that high-rated firms (AAA to A) have very low default rates. For lower-rated firms, default risk quickly becomes more important. We use these data to estimate π_D for each bond index duration T. As S&P provide cumulative default rates with annual intervals, and since the durations of the bond indices are not integers, we interpolate between the appropriate annual cumulative default rates. As in Elton et al. (2001), we use historical loss rates reported in Altman and Kishmore (1998), which vary from 32% for AAA-rated firms to 62% for CCC-rated firms. Finally, in each month of our dataset we observe government bond yields and credit spreads, so that each month we can construct an estimate for the expected return using equation (3). For each index, we take the time-series average of these expected return estimates to obtain an estimate for the unconditional expected return.

Figure 1 contains the results of the procedure described above. First of all, figure 1 contains the average credit spread for each bond index. The graph shows that even high-rated bonds have credit spreads of at least 50 basis points, while speculative-grade bonds have credit spreads between 3% (BB) and 10% (CCC). Second, figure 1 contains the expected excess corporate bond returns (from equation (3)), and the expected loss in terms of returns, defined here as the difference between the credit spread and the expected excess return. The graph shows that the credit spread level tracks the shape of the expected loss across ratings, but there is clear evidence for a positive expected excess return, as indicated by the solid line in figure 1. The expected return increases with the credit risk, and varies from about 50 basis points for AAA-rated bonds to 256 basis points for CCC-rated bonds. This figure also illustrates the credit spread puzzle: for investment grade bonds, actual default risk is extremely small relative to the observed credit spread. In addition, speculative-grade bonds also have high expected excess returns. As discussed earlier, this motivates our study of liquidity risk premia for corporate bonds.

These estimates can be compared with estimates obtained by Elton et al. (2001) and Campello et al. (2004), who use similar, but slightly different methodologies to estimate expected returns. Table 2 compares the different estimates and shows first of all that our expected return estimates are slightly higher than those of Elton et al. for the AA, A, and BBB rating categories. Campello et al. also report lower estimates compared to ours, which is however due to the fact that they correct their estimates for a 4% tax rate. Elton et al. (2001) and Driessen (2005) show that the impact of such a tax rate is between 30 and 35 basis points. If we would add back this tax effect to the estimates of Campello et al., their estimates would be slightly higher than ours. In the next section, we include this tax effect as a robustness check.

Finally, we follow Elton et al. (2001) in constructing the part of corporate bond holding returns that is driven by credit spread changes. We use the duration approximation to obtain a monthly time series of these returns, multiplying the (negative of the) bond index duration with the monthly change in the credit spread of each bond index. The time series of these 'returns' will be used later to examine whether credit spread changes are exposed to systematic market and liquidity shocks, by calculating market and liquidity-beta's. This analysis is conservative in the sense that we do not incorporate any potential systematic variation in the time series of realized default losses.[8]

3.2 Equity market data

In our analysis, we incorporate two market risk factors. The first is the excess return on the US equity market, constructed as the value-weighted return on all NYSE, AMEX, and NASDAQ stocks, as provided on Kenneth French's website. In addition, we also incorporate a factor that captures changes in market volatility. To this end, we use data on the VIX index, provided by CBOE on their website. The VIX is an estimate of the expected 30-day risk-neutral volatility, as implied by S&P 500 option prices. Inspecting the correlations between the risk factors, we find a substantial

[8]More formally, our analysis assumes that default events are idiosyncratic, conditional upon the observed variation in default probabilities. Jarrow, Lando, and Yu (2005) show that this assumption implies that systematic credit spread variation is the only source of risk premia in corporate bond returns.

leverage effect for the US equity index: the correlation between equity index returns and the change in the volatility index equals -53%. We therefore orthogonalize the change in volatility with respect to the market index return by regressing the change in the VIX on the market return. The regression residuals represent leverage-corrected volatility changes. Hence, the volatility risk variable captures volatility risk in excess of the leverage effect.

We do not estimate the equity market risk premium. Instead, we consider several fixed levels for the equity premium. In each case, the chosen equity premium is multiplied with the equity market-beta to obtain the total contribution to the expected corporate bond return. We consider five values for the equity premium, ranging from 2% to 8% per year. Recently, Fama and French (2002) have argued that the historically observed average stock return, which typically ranges from 5% to 8%, are likely to be upward biased estimates of the ex-ante equity premium. Instead, using dividend yield information, they estimate the equity premium at about 4%. We will use this value as our benchmark case.

3.3 Construction of liquidity measures

We now discuss the construction of liquidity measures for the equity and treasury bond markets. For the equity market, we follow Acharya and Pedersen (2005) and use Amihud's illiquidity measure ILLIQ. A stock is defined to be liquid if large volumes can be traded without generating much price impact. Amihud (2000) suggest to estimate the price impact by the ratio of the absolute daily price change and the daily absolute trading volume, averaged over a number of days. This so-called ILLIQ measure for stock i in month t is estimated as follows

$$ILLIQ_{i,t} = \frac{1}{D_t} \sum_{d=1}^{D_t} \frac{|r_{i,t}^d|}{V_{i,t}^d} \tag{4}$$

where D_t denotes the number of trading days in month t, $r_{i,t}^d$ denotes the return on stock i in the d^{th} day of month t, and $V_{i,t}^d$ denotes the dollar trading volume for stock i in the d^{th} day of month t, as a percentage of the dollar market capitalization of the stock.

To construct this measure, we use daily Datastream data on equity returns, volume, and market capitalization for S&P 500 stocks, S&P Midcap 400 stocks, and

S&P Smallcap 600 stocks (again for the 1993-2002 sample period). For each stock we then construct a monthly ILLIQ time series. Figure 2 reports the time series of the monthly median ILLIQ for the three indices. The graph shows that smallcap stocks have the highest illiquidity. In most months, the S&P 500 stocks have the lowest ILLIQ median, although the liquidity-difference between midcap and largecap stocks decreases during the sample period. The figure also nicely illustrates the increase in illiquidity during the Russia/LTCM crisis. Overall, there seems to be a downward trend in illiquidity. Importantly, most of the monthly changes in the median ILLIQ seem to be common to smallcap, midcap, and largecap stocks. This is evidence for common or systematic liquidity shocks, in line with Hasbrouck and Seppi (2001) and Chordia, Sarkar, and Subrahmanyam (2003). Given our focus on systematic liquidity changes, we use a single liquidity measure for the entire equity market in our empirical analysis, obtained by simply taking the median of the ILLIQ measures across all 1500 stocks each month.

For the treasury bond market, we use data on the quoted bid-ask spread for long-maturity US treasury bonds. Fleming (2003) compares several liquidity proxies, such as trade size, quote size, the on-the-run/off-the-run spread, and the quoted bid-ask spread, and concludes that for government bonds the bid-ask spread is the most useful commonly available measure for assessing and tracking liquidity. In particular, the bid-ask spread is highly correlated with a more sophisticated price-impact measure (which is similar to the ILLIQ measure). Fleming (2001) reports bid-ask spreads for several treasury bonds. This series is available for the period January 1997 until March 2000. We use the data for the longest bond maturity available, 10 years, since we mainly focus on intermediate- and long-maturity corporate bonds in our analysis. Figure 3 contains the time series of the bid-ask spread for 10-year government bonds, and, for comparison, the average credit spread across all rating categories and maturities. This graph provides some first evidence that liquidity shocks influence the level of credit spreads. In particular, the Russia/LTCM crisis leads to an increase in both the bid-ask spread and the credit spread, but a positive relationship seems to be present at other times as well. In the next section we will present more formal evidence of this relationship.

4 Empirical Results for US Bonds

To obtain the exposure of bond returns to the risk factors, we regress the corporate bond returns, in excess of the government bond return, on the contemporaneous changes in our liquidity measures, the stock market index return and the monthly change in the volatility index using equation (1). The results in table 3 show that corporate bonds have a significant exposure to all factors, except to the orthogonalized volatility index. That is, there is no evidence that volatility risk plays a role for corporate bond index returns once we incorporate liquidity factors, the market index return and the leverage effect. In the remainder of the analysis we therefore drop the volatility index from our regressions. We also estimated the exposure of excess corporate bond returns to default-free interest rate changes, but we found only very small and generally insignificant coefficients. Therefore, we also don't include interest rates as a factor in our further analysis.

Table 4 presents the factor-beta's that are obtained if we leave out the volatility risk factor. The results show that corporate bonds have a strong and significant exposure to liquidity risk. First of all, all corporate bonds have a negative loading on the change in the equity market liquidity, the ILLIQ measure. The negative signs imply that when the illiquidity of the equity market increases, corporate bond prices fall, and credit spreads increase. In other words, when liquidity is low investors bid lower prices for corporate bonds. This relationship is significant for 10 out 11 portfolios at the 10% level, and for 9 out of 11 portfolios at the 5% level. In addition, the ILLIQ-beta is larger (more negative) for long-maturity bond portfolios and for lower-rated portfolios. To assess the economic impact of liquidity shocks in the equity market, we focus on a monthly shock in the ILLIQ measure of one standard deviation. We find that an increase in ILLIQ of one standard deviation implies a return on the A-rated long-maturity bond portfolio of 0.27%, which is substantial.

The exposure to liquidity shocks in the government bond market also turns out to be important. Again, all portfolios have a negative exposure to shocks in the bid-ask spread of government bonds. For 8 out of 11 portfolios this relationship is significant at the 10% level. A monthly one standard deviation shock in the bid-ask spread corresponds to a corporate bond return of 0.32% on the A-rated long-maturity bond portfolio, which is similar to the impact of the ILLIQ measure. Again, long-maturity and lower-rated bond portfolios have the strongest dependence on the liquidity measure.

All corporate bond portfolios have a positive (and mostly significant) exposure to market risk, proxied for by the equity index return. The market-beta's are relatively small for high-rated bonds. For example, AA-rated long-maturity bonds have a market-beta of 0.063, which is not very different from the results of Elton et al. (2001), who report a market-beta of 0.0912 for 10-year AA-rated bonds.[9] These low beta's can be explained by the fact that high-rated firms contain only a small amount of default risk, which makes these bonds relatively insensitive to systematic stock price changes. Given that the monthly standard deviation of the equity index returns equals 4.36%, a one standard deviation shock to the equity index value corresponds to a return on the A-rated long-maturity bond portfolio of 0.38%. This shows that the economic impact of liquidity shocks is close to the impact of systematic equity price changes. As expected, low-rated firms do have a higher stock market exposure. For example, the B-rated portfolio has a stock market-beta of 0.292. In total, the two liquidity measures and the S&P 500 return explain a considerable part of the variation in corporate bond returns. Only for CCC-rated firms the R^2 is quite small. This is most likely due to the fact that the CCC-rated firms are more sensitive to firm-specific shocks. Across all portfolios however, the average R^2 is 42%. This is considerably higher than the R^2 reported by Elton et al. Regressing corporate bond returns on the three Fama-French factors, they report an average R^2 of about 17% across all portfolios. In sum, the results reported in table 3 provide strong evidence that returns on corporate bonds are correlated with market-wide fluctuations in the liquidity of both equity and government bond markets.

Table 5 reports the results of the cross-sectional expected return regressions from equation (2). We first consider a regression where only the equity ILLIQ-beta's are included on the right-hand side (in addition to the market-beta's), but not the government bond BAS beta. At a 4% equity premium, the estimate for the premium on changes in the ILLIQ measure is negative and significant. The negative sign implies that corporate bond portfolios with larger (i.e. more negative) ILLIQ-beta's have higher expected returns. In other words, investors that hold corporate bonds

[9]Across all rating categories, the market-beta's reported by Elton et al. (2001) are somewhat larger than our estimates. Since we also have liquidity risk factors in our regressions, while Elton et al. include book-to-market and size factors, some differences between the market-beta's may be expected.

that have a high exposure to equity market liquidity shocks are compensated for this risk by earning a higher expected return. The cross-sectional R^2 is 91.8%, so that the ILLIQ-beta's, together with the equity market-beta's, explain most of the cross-sectional variation in expected corporate bond returns. The cross-sectional R^2 equals 78.1% if we exclude the ILLIQ-beta's, which shows the incremental value of the risk premium on ILLIQ. This result is somewhat sensitive to the choice for the equity market risk premium, but table 5 shows that only for high levels of the equity premium (6% and 8%), the estimated liquidity risk premium is insignificant. Unreported results show that estimating the equity premium along with the liquidity risk premia in the cross-sectional regression gives an estimated equity risk premium of 2.52% per year, with a t-statistic of 0.75.

Next we estimate both the ILLIQ risk premium and the premium associated with changes in the bid-ask spread of government bonds. Given that both liquidity measures have similar beta-patterns (see tables 3 and 4), disentangling the two liquidity risk premia is difficult. Indeed, the correlation between the liquidity-beta's across corporate bond portfolios equals 74.7%. It is therefore not surprising that allowing for a risk premium on government bond liquidity leads to only a tiny increase in the cross-sectional R^2, from 91.8% to 92.1%. Despite this large positive correlation between the beta's of the two liquidity measures, in almost all cases negative estimates for both liquidity risk premia are obtained. The estimate for the government bond liquidity premium is significant in all cases, and the estimate hardly varies with the assumed equity premium. The ILLIQ-premium is not significant, and the estimated risk premium is somewhat smaller compared to the regression without the government bond liquidity premium. We also estimated a model with only the government bond BAS beta's and without the ILLIQ beta's. The estimated illiquidity risk premium (not reported) is somewhat larger than the one estimated in regression II, and the fit ($R^2 = 0.92$) is almost the same as for the model with both beta's included. Again, this is caused by the high correlation between the government bond BAS beta's and the ILLIQ beta's. For the remainder of the analysis and the graphs, we use the estimates from regression II in table 5 with both illiquidity measures included.

Our results can be nicely summarized by graphing the direct estimates of expected returns and comparing those with the model-implied expected returns. Figure 4 shows these patterns for the equity risk premium fixed at 4% per annum, and decomposes the premia on market risk and the two liquidity risk measures. The graph shows that market and liquidity risk premia contribute roughly equally to the total expected return. Even though our model generates considerable liquidity risk premia for most categories, the model still underestimates the level of expected returns for short-maturity, high-rated bonds.[10] For all other bond indices the model describes expected returns quite accurately. Figure 5 graphs the market risk premium and ILLIQ risk premium per category for the case where the market risk premium is cross-sectionally estimated (at 2.52% per year). The fit of the model is almost the same, but the role of the market risk premium is smaller and the and illiquidity risk premium is somewhat bigger.

As a robustness check, we include a tax effect in our analysis. Elton, Gruber, Agrawal, and Mann (2001) argue that corporate bond coupons are taxed at the state level, while government bond coupons are not. In addition, a tax refund is obtained in case of default losses. This creates a spread between corporate and government bond yields.[11] To analyze the potential impact of this tax effect, we exactly follow the procedure described by Elton et al. We use an effective state tax rate of 4.875%, as reported by Elton et al., and a coupon rate of 7.6% (based on Driessen (2005)), to calculate the expected return on before-tax corporate bonds, in excess of government bonds. We then subtract these tax-generated excess returns from our direct estimates for the expected corporate bond returns from equation (3), and re-estimate the liquidity risk premia, again using cross-sectional regressions. Figure 6 summarizes the results. The figure shows the fitted expected returns given the tax correction. The tax correction itself is largest for high-rated bonds. For these firms, the default probability is low and the main effect is the lower after-tax coupon rate. For low-rated firms with higher default probabilities, an opposing effect of taxes starts to play a role, due to the fact that default losses generate a tax refund. As a result, the total tax effect is essentially zero for CCC-rated bonds. In general, allowing for a tax effect leads to a fit that is better overall, and produces slightly lower estimates for the liquidity risk premia.

[10]Note that the average difference between the 'observed' and model-implied expected returns is not equal to zero, since we don't include an intercept in the cross-sectional regression.

[11]The tax argument is not uncontroversial. For example, Amato and Remolona (2004) argue that, since state tax rates vary across states, it is not obvious what the average marginal tax rate for US investors is.

5 Results for European Corporate Bonds

In this section we perform a robustness check on the results presented above, by analyzing a sample of corporate bond indices from the countries in the Euro zone. This market has emerged since the introduction of the Euro in 1999 and has grown substantially over the years. Our main interest is to analyze whether European corporate bond returns have an exposure to shocks in liquidity. Given the relatively short sample period, it will be difficult to precisely estimate the liquidity risk premium, but as we shall show, the main results of the US analysis also hold for the European data.

5.1 Return and Liquidity Measures

The construction of European (expected) corporate bond returns and liquidity measures is performed in the same way as for the US data. The only difference with the US analysis is that we do not have access to aggregate data on government bond liquidity. We therefore focus on the measure for equity market liquidity.

The corporate bond data consist of Lehman Brothers Euro indices. For each rating category, we have data on indices that cover the entire maturity spectrum. For each index we observe the average credit spread over the all-maturity Lehman Brothers Euro government bond index and the duration of the corporate bond index. The durations of the indices are typically between 4 and 5 years. The data frequency is monthly, and the sample runs from August 2000 to December 2004. All bonds are Euro-denominated.

To estimate expected corporate bond returns we again use equation (3). Historical default rates are taken from Standard and Poor's (2004), who provide average multi-year default rates using a sample of European firms for the 1985-2003 period. Table 1 compares the default rates for Europe with the US rates at the 5-year horizon. It turns out that high-rated European firms have lower default rates, while low-rated European firms have higher default rates than US firms. Since we do not have information on loss rates across rating categories for European firms, we use the loss rates derived from US data.

Figure 7 contains the resulting estimates for the expected European corporate bond returns across ratings. The graph shows first of all that average credit spreads vary from 29 basis points for AAA bonds to almost 19% for CCC bonds. After correcting for the expected loss, the expected return varies from 29 basis points for AAA to 426 basis points for BB. In contrast to the US results (figure 1), the expected excess return is not entirely monotonic in the rating level, which reflects the shorter sample we have for Europe. Unreported results show that the expected return estimates are significant at the 5% level for all categories, except for the B and CCC categories, which are the exactly the ratings for which the nonmonotonic behavior occurs. Inspection of the credit spread time series reveals that the B and CCC credit spreads exhibit extremely large time series volatility, which may be partially due to the relatively low number of bond issues in the index. In contrast, the credit spreads of high rated bonds are quite stable over time. Overall, the expected European corporate bond returns are slightly lower than the US returns for high ratings, and slightly higher for low ratings. Despite these differences between the US and European estimates, these results clearly indicate that a similar credit spread puzzle exists for European bonds.

As before, we obtain an approximation of the time series of realized bond returns by multiplying the (negative of the) bond index duration with the monthly change in the credit spread of the index. The resulting time series of bond returns will be used to estimate the exposure to market risk, volatility risk, and liquidity risk. As proxy for the market return, we use monthly returns (in Euros) on the S&P Europe 350 index. Volatility risk is captured using data on the Dow Jones Euro Stoxx 50 Volatility Index (VSTOXX). This index presents an estimate for the one-month ahead risk-neutral volatility of the Dow Jones Euro Stoxx 50 index, obtained from prices of short-maturity options on this index.

We again use the ILLIQ measure to capture the liquidity risk of equity markets. We use daily Datastream data on equity returns, market capitalization and volume of all stocks in the S&P Europe 350 index in order to estimate a monthly ILLIQ value for each stock. As before, we calculate the median across all stocks to obtain a monthly market-wide liquidity level. Figure 8 plots the time series of this market-wide ILLIQ level, along with the credit spread (averaged across all ratings). The striking relationship in the graph gives some first informal evidence that liquidity changes and credit spreads are related. For example, in September 2001 both credit spreads and equity market illiquidity increase substantially.

5.2 Empirical Results

In a first step, we assess the exposure of corporate bonds to market, volatility, and liquidity risk by regressing corporate bond returns on the S&P 350 index return, the monthly change in the VSTOXX level, and the monthly change in the ILLIQ level. The leverage effect for the European equity market is even larger than in the US: the correlation between equity index returns and the change in the VSTOXX equals -84%. We therefore again orthogonalize the change in the volatility with respect to the market index return. Table 6 presents the exposures to the risk factors. We find a mostly significant exposure to market risk, which is increasing as the rating decreases. The exposure to volatility risk is negative and more so for lower ratings. It is significant at the 5% level for 2 out of 8 indices. Finally, we find a negative exposure to liquidity risk that becomes monotonically more negative as the rating decreases, and is significant at the 5% level in 4 out of 8 cases. These results are quite similar to the US results. The market and liquidity risk exposures are slightly smaller for high ratings and somewhat larger for lower ratings, which is line with the difference between expected returns for the US versus Europe. The main difference is that there is some evidence for volatility risk exposure for the European sample. The economic effect of volatility risk is however moderate: the average R^2 decreases from 30.2% to 26.7% if we exclude volatility risk. For comparison, if we exclude the liquidity measure the average R^2 decreases to 24.2%. Given the mild economic and statistical significance of volatility risk, and multicollinearity with the liquidity risk exposures, we will not incorporate the volatility factor in our cross-sectional regressions. Table 7 reports the market and liquidity exposures for the model without volatility risk.

Next, we turn to the results of the cross-sectional regression of expected returns on market and liquidity beta's. This analysis should be considered as explorative, since we have a rather short sample to estimate expected returns. We again consider several levels for the equity premium.[12] Not surprisingly, table 8 shows that the statistical significance of the liquidity risk premium estimate is relatively small. Still, the estimated liquidity premium is negative for all equity premium levels, in line with the results for the US. Thus, European bond indices with high liquidity risk have high expected returns to compensate for this risk. Relative to the US, the estimated liquidity risk premium is somewhat smaller for Europe. Figure 9 gives a

[12]The average equity index return over the European sample period is actually negative.

decomposition of the model-implied expected return, and shows that the liquidity risk premium is negligible for high-rated bonds, while it is considerable for speculative-grade bonds. For high-rated bonds the market beta is small, so that a significant part of the expected return on these bonds remains unexplained. For speculative-grade bonds a very significant part of the credit spread puzzle can be explained.

In sum, this section has shown that systematic shocks in equity market liquidity have a significant impact on European bond prices, even if we control for market and volatility risk. In addition, we have provided some first, preliminary evidence for the existence of a liquidity risk premium in European corporate bond markets.

6 Conclusion

In this paper, we investigated liquidity risk as a determinant of expected returns on corporate bonds. The modeling approach is to treat liquidity as a risk factor, where the exposures of corporate bond returns to liquidity shocks are priced. We include two types of liquidity exposure, one to equity market liquidity and one to treasury bond market liquidity. First of all, we show that corporate bond returns have a significant exposure to the liquidity factors, even if we control for market and volatility risk. In addition, the liquidity factors contribute significantly to the expected return on corporate bonds. In terms of expected returns, the estimated liquidity premium is around 0.45% for long-maturity investment grade bonds, and around 1% for below investment grade bonds. Together with the market risk premium, the liquidity premium explains a significant part of the credit spread puzzle. Only for short-maturity, high-rated bonds our model underestimates the expected excess returns. We validate our US results by studying a recent sample of European bond data. European bonds also appear to exhibit a credit spread puzzle. In line with the US results, we find that European corporate bonds have a significant exposure to liquidity shocks, which helps to explain the expected bond returns.

An important extension of this paper would be to combine our model for liquidity risk premia with the impact of expected corporate bond liquidity. Such an analysis would require detailed information on, for example, bid-ask spreads of individual corporate bond issues. It would also be interesting to allow for priced jump risk in this model. As shown by Cremers et al. (2005), priced jump risk has a strong effect on high-rated short-maturity bonds and a relatively smaller effect on long-maturity bonds. Together with the effect of expected liquidity, priced jump risk may help to explain expected corporate bond returns across ratings and maturities.

References

[1] Acharya, Viral V. and Lasse Heje Pedersen (2005), Asset Pricing with Liquidity Risk, Journal of Financial Economics, 77(2), 375-410.

[2] Altman, E., and V. Kishmore (1998), Defaults and Returns on High-Yield Bonds: Analysis through 1997, NYU Salamon center working paper.

[3] Amato, Jeffrey and Eli Remolona (2003), The Credit Spread Puzzle, BIS Quarterly Review, 51-63.

[4] Amihud, Yakov (2002), Illiquidity and stock returns: cross-section and time-series effects, Journal of Financial Markets 5, 31-56.

[5] Amihud, Yakov and Haim Mendelson (1986), Asset pricing and the bid-ask spread, Journal of Financial Economics 17, 223-249.

[6] Amihud, Yakov and Haim Mendelson (1991), Liquidity, maturity, and the yields on U.S. Treasury securities, Journal of Finance 46, 1411-1425.

[7] Bakshi, Gurdip, and Nikunj. Kapadia (2003), Delta Hedged Gains and the Negative Volatility Risk Premium, Review of Financial Studies 18, 527-566.

[8] Bekaert, Geert, Campbell Harvey, and Chistian Lundblad (2005), Liquidity and Expected Returns: Lessons from Emerging Markets, working paper, Indiana University.

[9] Blanco, R., S. Brennan, and I.W. Marsh (2004), An empirical analysis of the dynamic relationship between investment grade bonds and credit default swaps, Journal of Finance, forthcoming.

[10] Brennan, Michael J., and Avanidar Subrahmanyam (1996), Market Microstructure and Asset Pricing: On the Compensation for Illiquidty in Stock Returns, Journal of Financial Economics 41, 441-464.

[11] Campello, M., L. Chen, and L. Zhang (2004), Expected Returns, Yield Spreads, and Asset Pricing Tests, Working paper, University of Illinois at Urbana-Champaign.

[12] Chacko, George (2005), Liquidity Risks in the Corporate Bond Markets, working paper Harvard Business School.

[13] Chakravarty, S., and A. Sarkar (1999), Liquidity in US Fixed Income Markets: A Comparison of the Bid-Ask Spread in Corporate, Government and Municipal Bond Markets, Working Paper, Purdue University.

[14] Chen, Ren-raw, Xiaolin Cheng, and Liuren Wu (2005), Dynamic Interactions Between Interest Rate, Credit, and Liquidity Risks: Theory and Evidence from the Term Structure of Credit Default Swap Spreads, working paper, Rutgers University.

[15] Chen, L., D.A. Lesmond and J. Wei (2004), Corporate Yield Spreads and Bond Liquidity, Working Paper.

[16] Chordia, Tarun, Richard Roll and Avanidhar Subrahmanyam (2000), Commonality in liquidity, Journal of Financial Economics 56, 3-28.

[17] Chordia, Tarun, Richard Roll and Avanidhar Subrahmanyam (2001), Market liquiidty and trading activity, Journal of Finance 52, 501-530.

[18] Chordia, Tarun, Asani Sarkar and Avanidhar Subrahmanyam (2003), An Empirical Analysis of Stock and Bond Market Liquidity, Working paper, Emory University, forthcoming Review of Financial Studies.

[19] Collin-Dufresne, Pierre, Richard Goldstein and Jean Helwege (2003), Is Credit Event Risk Priced? Modeling Contagion via the Updating of Beliefs, working paper, University of California, Berkeley.

[20] Cremers, Martijn, Joost Driessen, Pascal Maenhout, and David Weinbaum (2005), Explaining the Level of Credit Spreads: Option-Implied Jump Risk Premia in a Firm Value Model, Working paper, Yale University.

[21] Delianedis, Gordon, and Robert Geske (2001), 'The Components of Corporate Credit Spreads: Default, Recovery, Tax, Jumps, Liquidity, and Market Factors', Working Paper, UCLA.

[22] Downing, C., S. Underwood, and Yuhang Xing(2005), Is Liquidity Risk Priced in the Corporate Bond Market?, working paper Rice University.

[23] Driessen, Joost (2005), Is Default Event Risk Priced in Corporate Bonds?, Review of Financial Studies, 18, 165-195.

[24] Elton Edwin J., and T.C. Green (1998), Tax and Liquidity Effects in Pricing Government Bonds, Journal of Finance 53 (5), 1533-1562.

[25] Elton E.J., M.J. Gruber, D. Agrawal, C. Mann (2001), 'Explaining the Rate Spread on Corporate Bonds', Journal of Finance, 56, 247-277.

[26] Fama, Eugene F., and Kenneth R. French (1993), Common risk factors in the returns on stocks and bonds, Journal of Financial Economics, 33, 3-56.

[27] Fama, Eugene F., and Kenneth R. French (2002), The equity premium, Journal of Finance, 57 (2), 637-659.

[28] Fleming, Michael (2001), Measuring Treasury Market Liquidity, Federal Reserve Bank of New York Staff Reports No. 133, July 2001.

[29] Fleming, Michael (2003), Measuring Treasury Market Liquidity, Federal Reserve Bank of New York Economic Policy Review, 9 (3), 83-108.

[30] Glosten, Lawrence, and Lawrence Harris (1988), Estimating the components of the bid/ask spread, Journal of Financial Economics, 21, 123-142.

[31] Goldreich, David, B. Hanke, and P. Nath (2003), The Price of Future Liquidity: Time-Varying Liquidity in the US Treasury Market, CEPR Discussion Paper 3900.

[32] Hasbrouck, Joel (2003), Trading Costs and Returns for US Equities: The Evidence from Daily Data', Working paper, New York University.

[33] Hasbrouck, Joel and Duane Seppi (2001), Common factors in prices, order flows, and liquidity, Journal of Financial Economics 59, 383-411.

[34] Huang, Jing-Zhi, and Ming Huang (2003), How Much of the Corporate Treasury Yield Spread is Due to Credit Risk?, Working Paper, Penn State University.

[35] Houweling, Patrick, Albert Mentink, and Ton Vorst (2003), How to Measure Corporate Bond Liquidity?, Working Paper, Erasmus University Rotterdam.

[36] Janosi, T., R. Jarrow, and Y. Yildirim (2002), Estimating Expected Losses and Liquidity Discounts Implicit in Debt Prices, The Journal of Risk, 5(1).

[37] Jarrow, Robert, David Lando, and Fan Yu (2005), Default Risk and Diversification: Theory and Empirical Implications, Mathematical Finance, 15(1), 1-26.

[38] Krishnamurthy, Arvind (2002), The bond/old-bond spread, Journal of Financial Economics 66, 463-506.

[39] Liu, S., H. Qi, and C. Wu (2004), Taxes, Default Risk and Corporate Bond Yield Spreads: A Structural Approach, Working paper, Youngstown University.

[40] Longstaff, Francis, Sanjay Mithal and Eric Neis (2005), Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit-Default Swap Market, Journal of Finance 60(5), 2213-2253.

[41] Odders-White, Elisabeth and Mark Ready (2003), Credit Ratings and Stock Liquidity, Working paper, University of Wisconsin.

[42] Pastor, Lubos and Stambaugh, Robert F. (2003), Liquidity Risk and Expected Stock Returns. Journal of Political Economy, 111, 642-85.

[43] Perraudin, William, and A. Taylor (2003), Liquidity and Bond Market Spreads, Working paper, Bank of England.

[44] Piqueira, Natalia S. (2004), Stock Returns, Illiquidity Cost and Excessive Trading Activity, unpublished manuscript, Princeton University.

[45] Sadka, Ronnie (2004), Liquidity Risk and Asset Pricing, working paper University of Washington.

[46] Shanken, Jay (1992), On the Estimation of Beta Pricing Models, Reviwe of Financial Studies 5, 1-33.

[47] Strebulaev, Ilya (2002), Liqudity and Asset Pricing: Evidence from the U.S. Treasury Securities Market, Working Paper London Business School.

Table 1: Historical Cumulative Default Rates

The table contains historical estimates of cumulative default probabilities by rating category, based on S&P data for 1985-2003.

	US: 5 Years	US: 10 Years	US: 15 Years	Europe: 5 Years
AAA	0.10%	0.48%	0.65%	0.0%
AA	0.31%	0.94%	1.45%	0.0%
A	0.65%	1.95%	3.10%	0.3%
BBB	3.41%	6.93%	10.02%	2.3%
BB	12.38%	21.00%	24.57%	7.3%
B	26.82%	35.41%	40.56%	48.4%
CCC	53.00%	58.44%	61.58%	69.0%

Table 2: Estimated Expected Corporate Bond Returns

The table provides estimated for expected excess corporate bond returns across rating categories, as constructed from equation (3). For investment grade bonds, the intermediate-maturity index is reported. For comparison, estimates from Elton, Gruber, Agrawal and Mann (EGAW, 2001), for a 4-year maturity, and Campello, Chen and Zhang (CCZ, 2004) are also reported.

	AAA	AA	A	BBB	BB	B	CCC
This paper: US bonds	52 bp	67 bp	88 bp	111 bp	163 bp	199 bp	256 bp
EGAW (2001) Financial	-	45 bp	65 bp	99 bp	-	-	-
EGAW (2001) Industrial	-	61 bp	83 bp	103 bp	-	-	-
CCZ (2004)	46 bp	47 bp	61 bp	93 bp	105 bp	224 bp	-

Table 3: Corporate Bond Beta's: US Market

Using US data, the table reports regression coefficients and t-statistics (in square brackets), for a time-series regression of corporate bond returns on two liquidity measures, the stock market index return and the monthly change in the leverage-corrected volatility index (equation (1)).

	ILLIQ Beta (x100)	Gov-Bond BAS Beta (x100)	S&P 500 Beta	VIX Beta
AAA short-mat	-0.22 [-4.46]	-0.17 [-0.60]	0.013 [2.41]	-0.005 [-0.57]
AAA long-mat	-0.62 [-3.53]	0.77 [0.76]	0.028 [1.40]	-0.071 [-2.48]
AA short-mat	-0.10 [-1.54]	-0.74 [-2.00]	0.024 [3.28]	0.002 [0.02]
AA long-mat	-0.57 [-2.78]	-1.78 [-1.52]	0.063 [2.74]	-0.012 [-0.37]
A short-mat	-0.18 [-2.50]	-1.01 [-2.41]	0.036 [4.34]	-0.005 [-0.41]
A long-mat	-0.55 [-3.14]	-2.04 [-2.05]	0.088 [4.50]	-0.020 [-0.71]
BBB short-mat	-0.19 [-2.10]	-1.16 [-2.29]	0.044 [4.40]	0.001 [0.05]
BBB long-mat	-0.59 [-2.59]	-2.85 [-2.18]	0.111 [4.31]	-0.016 [-0.42]
BB	-0.77 [-2.41]	-5.28 [-2.90]	0.157 [4.38]	0.030 [0.57]
B	-1.61 [-3.28]	-5.58 [-2.00]	0.294 [5.35]	-0.087 [-1.05]
CCC	-1.63 [-1.75]	-3.91 [-0.74]	0.379 [3.65]	0.077 [0.51]

Table 4: Corporate Bond Beta's: US Market

Using US data, the table reports regression coefficients and t-statistics (in square brackets), for a time-series regression of corporate bond returns on two liquidity measures and the stock market index return (equation (1)).

	ILLIQ Beta (x100)	Gov-Bond BAS Beta (x100)	S&P 500 Beta	R^2
AAA short-mat	-0.21 [-4.47]	-0.20 [-0.73]	0.013 [2.44]	52.0%
AAA long-mat	-0.58 [-3.62]	0.27 [0.30]	0.027 [1.50]	27.6%
AA short-mat	-0.10 [-1.56]	-0.73 [-2.05]	0.024 [3.33]	37.8%
AA long-mat	-0.56 [-2.79]	-1.86 [-1.66]	0.063 [2.79]	42.6%
A short-mat	-0.18 [-2.48]	-1.05 [-2.57]	0.036 [4.40]	50.0%
A long-mat	-0.53 [-3.14]	-2.18 [-2.28]	0.088 [4.61]	52.3%
BBB short-mat	-0.19 [-2.13]	-1.16 [-2.35]	0.044 [4.47]	41.4%
BBB long-mat	-0.58 [-2.58]	-2.96 [-2.34]	0.111 [4.38]	46.3%
BB	-0.79 [-2.50]	-5.08 [-2.86]	0.167 [4.44]	50.4%
B	-1.55 [-3.24]	-6.19 [-2.30]	0.292 [5.45]	51.3%
CCC	-1.68 [-1.83]	-3.37 [-0.65]	0.381 [3.72]	9.9%

Table 5: Estimated Liquidity Risk Premia: US Market

The table reports estimates of liquidity risk premia, obtained from a cross-sectional regression of expected bond returns on liquidity-beta's (equation (2)). Market risk is accounted for by including the market-beta times the assumed equity premium (for which five different levels are chosen).

Equity Premium	Regression I	Regression II	
	ILLIQ	ILLIQ	Gov-Bond BAS
2%	-0.068 [-4.21]	-0.060 [-1.60]	-0.010 [-2.38]
3%	-0.056 [-3.45]	-0.045 [-1.20]	-0.010 [-2.31]
4%	-0.044 [-2.74]	-0.030 [-0.80]	-0.010 [-2.24]
6%	-0.022 [-1.32]	-0.000 [-0.00]	-0.009 [-2.09]
8%	0.002 [0.10]	0.029 [0.79]	-0.009 [-1.95]
Cross-sectional R^2 at 4% EP	91.8%	92.1%	

Table 6: Corporate Bond Beta's: European Market

Using European data, the table reports regression coefficients and t-statistics (in square brackets), for a time-series regression of corporate bond returns on two liquidity measures, the stock market index return and the monthly change in the leverage-corrected volatility index (equation (1)).

	ILLIQ Beta (x100)	S&P 350 Beta	VSTOXX Beta
AAA	-0.03 [-1.06]	0.004 [1.19]	-0.005 [-1.20]
AA	-0.03 [-0.68]	0.013 [3.20]	-0.007 [-1.42]
A	-0.26 [-2.27]	0.020 [1.61]	-0.011 [-0.73]
BBB	-0.55 [-3.08]	0.043 [2.25]	-0.052 [-2.17]
BB	-1.81 [-1.51]	0.387 [3.04]	-0.337 [-2.14]
B	-2.37 [-2.29]	0.224 [2.03]	-0.123 [-0.89]
CCC	-7.57 [-2.49]	0.491 [1.52]	-0.752 [-1.87]

Table 7: Corporate Bond Beta's: European Market

Using European data, the table reports regression coefficients and t-statistics (in square brackets), for a time-series regression of corporate bond returns on two liquidity measures and the stock market index return (equation (1)).

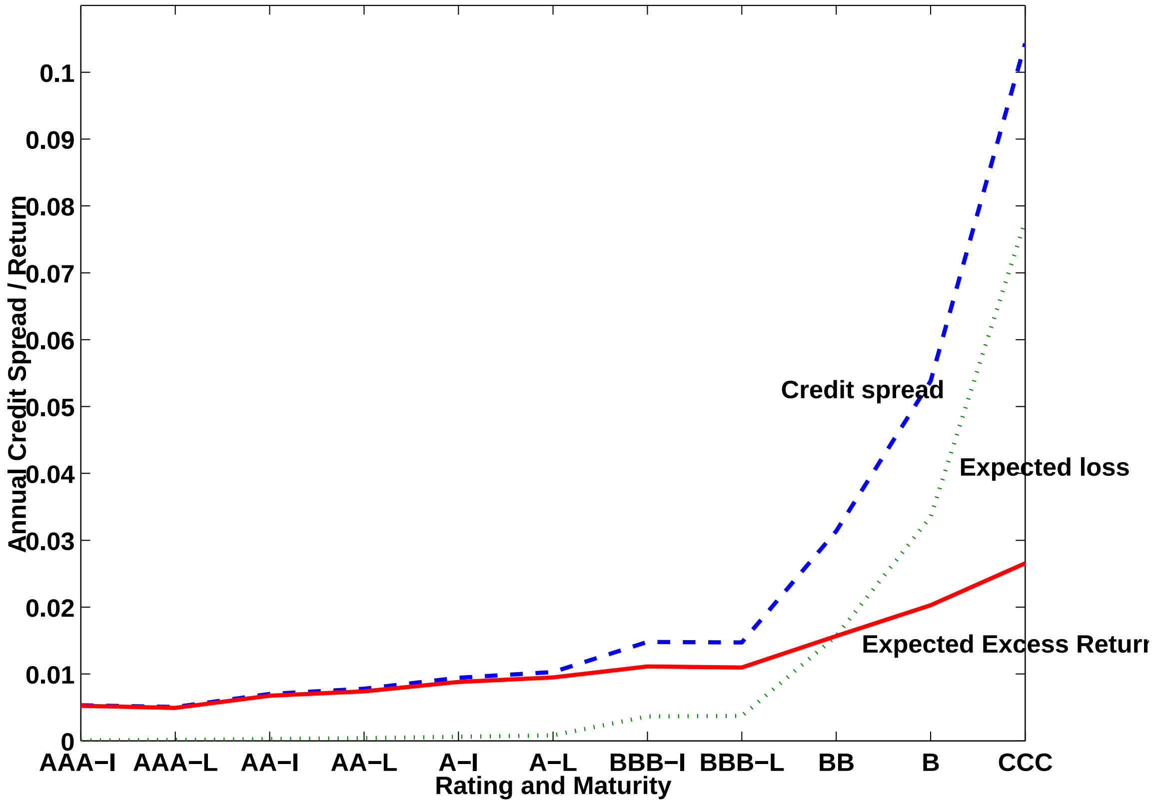
	ILLIQ Beta (x100)	S&P 350 Beta	R^2
AAA	-0.04 [-1.18]	0.004 [1.12]	10.3%
AA	-0.03 [-0.82]	0.013 [3.09]	26.8%
A	-0.27 [-2.37]	0.019 [1.59]	25.4%
BBB	-0.59 [-3.21]	0.041 [2.06]	37.7%
BB	-2.07 [-1.69]	0.372 [2.83]	31.0%
B	-2.46 [-2.40]	0.219 [1.99]	29.4%
CCC	-8.16 [-2.64]	0.458 [1.38]	26.4%

Table 8: Estimated Liquidity Risk Premia: European Market

Using European data, the table reports estimates of liquidity risk premia, obtained from a cross-sectional regression of expected bond returns on liquidity-beta's (equation (2)). Market risk is accounted for by including the market-beta times the assumed equity premium (for which five different levels are chosen).

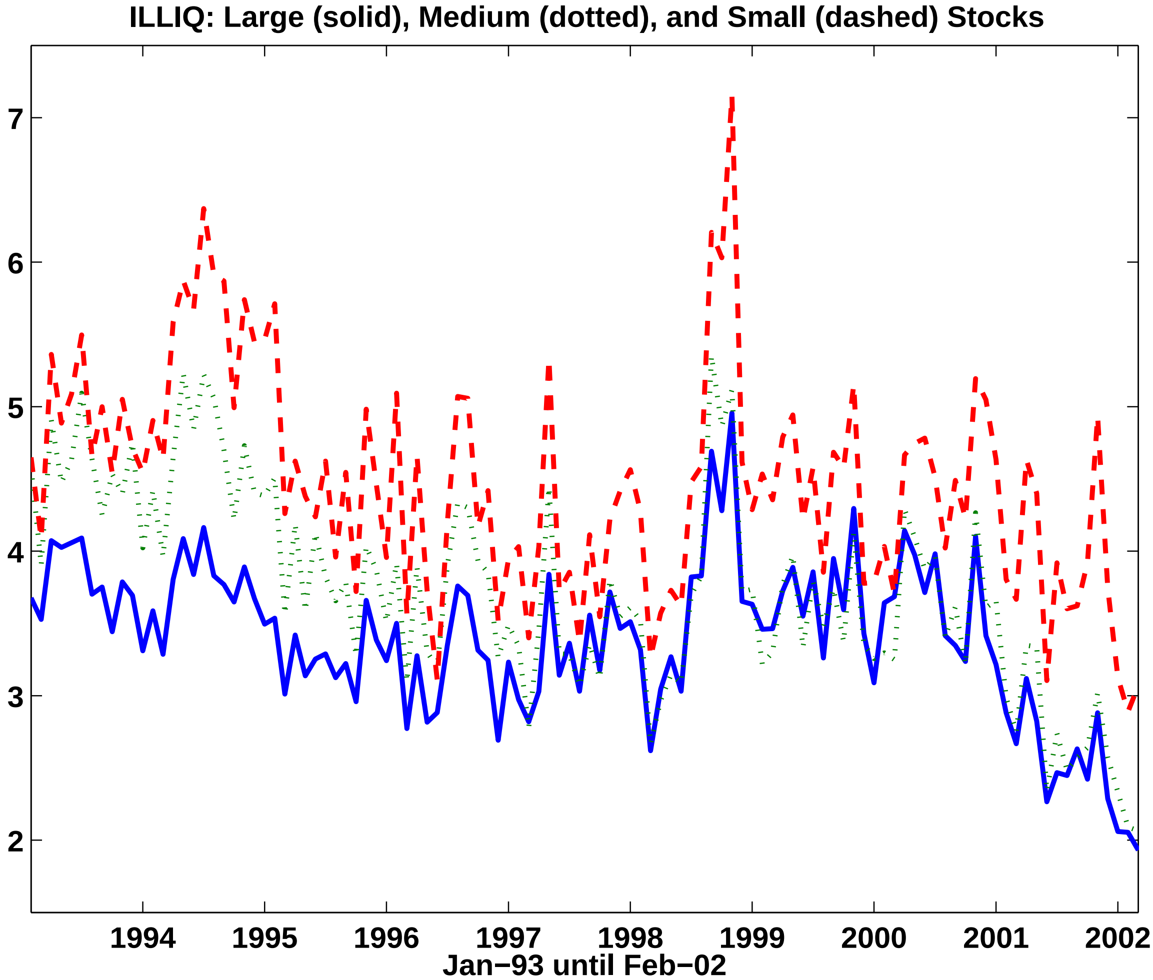
Equity Premium	Regression I ILLIQ
2%	-0.034 [-1.04]
3%	-0.029 [-0.88]
4%	-0.024 [-0.71]
6%	-0.013 [-0.38]
8%	-0.002 [-0.05]
Cross-sectional R^2 at 4% EP	79.5%

Figure 1: US credit spreads and expected returns



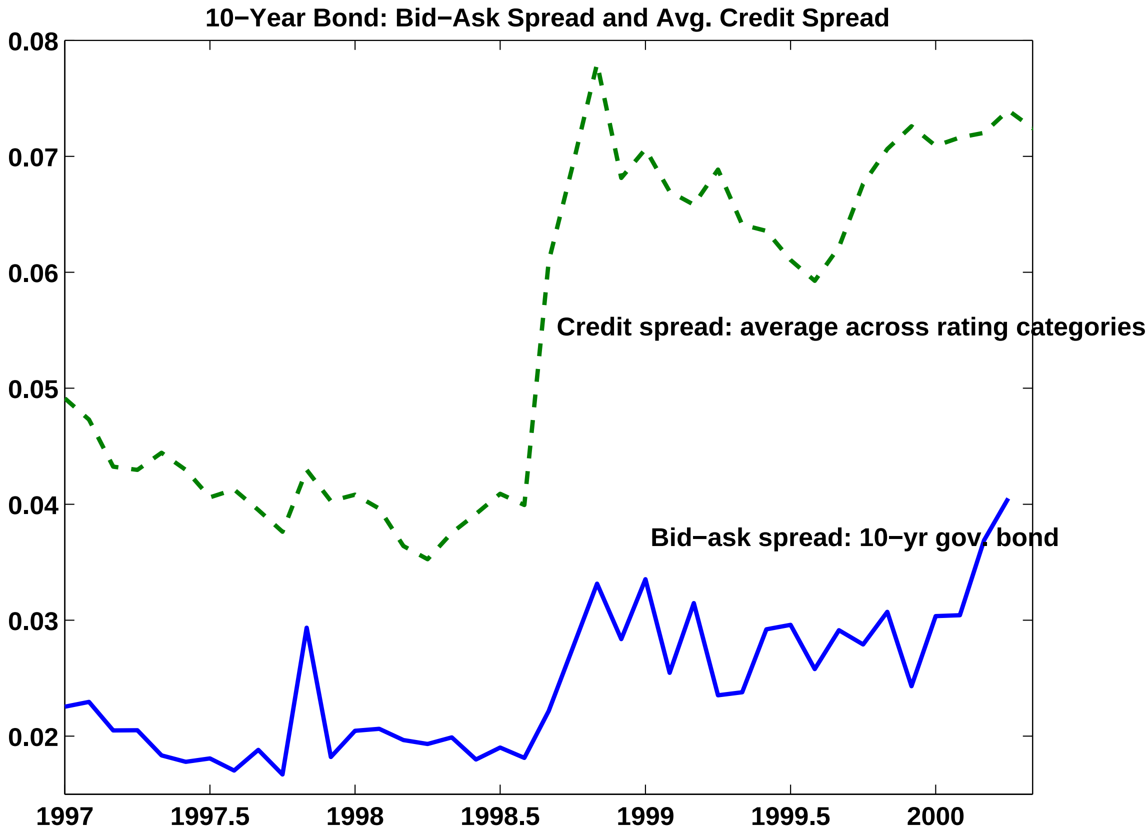
The graph depicts average credit spreads, expected bond returns (equation (3)), and the difference (expected loss) per rating and maturity category, for the US sample. "I" indicates the intermediate maturity category, and "L" the long maturity category.

Figure 2: Illiquidity measures for US equities



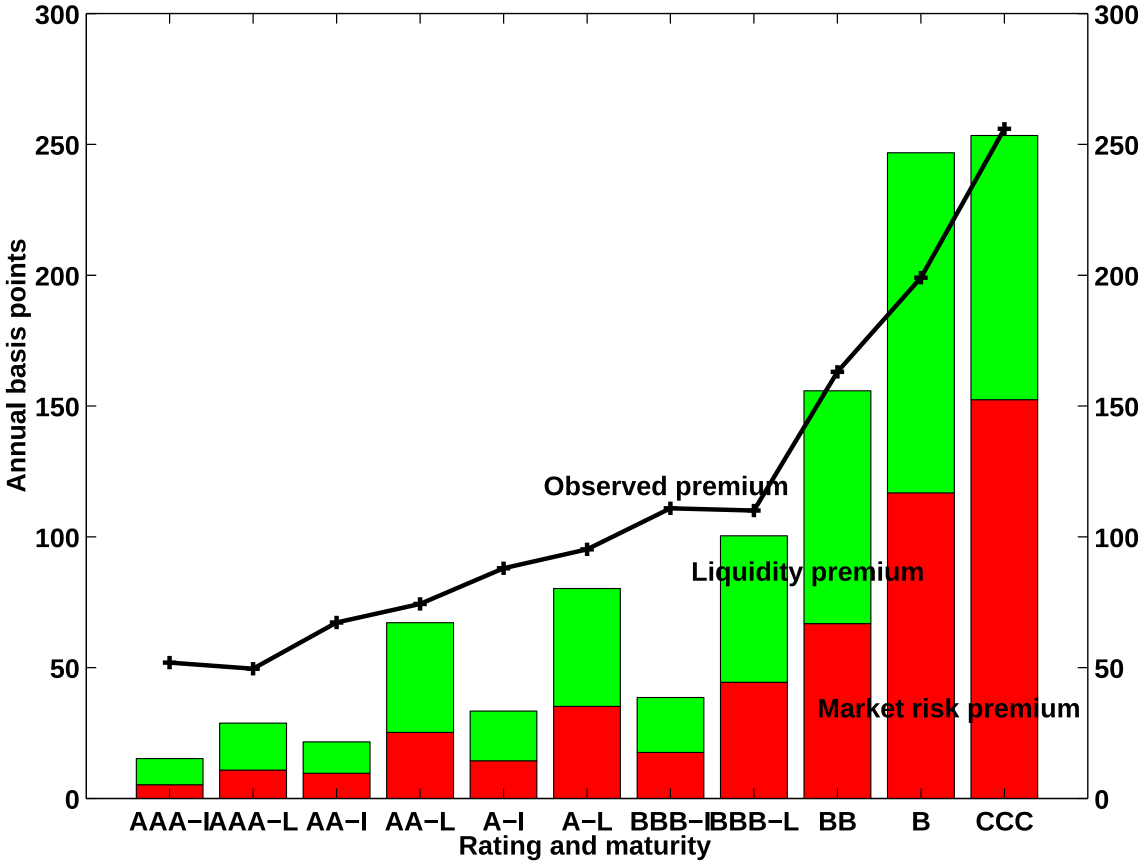
The figure reports the median ILLIQ across 600 smallcap stocks, 400 midcap stocks, and 500 large stocks, for the US sample.

Figure 3: Illiquidity measure for US government bond market and credit spread



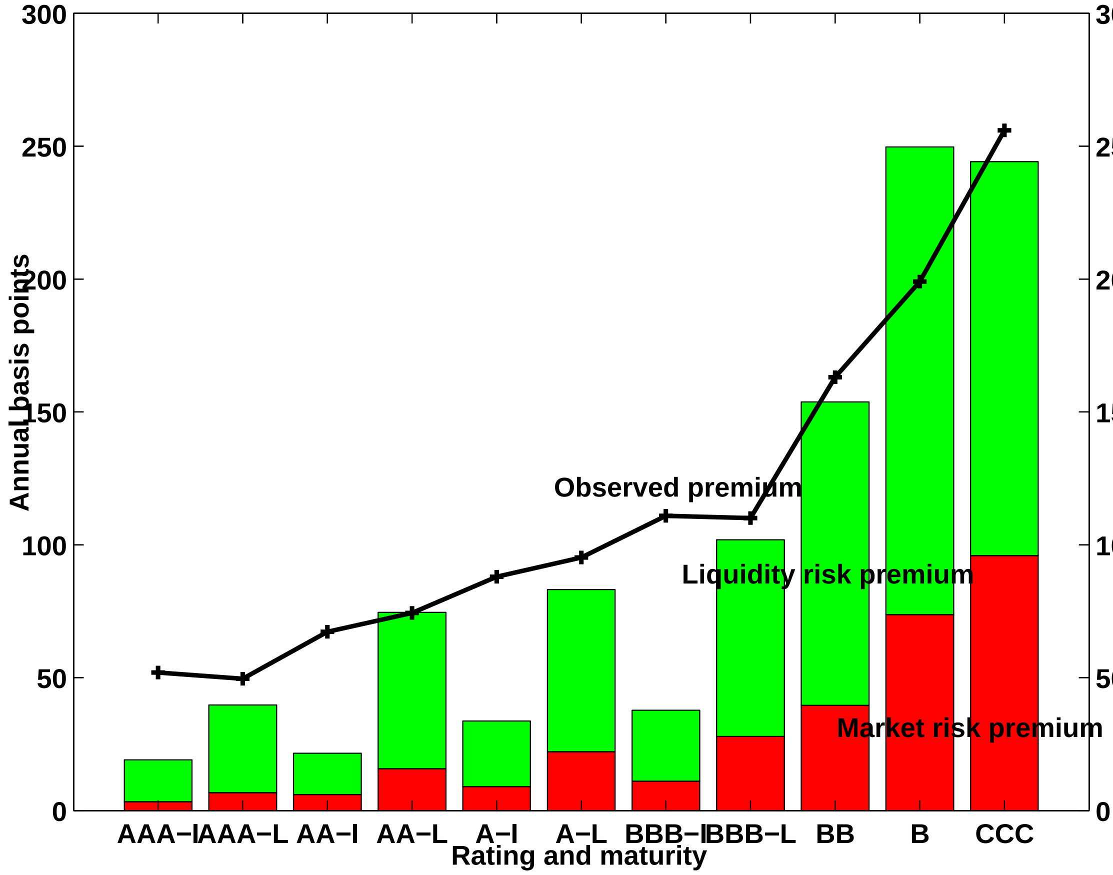
The graph shows the bid-ask spread on 10-year US government bonds, and, for comparison, the average credit spread across all US indices.

Figure 4: Expected US bond returns and model-implied values at 4% equity risk premium



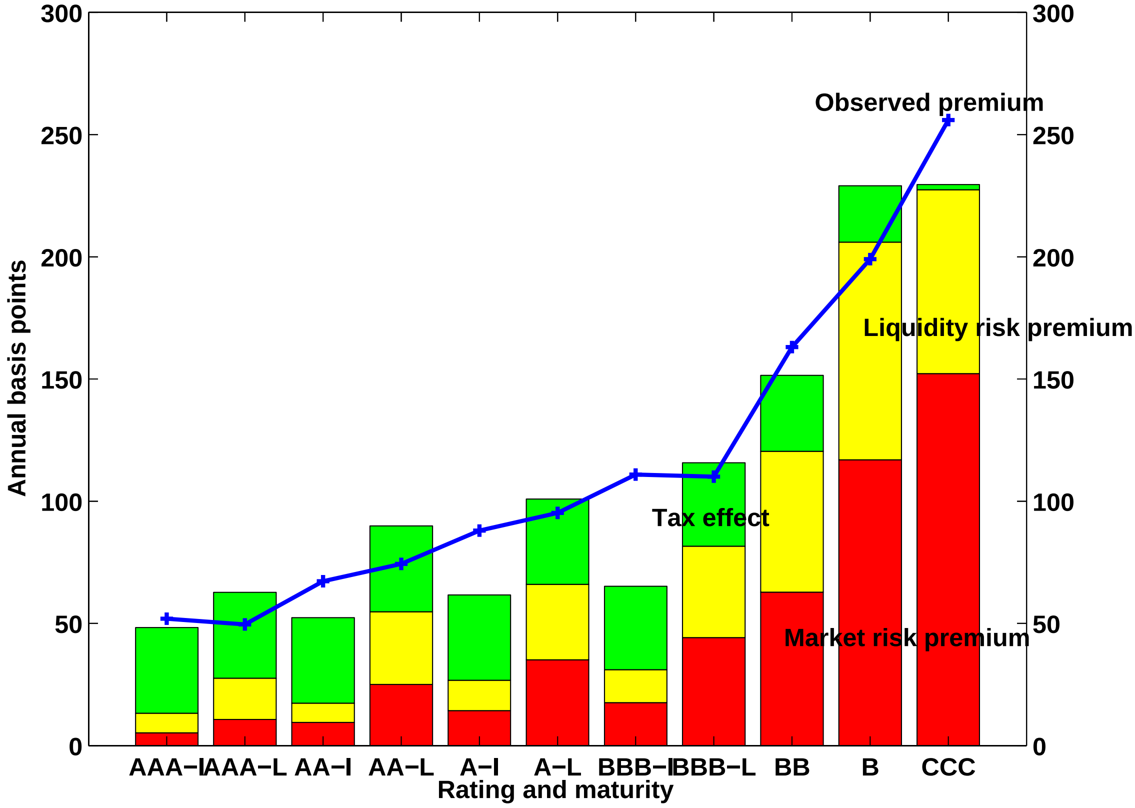
The graph shows the direct estimates of expected US bond returns (equation (3)), and model-implied values (equation (2)) calculated using regression II in table 5 with the equity market risk premium fixed at 4% per annum. The liquidity premium is the sum of the premia on equity and government bond market liquidity.

Figure 5: Expected US bond returns and model-implied values



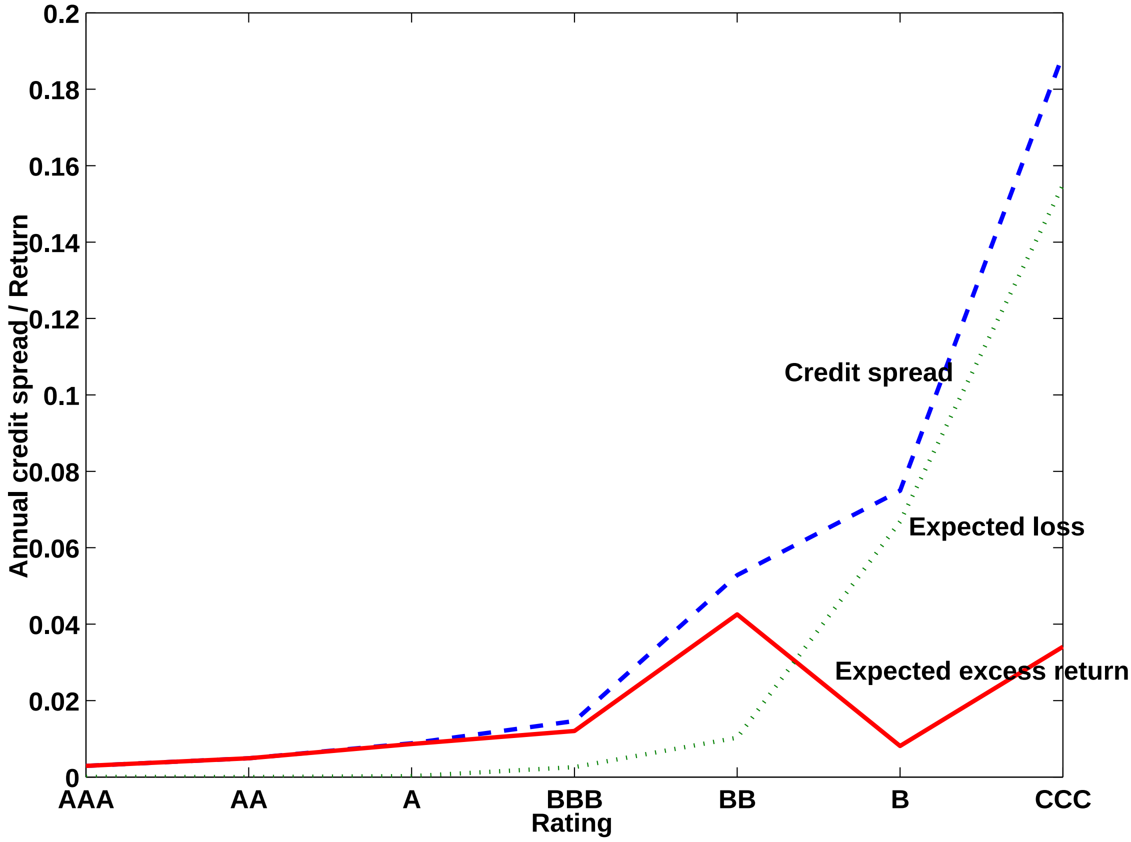
The graph shows the direct estimates of expected US bond returns (equation (3)), and model-implied values (equation (2)) calculated using regression II in table 5 with the equity risk premium as a free parameter. The liquidity premium is the sum of the premia on equity and government bond market liquidity.

Figure 6: Expected US bond returns and model-implied values with tax effect



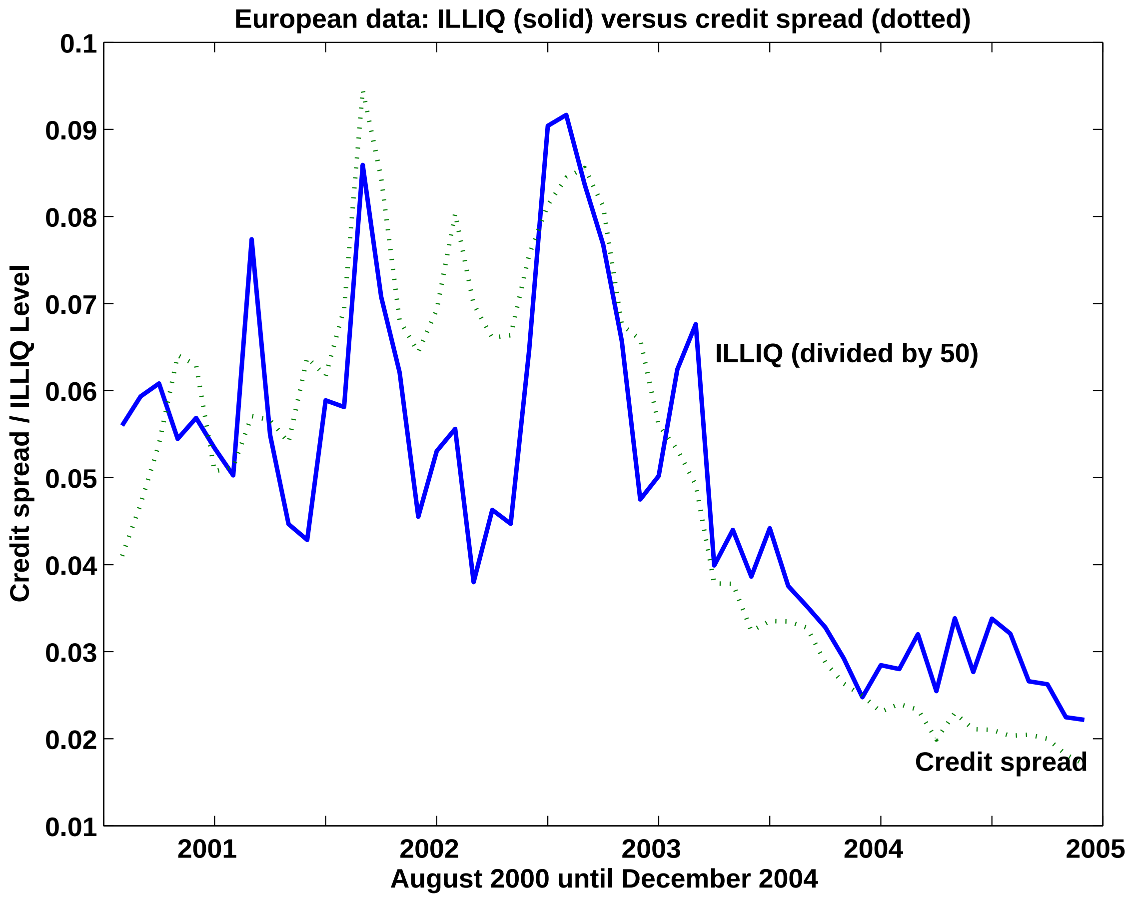
The graph shows the direct estimates of expected US bond returns (equation (3)), and model-implied values (equation (2)). A state tax rate of 4.875% is included. The liquidity premium is the sum of the premia on equity and government bond market liquidity.

Figure 7: Credit spreads and expected returns: European data



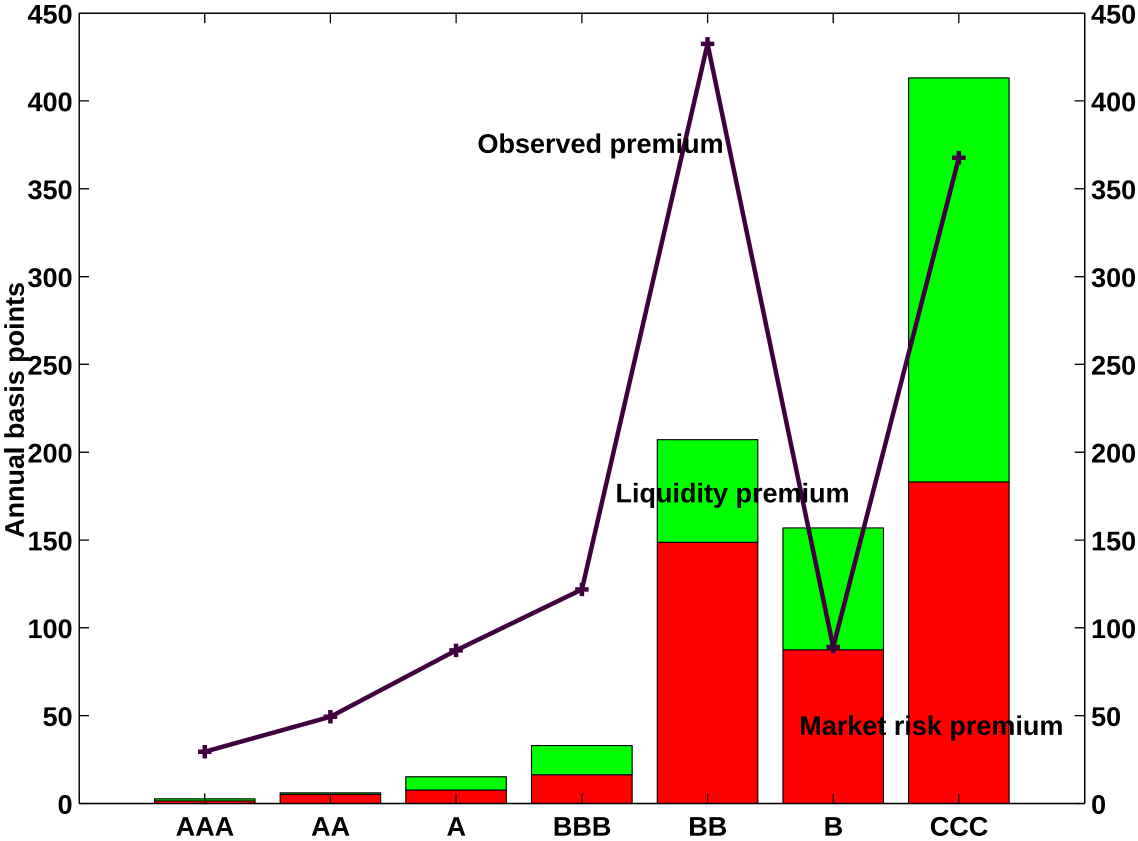
The graph depicts average credit spreads, expected bond returns (equation (3)), and the difference (expected loss) per rating and maturity category, for the European sample.

Figure 8: Illiquidity measure and credit spread: European data



The figure reports the median ILLIQ across 350 European stocks, and the average credit spread across all indices.

Figure 9: Expected bond returns and model-implied values: European data



The graph shows the direct estimates of expected European bond returns (equation (3)), and model-implied values (equation (2)) calculated using regression I in table 8. The liquidity premium is the sum of the premia on equity and government bond market liquidity.