# Determinant of Corporate Bond Yield Spread: Unconditional and Conditional Effect of Liquidity Premium

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## ABSTRACT

This paper investigates the unconditional and conditional effects of liquidity premium on corporate bond yield spread after controlling for default premium over the period of 2007-2010. Following Longstaff, Mithal, and Neis (2005), I utilize over 15,000 CDS premium data from 28 countries to estimate default premium and 199,000 corporate bonds to estimate liquidity premium. Results show that CDS data explains significant component of corporate yield spread. I proceed to find that unconditional effect of liquidity premium is significant and robust to the inclusion of Longstaff et al. (2005) default premium factor, while conditional effect loses robustness.

## 1. Introduction

Is liquidity exposure of corporate bond robust to different measures of default and liquidity? I investigate the robustness of unconditional and conditional liquidity exposures under Markov regime-switching model. Using the information of credit default swap, I propose direct measures of the size of default premium and liquidity premium. The results suggest that unconditional effects of liquidity remain robust to direct measure of default premium. Conditional liquidity exposures, on the other hand, are dependent on the choice of liquidity measure, which indicates loss of robustness.

Extensive literature suggests relation between illiquidity and asset price. Rise in illiquidity shock persists long enough to raise expected future illiquidity, thereby raising expected return as well. Amihud and Mendelson (1986, 1991) document effect of expected liquidity on expected returns. Increased expected return will consequently lower asset price, generating negative liquidity beta. Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005), and Sadka (2006) research these relations in stocks, and de Jong and Driessen (2007), and Lin, Wang, and Wu (2011) in corporate bonds. This paper confirms negative liquidity exposure in corporate bond market.

Documented relation between illiquidity and realized return, however, relies on indirect proxy of term structure premium, default premium, and liquidity premium. Examples of widely accepted proxies include yield difference between short-term and long-term Treasuries for term structure premium, return difference between portfolio of all corporate bonds and portfolio of Treasuries for default premium, and bid-ask spread of short-term

Treasuries for liquidity premium. Because these proxies are, by nature, indirect measure of risk premium, corresponding beta coefficients may be imprecise. Proxies of liquidity premium may suffer from greater ambiguity due to the innate elusiveness of liquidity.

This paper contributes to earlier literature of bond pricing with liquidity factor in two aspects. First, corporate bond yield spread is employed as dependent variable instead of bond return. Riskless yield is computed for each corporate bond, reflecting coupon rate, frequency, date, and maturity information. By deducting riskless yield from bond yield, term structure premium can be controlled effectively. Therefore regression of corporate yield spreads is expected to accommodate more precise liquidity exposure.

Second, I adopt Longstaff, Mithal, and Neis (2005) estimates of default and liquidity premium, which directly measure the size of respective risk premium. To quantify default premium and liquidity premium within corporate yield spread, I append CDS premium as supplementary source of information. As Longstaff et al. (2005) measures incorporate wider spectrum of information than conventional bond market factors, I expect more rigorous results from the regression of corporate yield spreads on these measures. Two terms, Longstaff et al. (2005) measure and direct measure, will be used interchangeably, hereafter.

Recent theoretical studies argued that market liquidity and its effects on asset returns are conditional to fluctuation in funding liquidity. Brunnermeier and Pedersen (2009) provide a model where financial intermediaries become capital constrained in adverse market condition and their funding illiquidity negatively affects market liquidity. This indicates that the documented relation between asset price and liquidity may encompass conditionality. Beber, Brandt, and Kavajecz (2008) also address time-varying liquidity and conditionality of liquidity on the state of market. In times of heightened market uncertainty (volatility), investors' propensity to favor liquid assets surges and bond prices grow increasingly dependent on liquidity factors. Acharya, Amihud, and Bharath (2013) study conditional effect of liquidity factor in corporate bond markets under Markov regime-switching model.

I follow Acharya, Amihud, and Bharath (2013) to investigate how robust the unconditional and conditional liquidity exposures are to the choice of default and liquidity measures. I include Longstaff et al. (2005) measures in bond pricing specification of Acharya, Amihud, and Bharath (2013). Main finding is that unconditional liquidity exposure of corporate bonds is indeed robust, while conditional liquidity exposure of corporate bonds is not. In my model, direct measure of default premium, *LAMBDA*, increases the precision of liquidity coefficient. In addition, Longstaff et al. (2005) measure of liquidity premium, *GAMMA*, holds superior efficacy over conventional bid-ask spread in explaining liquidity exposure.

The paper proceeds as follows. Section 2 summarizes previous literature on bond pricing and liquidity. Section 3 describes the corporate bond and CDS data and Longstaff et al. (2005) methodology. Section 4 and 5 present results of unconditional and conditional tests of liquidity risk, respectively. Section 6 concludes.

## 2. Literature review

A great extent of literature attempted to explain the determinants of the corporate bond yield. Earliest studies suggest term structure models, where default risk was perceived as a driving factor. Further empirical evidences have shown that term structure models are insufficient to explain the entirety of corporate bond yield spreads. Of the many factors proposed, liquidity is regarded as strong candidate of missing price determinant. Because corporate bond market is recognized as less liquid than equity, enthusiasm toward bond market liquidity is quite understandable (see Fisher, 1959).

Elusiveness of the liquidity concept, however, poses immense constraints in quantifying liquidity risk premium. Furthermore, Duffie and Singleton (1999) point out that disentangling default premium and liquidity premium from corporate yield spread, using bond data alone, is doubly troublesome. Acknowledging these difficulties, researches, more often than not, resort to liquidity proxies such as bid-ask spread instead.

Disentangling the risk premium of these two factors from yield spread requires additional information and credit derivative is a suitable source. Credit derivatives built upon corporate bonds are exposed to the same default risk and default premium as the underlying bonds. By utilizing shared default component within corporate bond and credit derivative prices, it is possible to infer the magnitude of the default premium. With default premium is sorted out, magnitude of liquidity premium can be disentangled from the corporate yield spread (see Lin, H., Liu, Wu, 2009). Longstaff, Mithal and Neis (2005) use the information in CDS to obtain direct measures of the size of the default and non-default components in corporate yield spreads. They also find that non-default component is strongly related to measures of bond-specific illiquidity. This suggests that liquidity premium of corporate bonds constitute majority of non-default component.

## 3. Data and methodology

Before this paper progress further into analysis, this section provides brief description of data collection and research methodology. Estimation process of default premium and liquidity premium closely follows Longstaff, Mithal, and Neis (2005) with only few distinctions.

All market quotes are collected DataStream at weekly interval from Jan, 2007 to Oct, 2010: price and yield (mid, bid, and ask) of corporate bonds and premium (mid, bid, and ask) of corporate CDSs. Subject countries include U.S., European Union (EU) countries, Switzerland, Norway, and Russia. Sample period is restricted from 2007 to 2010 due to data availability of DataStream CDS quotes.

Because DataStream does not provide any information of reference entity, each corporate CDS are matched against corporate bonds by issuer identity and issued market. The first, second, and third string of corporate bond issuer identity and CDS issuer identity is compared, word by word. When issuer identity and issued market of specific corporate bond and CDS match perfectly, I categorize them as fully-matched. When issued market matches perfectly and two out of 3 words of issuer identity match, bond and CDS are categorized as semi-matched. Assets excluded from fully- and semi-matched group are defined unmatched and are discarded from the sample.

S&P and Moody’s ratings on corporate bonds and CDSs are also collected from DataStream. From AAA to D for S&P and from Aaa to C for Moody’s, I assign credit score of 22 to 1, 22 being the best possible credit score. Assets with no ratings are assigned zero. When credit score of corporate bond does not equate with that of CDS, I prioritize bond score. Since S&P provides covers wider range of assets, I prioritize S&P score whenever credit scores of two agencies differs by more than 2 points.

I also compile data of constant maturity Treasuries (CMT) yield for 6-month, 1-year, 2-year, 3-year, 5-year, 7-year, and 10-year from the Federal Reserve, Treasury yield curve is constructed from these par rates using cubic spline algorithm to interpolate at semi-annual interval. Next, riskless spot rates from the Treasury curve are bootstrapped to compute riskless forward rates. I use straight-line linear interpolation of forward rates to build riskless discount curve can be built for all maturities.

Riskless discount curve is essential in this paper to generate riskless yield of individual corporate bond. Cash flow of each bond, coupon and nominal, are discounted using riskless discount curve to compute riskless bond price. Intuitively, only the term premium is factored in the riskless bond price. I then calculate the yield-to-maturity implied by the riskless bond price. I refer to this yield-to-maturity as riskless yield, hereafter. For each corporate bond, yield spread is defined as the difference between mid yield and computed riskless yield.

I employ Longstaff et al. (2005) methodology to estimate default premium and liquidity premium. Since the estimation procedure is standard, I do not provide detailed description.

One distinction with Longstaff et al. (2005) methodology must be addressed. To obtain yield spread of a firm at 5-year horizon, Longstaff et al. (2005) regresses individual bonds' yield spread on maturity and use the fitted value. For simplicity, I use average individual bonds' yield spread as the dependent variable.

## 4. Test of unconditional liquidity premium

In this section, I examine robustness of unconditional liquidity exposures. Corporate bonds with credit rating above BBB are categorized as investment- (*IG*), and those with rating below BB+ as speculative-grade (*JK*) portfolios.

### I. Validity of Longstaff et al. (2005) measures

As a first step, I propose unconditional test of liquidity exposure in order to validate Longstaff et al. (2005) measure of default premium (*LAMBDA*) as a supplementary control variable. Tests are specified as

$$SPR_{p,t} = \alpha_p + \beta_{D,p} DEF_t + \beta_{B,p} BILLIQ_t + \epsilon_{p,t}, \quad (1)$$

$$SPR_{p,t} = \alpha_p + \beta_{L,p} LAMBDA_t + \beta_{B,p} BILLIQ_t + \epsilon_{p,t}, \text{ and} \quad (2)$$

$$SPR_{p,t} = \alpha_p + \beta_{D,p} DEF_t + \beta_{L,p} LAMBDA_t + \beta_{B,p} BILLIQ_t + \epsilon_{p,t}, \quad (3)$$

where $p$ = *IG*, *JK*. For each investment- (*IG*) and speculative-grade (*JK*) bond portfolio, $SPR_{p,t}$ denotes the equally weighted corporate yield spread of the portfolio. *DEF* proxy bond market default factor, computed as the difference between equally weighted average of all corporate bond yields and one-year Treasury bond yield. *BILLIQ*, bid-ask spread of Treasuries with maturity less than 10 year, represents bond market illiquidity, bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from each CDS premium following Longstaff et al. (2005) methodology.

Specification (1) is similar to Acharya, Amihud, and Bharath (2013), confirming the effect of Treasuries bid-ask spread while controlling for term premium and default premium. Nuisances, however, emerge from the variable definitions and measurement. In lieu of bond yields, specifications (1), (2), and (3) study corporate yield spreads, $SPR_{p,t}$, to account for term premium. Corporate yield spread is calculated for individual bond by deducting riskless yield from bond yield. Moreover, Amihud (2002) measure of stock market liquidity is exempt in above specifications. Instead, I exploit information content of corporate CDS, measures in direct relation to bond market factors.

Table 2 summarizes the unconditional effect of bond market liquidity on corporate yield spread, after controlling for default factor. Column (1) of Panel A and B show liquidity exposures in spirit to Acharya, Amihud, and Bharath (2013). With default factor (*DEF*) defined at market-level, exposure of both *IG* and *JK* portfolio to liquidity factor (*BILLIQ*) is negative and significant. Moreover, yield spreads for *JK* portfolio show higher sensitivity to *BILLIQ* than do *IG* portfolio, consistent with findings of Acharya, Amihud, and Bharath (2013). During the sample period, yield spread of *JK* portfolio exhibits higher adjusted R-squared of 57% than *IG* portfolio.

Column (2) substitutes *DEF* with *LAMBDA* as default premium proxy, whereas column (3) describes combined effect of *DEF* and *LAMBDA*. Together with column (1), they suggest that conventional measure of default (*DEF*) is valid as a primary source of bond's default information and that Direct measure of default (*LAMBDA*) is equivalently valid as secondary source. When explained by *LAMBDA* and *BILLIQ*, adjusted R-squared of *IG* and *JK* portfolio in column (2) are mere 4% and 40%, respectively. Inclusion of *DEF* in column (3) greatly enhances the fitness of *IG* and *JK* portfolio by 23% and 31%, respectively. When explained by *DEF* and *BILLIQ*, adjusted

R-squared of *IG* and *JK* portfolio in column (1) are 26% and 57%, respectively. Inclusion of *LAMBDA* in column (3) enhances the fitness of *IG* and *JK* portfolio by 1% and 14%, respectively. Increase in adjusted R-squared is greater when *DEF* is added as a supplementary factor indicating that wider spectrum of information content within *DEF*. For *LAMBDA*, increase in adjusted R-squared is less prominent than *DEF*. Nonetheless, *LAMBDA* provides substantial increase of 14% in adjusted R-squared of *JK* portfolio even in face of *DEF* as a primary measure of default premium.

Now, I turn to the examination of default coefficients ($\beta_{D,p}$ and $\beta_{L,p}$) in column (1), (2), and (3). All 8 coefficients in Panel A and B are significant at 10% level, and 7 out of 8 coefficients are significant at 5% level. This implies validity of each factor in explaining time-series fluctuation of corporate yield spread. As suggested by negative coefficient of *DEF* in column (1) and (3) for both *IG* and *JK* portfolio, corporate yield spreads fall as Treasury bid-ask spread increases. Speculative-grade bonds are more sensitive to *DEF* than investment-grade bonds. Consistent with Acharya, Amihud, and Bharath (2013), coefficients of *LAMBDA* in column (2) and (3) are generally positive and significant, especially for *IG* portfolio. However, correlation between two default factors, *DEF* and *LAMBDA,* complicates the interpretation of overall effect of default.

As for the beta coefficients of *BILLIQ* ($\beta_{B,p}$) in column (1), (2), and (3), all 6 coefficients are statistically significant at 10% level. With the exception of column (2) in Panel B, *BILLIQ* coefficients are negative and statistically significant at 1% level. The implication is that rise in Treasury bid-ask spread increases expected liquidity premium, thereby reducing the realized return and corporate yield spread. Liquidity exposures of speculative-grade bonds are greater in absolute size than investment-grade bonds. These findings are mostly consistent with the results of unconditional approach noted by Acharya, Amihud, and Bharath (2013).

Column (1) and (3) of Panel B reveals another finding that liquidity exposure documented in previous literature may partially be attributed to default factor. *BILLIQ* coefficient suffers substantial loss in economic size and statistical significance following the inclusion of *LAMBDA*, coefficient decreasing from -13.73 to -8.67 and t-statistic from -9.85 to -6.99. This implies that information content of CDS conveyed through *LAMBDA* can straighten out entanglement within liquidity exposure.

Next step is to study bonds' exposure to direct measure of liquidity premium (*GAMMA*). Tests are specified as

$$SPR_{p,t} = \alpha_p + \beta_{D,p}DEF_t + \beta_{L,p}LAMBDA_t + \beta_{G,p}GAMMA_t + \epsilon_{p,t}, \text{ and} \qquad (4)$$

$$SPR_{p,t} = \alpha_p + \beta_{D,p}DEF_t + \beta_{L,p}LAMBDA_t + \beta_{B,p}BILLIQ_t) + \beta_{G,p}GAMMA_t + \epsilon_{p,t}, \qquad (5)$$

where $p$ = *IG*, *JK*. Following Longstaff et al. (2005) methodology, *GAMMA* is estimated by using CDS premium as well as price of referenced bond.

Column (4) and (5) of Table 2 is intended to show clear contrast between two liquidity factors, *BILLIQ* and *GAMMA*. These two columns employ both *LAMBDA* and *DEF* to adequately control for default premium factor. Column (4) replaces *BILLIQ* from column (3) with *GAMMA* whereas column (5) demonstrates the combined effect of the two.

Column (3), (4), and (5) indicate that *GAMMA* depicts more vivid picture of liquidity than do conventional measure of liquidity (*BILLIQ*). When explained by *DEF*, *LAMBDA* and *BILLIQ*, adjusted R-squared of *IG* and *JK* portfolio in column (3) are 27% and 71%, respectively. Inclusion of *GAMMA* in column (5) substantially enhances the fitness of *IG* and *JK* portfolio by 26% and 12%, respectively. When explained by *DEF*, *LAMBDA* and *BILLIQ*, adjusted R-squared of *IG* and *JK* portfolio in column (4) are 49% and 80%, respectively. Inclusion of *LAMBDA* in column (5) barely enhances the fitness of *IG* and *JK* portfolio. Results are robust even when single default factor is used. These findings indicate superior efficacy of *GAMMA* as a proxy for liquidity premium.

Liquidity coefficients ($\beta_{B,p}$, $\beta_{G,p}$) indicate the same. All 6 liquidity coefficients in column (3), (4), and (5) are negative and significant at 1% level. Therefore it can be said that the results are generally in line with previous researches. *BILLIQ* coefficients, however, show remarkable decrease in size and significance if *GAMMA* is introduced in the regression. Absolute size of *BILLIQ* coefficient decreases by 48% for *IG* portfolio and by 39% for *JK* portfolio. In contrast, size of *GAMMA* coefficients experience only about 10% drop for both portfolios even if *BILLIQ* is introduced. Statistical significance also remains hardly scathed. These findings suggest superior efficacy of *GAMMA* as well. Nonetheless both liquidity factors inflict significant change in corporate yield spread.

II. Information content of Longstaff et al. (2005) measures

As shown earlier, corporate CDS contains default premium information supplementary to conventional measures of bond market default. Such information resides in CDS premium data along with liquidity premium information. In order to confirm that Longstaff et al. (2005) measure of default and liquidity premium accurately reflect corresponding information, I include two CDS market factors, *CILLIQ* and *NONLIQ*, in the regression specification (5). Tests of information content of Direct measures are specified as

$$SPR_{p,t} = \alpha_p + \beta_{D,p}DEF_t + \beta_{L,p}LAMBDA_t + \beta_{B,p}BILLIQ_t + \beta_{G,p}GAMMA_t + \beta_{N,p}NONLIQ_{p,t} + \epsilon_{p,t}, \quad (6)$$

$$SPR_{p,t} = \alpha_p + \beta_{D,p}DEF_t + \beta_{L,p}LAMBDA_t + \beta_{B,p}BILLIQ_t + \beta_{G,p}GAMMA_t + \beta_{C,p}CILLIQ_t + \epsilon_{p,t}, \text{ and} \quad (7)$$

$$SPR_{p,t} = \alpha_p + \beta_{D,p}DEF_t + \beta_{L,p}LAMBDA_t + \beta_{B,p}BILLIQ_t + \beta_{G,p}GAMMA_t + \beta_{N,p}NONLIQ_{p,t} + \beta_{C,p}CILLIQ_t + \epsilon_{p,t}, \quad (8)$$

where $p = IG, JK$. *CILLIQ* is measured as equally weighted bid-ask spread of CDS on U.S. Treasuries, representing liquidity component of CDS premium. *NONLIQ*, on the other hand, is the residual from regressing CDS premium on *CILLIQ*, and it is an orthogonalized measure of non-liquidity component. Intuitively, non-liquidity component would be free of CDS liquidity risk and exposed to default risk of referenced bond.

Table 3 states the result of the test. I repeat the column (5) of Table 2 for comparison in column (1). Column (2) and (3) introduce non-liquidity and liquidity component of CDS, respectively. Column (4) illustrates the combined effect of *NONLIQ* and *CILLIQ*.

In Panel A, *NONLIQ* coefficients are statistically significant at 1% level. When introduced in column (2) and (4), *NONLIQ* increases the absolute size and significance of all other coefficients. Only the intercept loses significance, implying that yield spread will approximate to zero as all risk factors approach zero. Inclusion of *CILLIQ* in column (3) and (4) hardly has any impact on other coefficients and adjusted R-squared.

Panel B, however, poses conflicting results. Consistent with Panel A, default and liquidity coefficients in column (2) and (4) remain significant and untarnished against *NONLIQ*. Adjusted R-squared show no changes as well. In column (3) and (4), however, *CILLIQ* subsumes significances of *DEF* and *GAMMA* and gains statistical significance at 1% level. The intercepts also increase drastically in both size and significance and adjusted R-squared increase by 7%.

Findings in Panel B obscure the relation between bond yield spread and CDS market liquidity. Seemingly unrelated relation in Panel A reverts to strongly positive in Panel B. Simply put, investors of speculative bonds experience higher yield when bid-ask spread of Treasuries CDS expands. This positive relation may be caused by migration of investors from CDS to corporate bond market as liquidity risk escalates in CDS market.

The bottom line is that unconditional liquidity exposures remain robust even when direct measures of default premium and liquidity premium are introduced, negative and significant.

## 5. Test of conditional liquidity premium

Following the motivation and methodology of Acharya, Amihud, and Bharath (2013), I test whether conditional liquidity exposures survive under Longstaff et al. (2005) measures. With additional control variables introduced, I assume that corporate yield spreads in Regime $k$ ($s_t = k$) for $k \in \{1, 2\}$ are generated by the following process.

$$SPR_{p,t} = \alpha_p^k + \beta_{D,p}^k DEF_t + \beta_{B,p}^k LAMBDA_t + \beta_{L,p}^k BILLIQ_{p,t} + \epsilon_{p,t}^k, \text{ and} \quad (9)$$

$$SPR_{p,t} = \alpha_p^k + \beta_{D,p}^k DEF_t + \beta_{B,p}^k LAMBDA_t + \beta_{L,p}^k GAMMA_{p,t} + \epsilon_{p,t}^k, \quad (10)$$

where $p$ = *IG*, *JK*. The state variable, denoted $s_t$, determines the regime in which the yield spread is positioned. Markov transition probabilities are specified as

$$P(s_t = 1 | s_{t-1} = 1) = p, \text{ and} \quad (11)$$

$$P(s_t = 2 | s_{t-1} = 2) = q. \quad (12)$$

Variances of corporate yield spread as well as all explanatory variables are assumed to be regime-dependent. The model is estimated using maximum likelihood estimation following standard procedure of Hamilton (1989).

Table 5 exhibits the result of Markov regime switching model for corporate yield spreads. Panel A provides conditional liquidity exposure in Regime 1 and 2 estimated by conventional measure of liquidity, *BILLIQ*, and Panel B estimated by *GAMMA* as liquidity factor. Left-hand side of Panel A and B omit *LAMBDA* as control variable to verify the robustness.

Coefficient estimates in left-hand side of Panel A can be interpreted with ease. In Regime 2, *BILLIQ* coefficients of *IG* and *JK* portfolio are negative and significant congruent to findings in unconditional tests. When they shift from Regime 2 to Regime 1, yield spreads become more sensitive to liquidity risk of Treasuries. With *LAMBDA* included, results of right-hand side of Panel A are less intuitive. In Regime 2, *BILLIQ* coefficients are consistent to those in unconditional tests. As *IG* portfolio shifts from to Regime 1, however, liquidity exposure converts sign from -1.27 to 0.63 while maintaining p-value below 0.01. Meanwhile, *JK* portfolio becomes less sensitivity, from -8.64 to -6.51. The implication is that investors of *IG* portfolio will benefit from positive realized yield even when Treasuries bid-ask spread expands in Regime 1. Investors in *JK* portfolio benefit in Regime 1 as the negative yield due to illiquidity is mitigated.

These findings are only partially consistent with Acharya, Amihud, and Bharath (2013), and do not fully adhere to the concept of flight-to-liquidity from *JK* to *IG* during stress regime. Probability of flight-to-liquidity can be suggested on the basis that liquidity exposure of *IG* portfolio converts sign as regime shifts. Had flight-to-liquidity from *JK* to *IG* taken place, however, liquidity exposure of *JK* portfolio must have plummeted in Regime 1. Reduced sensitivity, thereby, poses another possibility that investors migrate from CDS to corporate bonds, especially speculative bonds during Regime 1 nullifying the impact of flight-to-liquidity. Possible migration from CDS to corporate bonds was suggested earlier in Table 3 as well.

## 6. Conclusion

I examine the robustness of corporate bonds' liquidity exposures over the period of 2007-2010. By utilizing information content of corporate CDS, I find that unconditional liquidity exposures remain robust, negative and significant, even when direct measures of default premium and liquidity premium are introduced. Conditional liquidity exposures, on the other hand, lose consistency and robustness, which indicates the vulnerability to the choice of measures.

During the process, I provide evidences that conventional measure of default (*DEF*) is valid as a primary source of bond's default information and that Longstaff et al. (2005) measure of default (*LAMBDA*) is also valid as secondary source. In addition, I find empirical results indicating superior efficacy of *GAMMA* as a direct measure of liquidity premium.

This paper contributes to earlier literature of bond pricing with liquidity factor in two aspects. First, corporate yield spread is used instead of bond yield as dependent variable. Because riskless yield reflects information about coupon rate/frequency/date, and maturity date of individual bonds, term structure premium can be effectively controlled by deducting it from bond yields.

Second, I adopt Longstaff, et al. (2005) estimates of default and liquidity premium, which directly measure the size of respective risk premium. To quantify and distinguish default premium from liquidity premium within corporate yield spread, I resort to CDS premium as supplementary source of information. Results show that these direct measures of default premium

(*LAMBDA*) and liquidity premium (*GAMMA*) play significant role in explaining corporate yield spread.

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**Table 1**
Summary statistics

*SPR* and *S* are the EW average of corporate yield spread and CDS premium (mid), respectively. *DEF* proxy bond market default factor, computed as the difference between EW bond market return and one-year Treasury bond yield. *BILLIQ* represents bond market illiquidity, measured using bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from CDS premium, and liquidity factor, *GAMMA*, is estimated from price of referenced bond following Longstaff et al. (2005) methodology. *CILLIQ* represents illiquidity measure of CDS premium estimated as the EW average of bid-ask spread of CDS premium.

| | IG | | | | |
|---|---|---|---|---|---|
| | N | MIN | MAX | MEAN | STD |
| SPR | 191 | -0.91 | 1.99 | 0.61 | 0.72 |
| S | 191 | 0.64 | 5.64 | 2.31 | 1.33 |
| DEF | 191 | 1.83 | 5.12 | 3.59 | 1.01 |
| BILLIQ | 191 | -0.57 | -0.12 | -0.35 | 0.10 |
| LAMBDA | 191 | 0.47 | 2.31 | 1.24 | 0.36 |
| GAMMA | 191 | -2.03 | -0.31 | -1.20 | 0.33 |
| CILLIQ | 191 | 0.07 | 0.39 | 0.23 | 0.09 |

| | JK | | | | |
|---|---|---|---|---|---|
| | N | MIN | MAX | MEAN | STD |
| SPR | 191 | -0.29 | 8.62 | 3.88 | 2.48 |
| S | 191 | 0.75 | 10.14 | 3.34 | 2.09 |
| DEF | 191 | 1.83 | 5.12 | 3.59 | 1.01 |
| LAMBDA | 191 | 2.41 | 12.06 | 6.06 | 2.16 |
| BILLIQ | 191 | -0.57 | -0.12 | -0.35 | 0.10 |
| GAMMA | 191 | -2.03 | -0.31 | -1.20 | 0.33 |
| CILLIQ | 191 | 0.04 | 1.31 | 0.20 | 0.16 |

**Table 2**

Regressions of corporate yield spread on bond market factors

Panel A and B present the estimates of investment-grade (*IG*) and speculative-grade (*JK*) portfolio, respectively. Dependent variable is the EW average of corporate yield spread. *DEF* proxy bond market default factor, computed as the difference between EW bond market return and one-year Treasury bond yield. *BILLIQ* represents bond market illiquidity, measured using bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from CDS premium, and liquidity factor, *GAMMA*, is estimated from price of referenced bond following Longstaff et al. (2005) methodology. Numbers in parentheses are t-statistics and *, **, *** represent a significance level at 10%, 5% and 1%, respectively.

| *Panel A. Investment grade (IG) bond portfolio* | | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Intercept | 1.02*** | 0.60*** | 0.90*** | -0.32 | -0.36 |
| | (5.59) | (2.78) | (4.69) | (-1.55) | (-1.83) |
| DEF | -0.42*** | | -0.49*** | -0.26*** | -0.35*** |
| | (-8.03) | | (-7.74) | (-5.49) | (-6.73) |
| LAMBDA | | -0.40** | 0.29* | 0.23* | 0.21* |
| | | (-2.57) | (1.82) | (1.71) | (1.64) |
| BILLIQ | -3.25*** | -1.46*** | -3.20*** | | -1.64*** |
| | (-6.18) | (-2.70) | (-6.10) | | (-3.66) |
| GAMMA | | | | -1.32*** | -1.18*** |
| | | | | (-11.72) | (-10.12) |
| Adj-$R^2$ | 0.26 | 0.04 | 0.27 | 0.49 | 0.53 |

| *Panel B. Speculative-grade (JK) bond portfolio* | | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Intercept | 7.07*** | 0.17 | 4.26*** | 1.15** | 1.42*** |
| | (14.69) | (0.30) | (8.84) | (2.38) | (3.12) |
| DEF | -2.21*** | | -1.77*** | -1.19*** | -1.52*** |
| | (-15.76) | | (-14.46) | (-14.83) | (-15.47) |
| LAMBDA | | 0.75*** | 0.49*** | 0.55*** | 0.47*** |
| | | (11.24) | (9.91) | (14.35) | (12.22) |
| BILLIQ | -13.73*** | 2.43* | -8.67*** | | -5.29*** |
| | (-9.85) | (1.72) | (-6.99) | | (-5.21) |
| GAMMA | | | | -3.07*** | -2.68*** |
| | | | | (-12.38) | (-11.03) |
| Adj-$R^2$ | 0.57 | 0.40 | 0.71 | 0.80 | 0.83 |

**Table 3**

Regressions of corporate yield spread on bond and CDS market factors

Panel A and B present the estimates of investment- (*IG*) and speculative-grade (*JK*) portfolio, respectively. Dependent variable is the EW average of corporate yield spread. *DEF* proxy bond market default factor, computed as the difference between EW bond market return and one-year Treasury bond yield. *BILLIQ* represents bond market illiquidity, measured using bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from CDS premium, and liquidity factor, *GAMMA*, is estimated from price of referenced bond following Longstaff et al. (2005) methodology. *CILLIQ* is measured as the EW bid-ask spread of all corporate CDSs and proxies CDS market illiquidity. *NONLIQ* is the residual from regression of CDS premium on *CILLIQ*. Numbers in parentheses are t-statistics and *, **, *** represent a significance level at 10%, 5% and 1%, respectively.

*Panel A. Investment grade (IG) bond portfolio*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Intercept | -0.36* | -0.09 | -0.87* | -0.31 |
| | (-1.83) | (-0.39) | (-1.81) | (-0.61) |
| DEF | -0.35*** | -0.45*** | -0.28*** | -0.41*** |
| | (-6.73) | (-7.38) | (-3.23) | (-4.23) |
| LAMBDA | 0.21* | 0.24* | 0.21 | 0.24* |
| | (1.64) | (1.86) | (1.62) | (1.84) |
| BILLIQ | -1.64*** | -1.68*** | -1.53*** | -1.63*** |
| | (-3.66) | (-3.82) | (-3.34) | (-3.60) |
| GAMMA | -1.18*** | -1.20*** | -1.22*** | -1.22*** |
| | (-10.12) | (-10.52) | (-10.01) | (-10.18) |
| NONLIQ | | -0.63*** | | -0.60*** |
| | | (-2.96) | | (-2.75) |
| CILLIQ | | | 0.93 | 0.40 |
| | | | (1.16) | (0.49) |
| Adj-$R^2$ | 0.53 | 0.55 | 0.53 | 0.54 |

| *Panel B. Speculative grade (JK) bond portfolio* | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Intercept | 1.42*** | 1.37*** | 2.75*** | 2.30*** |
| | (3.12) | (2.68) | (7.41) | (5.84) |
| DEF | -1.52*** | -1.50*** | -1.56*** | -1.40*** |
| | (-15.47) | (-12.40) | (-20.60) | (-15.28) |
| LAMBDA | 0.47*** | 0.47*** | 0.28*** | 0.28*** |
| | (12.22) | (12.14) | (8.19) | (8.31) |
| BILLIQ | -5.29*** | -5.28*** | -5.37*** | -5.22*** |
| | (-5.21) | (-5.17) | (-6.86) | (-6.78) |
| GAMMA | -2.68*** | -2.68*** | -1.76*** | -1.66*** |
| | (-11.03) | (-10.94) | (-8.58) | (-8.14) |
| NONLIQ | | 0.10 | | 1.04*** |
| | | (0.22) | | (2.94) |
| CILLIQ | | | 5.35*** | 5.66*** |
| | | | (11.30) | (11.90) |
| Adj-$R^2$ | 0.83 | 0.83 | 0.90 | 0.90 |

**Table 4**

Regressions of corporate yield spread on bond market factors and CDS premium

Panel A and B present the estimates of investment- (*IG*) and speculative-grade (*JK*) portfolio, respectively. Dependent variable is the EW average of corporate yield spread. *DEF* proxy bond market default factor, computed as the difference between EW bond market return and one-year Treasury bond yield. *BILLIQ* represents bond market illiquidity, measured using bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from CDS premium, and liquidity factor, *GAMMA*, is estimated from price of referenced bond following Longstaff et al. (2005) methodology. *S* is the EW average of CDS premium. Numbers in parentheses are t-statistics and *, **, *** represent a significance level at 10%, 5% and 1%, respectively.

*Panel A. Investment grade (IG) bond portfolio*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Intercept | 1.02*** | -0.78*** | -0.85*** | -1.55*** | -1.54*** |
| | (5.59) | (-3.40) | (-3.69) | (-7.86) | (-7.65) |
| DEF | -0.42*** | 0.04 | -0.02 | 0.01 | 0.00 |
| | (-8.03) | (0.58) | (-0.26) | (0.22) | (0.02) |
| BILLIQ | -3.25*** | -0.95** | -0.92* | | -0.10 |
| | (-6.18) | (-1.98) | (-1.94) | | (-0.26) |
| LAMBDA | | | 0.23* | 0.18* | 0.18* |
| | | | (1.79) | (1.70) | (1.69) |
| GAMMA | | | | -0.96*** | -0.95*** |
| | | | | (-10.07) | (-9.76) |
| S | | 0.40*** | 0.40*** | 0.33*** | 0.32*** |
| | | (10.21) | (10.18) | (10.82) | (9.81) |
| Adj-$R^2$ | 0.26 | 0.52 | 0.53 | 0.69 | 0.69 |

| *Panel B. Speculative grade (JK) bond portfolio* | | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Intercept | 7.07*** | 3.93*** | 4.08***\ | 3.25*** | 3.26*** |
| | (14.69) | (21.86) | (20.72) | (13.63) | (13.98) |
| DEF | -2.21*** | -1.04*** | -1.03*** | -0.93*** | -1.04*** |
| | (-15.76) | (-18.63) | (-18.67) | (-24.22) | (-20.28) |
| BILLIQ | -13.73*** | -1.82*** | -1.84*** | | -1.60*** |
| | (-9.85) | (-3.28) | (-3.33) | | (-3.11) |
| LAMBDA | | | -0.05* | 0.01 | 0.00 |
| | | | (-1.84) | (0.33) | (0.19) |
| GAMMA | | | | -0.83*** | -0.79*** |
| | | | | (-5.76) | (-5.61) |
| S | | 0.91*** | 0.95*** | 0.88*** | 0.84*** |
| | | (38.83) | (30.64) | (26.09) | (24.63) |
| Adj-$R^2$ | 0.57 | 0.95 | 0.95 | 0.96 | 0.96 |

**Table 5**

Markov two-stage regime switching model for bond yield spread

Panel A presents the estimates of the following model for investment- (*IG*) and speculative-grade bonds (*JK*).

Regime 1: $SPR_{p,t} = \alpha_p^1 + \beta_{D,p}^1 DEF_t + \beta_{B,p}^1 LAMBDA_t + \beta_{L,p}^1 BILLIQ_{p,t} + \epsilon_{p,t}^1$,

Regime 2: $SPR_{p,t} = \alpha_p^2 + \beta_{D,p}^2 DEF_t + \beta_{B,p}^2 LAMBDA_t + \beta_{L,p}^2 BILLIQ_{p,t} + \epsilon_{p,t}^2$, where $p = IG, JK$.

Dependent variable is the EW average of corporate yield spread. *DEF* proxy bond market default factor, computed as the difference between EW bond market return and one-year Treasury bond yield. *BILLIQ* represents bond market illiquidity, measured using bid-ask spread of Treasuries with maturity less than 10 year. Another default factor, *LAMBDA*, is extrapolated from CDS premium, and liquidity factor, *GAMMA*, is estimated from price of referenced bond following Longstaff et al. (2005) methodology.

*Panel A. Conditional risk exposure to BILLIQ*

| | Investment grade | | Speculative grade | | | Investment grade | | Speculative grade | |
|---|---|---|---|---|---|---|---|---|---|
| Regime 1 | Coeff | p-value | Coeff | p-value | | Coeff | p-value | Coeff | p-value |
| Intercept | -0.12 | 0.00 | 2.05 | 0.00 | Intercept | 8.41 | 0.00 | 5.67 | 0.08 |
| DEF | 0.07 | 0.00 | 0.27 | 0.07 | DEF | -1.67 | 0.00 | -2.02 | 0.00 |
| LAMBDA | | | | | LAMBDA | -0.34 | 0.00 | 0.52 | 0.00 |
| BILLIQ | -2.42 | 0.00 | -9.00 | 0.00 | BILLIQ | 0.63 | 0.00 | -6.51 | 0.02 |
| σ | 0.32 | | 0.84 | | σ | 0.32 | | 1.16 | |
| p | 1.00 | | 1.00 | | p | 1.00 | | 0.99 | |
| q | 0.98 | | 0.99 | | q | 1.00 | | 0.98 | |

| | Investment grade | | Speculative grade | | | Investment grade | | Speculative grade | |
|---|---|---|---|---|---|---|---|---|---|
| Regime 2 | Coeff | p-value | Coeff | p-value | | Coeff | p-value | Coeff | p-value |
| Intercept | 2.53 | 0.00 | 15.42 | 0.00 | Intercept | -0.81 | 0.00 | 2.45 | 0.00 |
| DEF | -0.75 | 0.00 | -3.15 | 0.00 | DEF | 0.44 | 0.00 | 0.10 | 0.56 |
| LAMBDA | | | | | LAMBDA | 0.11 | 0.00 | 0.01 | 0.74 |
| BILLIQ | -1.54 | 0.00 | -1.04 | 0.45 | BILLIQ | -1.27 | 0.00 | -8.64 | 0.00 |
| σ | 0.27 | | 0.64 | | σ | 0.14 | | 0.68 | |

Panel B presents the estimates of the following model for investment- (*IG*) and speculative-grade bonds (*JK*).

Regime 1: $SPR_{p,t} = \alpha_p^1 + \beta_{D,p}^1 DEF_t + \beta_{B,p}^1 LAMBDA_t + \beta_{L,p}^1 GAMMA_{p,t} + \epsilon_{p,t}^1$,

Regime 2: $SPR_{p,t} = \alpha_p^2 + \beta_{D,p}^2 DEF_t + \beta_{B,p}^2 LAMBDA_t + \beta_{L,p}^2 GAMMA_{p,t} + \epsilon_{p,t}^2$, where *p* = *IG*, *JK*.

*Panel B. Conditional risk exposure GAMMA*

| | Investment grade | | Speculative grade | | | Investment grade | | Speculative grade | |
|---|---|---|---|---|---|---|---|---|---|
| Regime 1 | Coeff | p-value | Coeff | p-value | | Coeff | p-value | Coeff | p-value |
| Intercept | -0.45 | 0.00 | -2.54 | 0.00 | Intercept | 6.15 | 0.00 | 1.16 | 0.00 |
| DEF | | | | | DEF | -1.42 | 0.00 | -1.18 | 0.00 |
| LAMBDA | 0.20 | 0.02 | 0.30 | 0.00 | LAMBDA | -0.04 | 0.00 | 0.55 | 0.00 |
| GAMMA | -0.87 | 0.00 | -2.41 | 0.00 | GAMMA | -0.41 | 0.00 | -3.06 | 0.00 |
| σ | 0.36 | | 1.02 | | σ | 0.28 | | 1.10 | |
| p | 1.00 | | 1.00 | | p | 0.99 | | 1.00 | |
| q | 0.97 | | 0.99 | | q | 1.00 | | 0.86 | |

| | Investment grade | | Speculative grade | | | Investment grade | | Speculative grade | |
|---|---|---|---|---|---|---|---|---|---|
| Regime 2 | Coeff | p-value | Coeff | p-value | | Coeff | p-value | Coeff | p-value |
| Intercept | -0.83 | 0.00 | -0.66 | 0.06 | Intercept | -1.14 | 0.00 | 0.81 | 0.00 |
| DEF | | | | | DEF | 0.50 | 0.00 | -4.11 | 0.00 |
| LAMBDA | 0.01 | 0.97 | 0.27 | 0.00 | LAMBDA | 0.07 | 0.00 | -0.19 | 0.00 |
| GAMMA | -0.28 | 0.01 | -3.55 | 0.00 | GAMMA | -0.49 | 0.00 | 13.40 | 0.00 |
| σ | 0.22 | | 0.73 | | σ | 0.14 | | 0.73 | |