Market Commentary

May 16, 2017

The U.S. Corporate Bond Risk Premium and Market Liquidity

Analyzing Post Credit Crisis Increases in the Corporate Bond Risk Premium in the Context of Corporate Bond Market Liquidity

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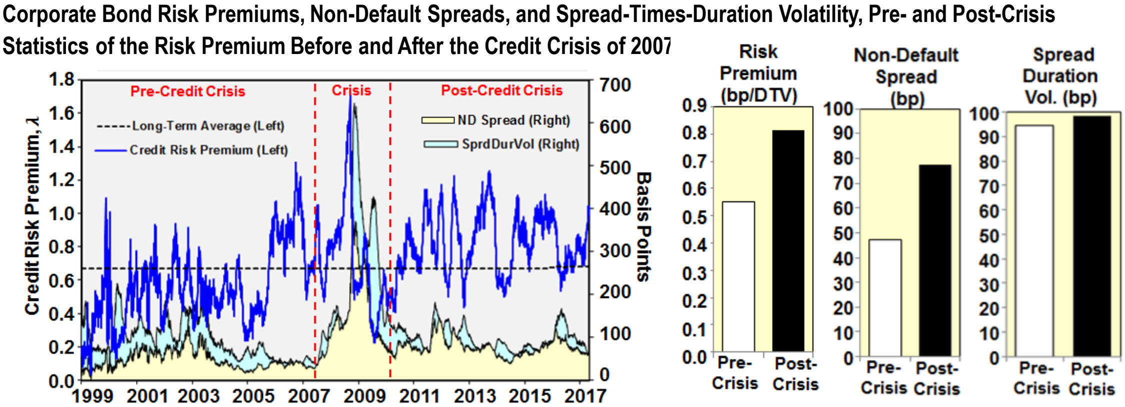
Each day we compute the price of risk in the U.S. corporate market as the average spread per unit of duration times spread (DTS) volatility. We call this the corporate bond risk premium. We observe that the average of those daily values has been consistently higher since the credit crisis of 2007-2009 and, along with other evidence, suggests that liquidity has decreased in the corporate bond market.

Highlights:

- The majority of buy- and sell-side market participants report that liquidity in the U.S. corporate bond market has decreased since the credit crisis of 2007-2009.
- Nevertheless, most traditional measures of market liquidity (i.e., bid/ask spreads, trading volumes, and price impact of trades) provide little support for decreases in corporate bond liquidity.
- Amid record new corporate bond issuance, the amount traded per face outstanding has decreased, and relative trading in illiquid assets has increased.
- One measure of liquidity not previously considered is the average amount of credit spread per unit of duration-times-spread volatility in the corporate bond market; the average daily risk-reward ratio.
- In fact, we observe a systematic increase in the price of risk in the corporate bond market, even though average price volatilities are similar before and after the credit crisis. That is, investors are requiring more spread compensation for their risk since the credit crisis, but risk has not increased.
- Changes in the price of risk in the corporate bond market may not be reflected in traditional measures of liquidity such as bid/ask spreads, but may be a reflection of decreased leverage in the financial system resulting in greater costs for market participants to fund cash positions.

Figure 1. Left: Time Series of the U.S. Corporate Bond Risk Premium, 1999-2017; Right: Average Values of Daily U.S. Corporate Bond Risk Premiums, Non-Default Spreads, and Spread-Times-Duration Volatility, Pre- and Post-Crisis Statistics of the Risk Premium Before and After the Credit Crisis of 2007



Source: Citi

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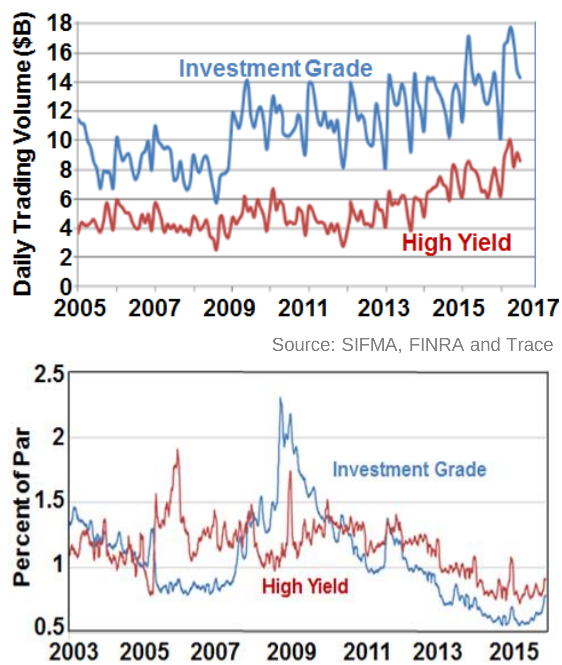
Introduction

In a recent report by IOSCO (2016) found 68% of buy-side respondents reported a perceived deterioration in corporate bond market liquidity between 2004 and 2015. Among sell-side participants, that number is 80%. Perceptions are that it is increasingly difficult to trade in large sizes, to execute orders quickly, or to establish reliable prices. Market participants also expressed the view that in the event of an unexpected or significant market event, such as an abrupt interest rate rise, investors could face a possible rush to a crowded exit to sell their positions. Reasons citied for this perceived deterioration in liquidity are complex. They reflect the interaction of various regulatory initiatives, extraordinary current and future monetary policy, and the undermining of the market-making liquidity model, largely due to greater capital constraints on banks and broker-dealers.

Despite these anecdotal reports, there is very little direct evidence to corroborate these views and nearly all report conclude that, at least in from typical measures of liquidity, little if any deterioration liquidity has occurred (see for example, Adrian, Fleming, Shachar and Vogt, 2015; Mizrach, 2015; Committee on the Global Financial System, 2016; Liebschutz and Smith, 2016).[1] Some even conclude that market liquidity has improved since the crisis.

Figure 2. Top: Average Daily Corporate Bond Trading Volume; Portfolio Guidelines for Credit Picking Robots: Bottom: 21-Day Moving Averages of Bid-Ask Spreads



Source: Federal Reserve Bank of New York

Trading Volume: For example, the top panel of Figure 2 shows that average daily trading volume of corporate bonds has increased since 2009. Although traded volume does not reveal the cost of trading or the amount of unexecuted trades, it is a direct measure of the level of activity that the market accommodates. However, given the record-breaking increase in new issuance (see below) since the credit crisis, overall *turnover*, the amount traded per face outstanding, has actually decreased.

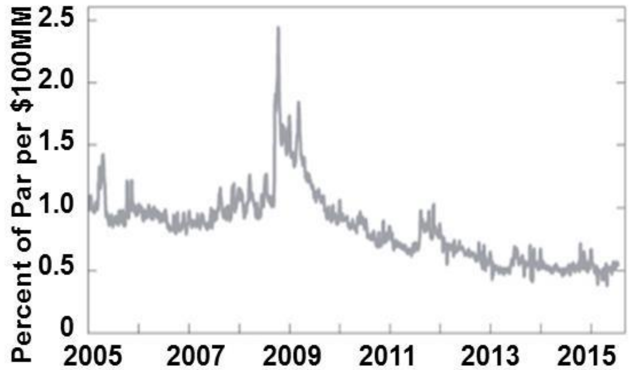
Bid/Ask Spreads: Proponents of the view that corporate market liquidity has not deteriorated robust point to the fact that average bid/ask spreads, as shown in the lower panel of Figure 2, have declined since the credit crisis. Despite this, the level of bid-offer spreads for corporate bonds has been consistently higher with respect to other, more liquid, fixed income markets. Moreover, because these spreads are estimated from transaction data,

[1] It is not the objective of this report to describe all the work that has been done on the issue of deteriorating liquidity, but merely to highlight the main evidence and themes that underlie the current debate.

they do not capture cases where investors may have forgone trading due to high bid-offer spreads.

Price Impact of Trades: Another measure of liquidity is the impact that executed trades have on market prices. In more liquid markets, executed trades of a given size may generate less price impact than in less liquid markets, all else equal. Figure 3 shows that the price impact per $100 million of corporate bonds traded has declined since the crisis and now sits below pre-crisis levels. Thus, the evidence from trading volume, bid/ask spreads and price impact of trades show little evidence of declining liquidity in the corporate bond market.

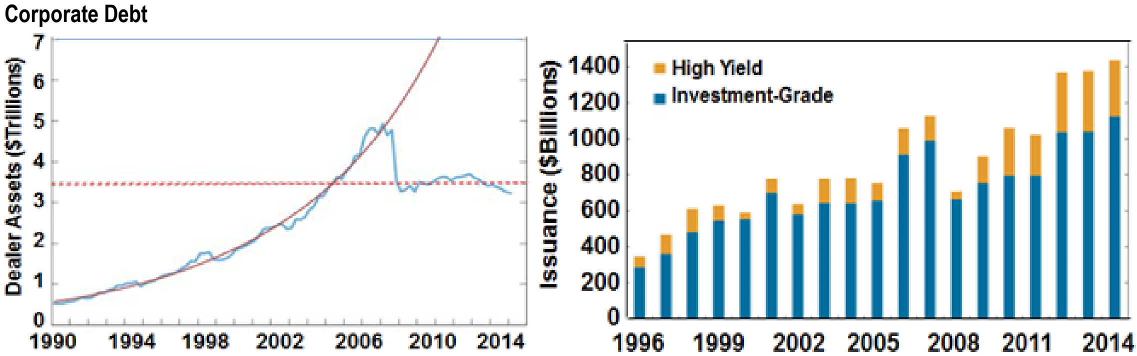
Figure 3. Relative Price Impact per $100MM of Corporate Bonds Traded, 2005-2015



Source: FRBNY (using FIRNA TRACE data)

Dealer Balance Sheets: Trading of corporate bonds in the secondary market is conducted over-the-counter. That is, most trading continues to be intermediated by brokers and dealers, but that has been changing with the emergence of exchange traded funds (ETFs) and automated trading. Dealers can match offsetting orders from investors so that they avoid holding bonds on their balance sheets, or they can buy bonds from sellers and hold them on their balance sheets until offsetting trades are found, thus bearing the risk that prices fall in the interim. The former is called the “agency model” while the latter is called the “principal model.” In the corporate bond market, some dealers have reportedly attempted to shift from the principal model toward the agency model in recent years, but the ability of dealers to switch trading models without affecting liquidity is limited by the market’s structure.

Figure 4. Left: Dealer Balance Sheet Size, 1990-2015; Right: Annual Issuance of Investment-Grade and High Yield Corporate Debt



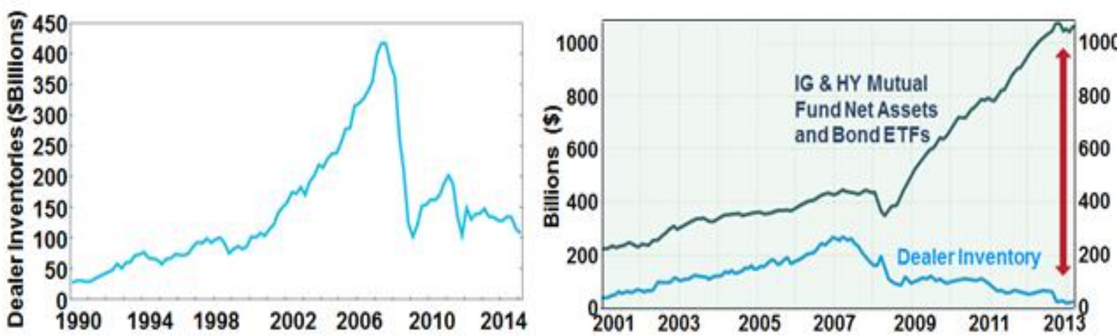
Source: Federal Reserve

Source: Securities Industry and Financial Markets Association

The left panel of Figure 4 shows dealer balance sheet size in dollar amounts since 1990. The figure indicates that dealer size grew exponentially from 1990 through 2008, with a peak close to $5 trillion. Dealer assets then collapsed after the Lehman failure and remain stalled at around $3.5 trillion, the level of 2005 (indicated by the red dotted line in the chart). If the previous trend growth had continued (indicated by the solid red line), dealer balance sheet size would be more than three times larger than it is today.

Dealer Inventory: Given the tens of thousands of outstanding corporate bond issues which vary in issuers, credit quality, maturity, seniority, and optionality, it is difficult for dealers to match demand and supply. As shown in the left and right panels of Figure 5, dealers' corporate bond inventories plunged during the financial crisis and have stagnated since. This decrease in dealer inventories mirrors the balance sheet stagnation of dealers shown in Figure 4 and is similarly consistent with the notion of decreased liquidity in the corporate bond market. Finally, the right panel of Figure 5 superimposes the growth of corporate bond assets on dealer inventories, serving to highlight the fact that dealer inventories have decreased amid accelerating growth in the size of the corporate bond market.

Figure 5. Left: Quantity of Corporate and Foreign Bonds (Held in the U.S.) Owned by Securities Brokers and Dealers; Right: Dealer Inventory and Investment-Grade and High Yield Mutual Fund Net Assets and Bond ETFs

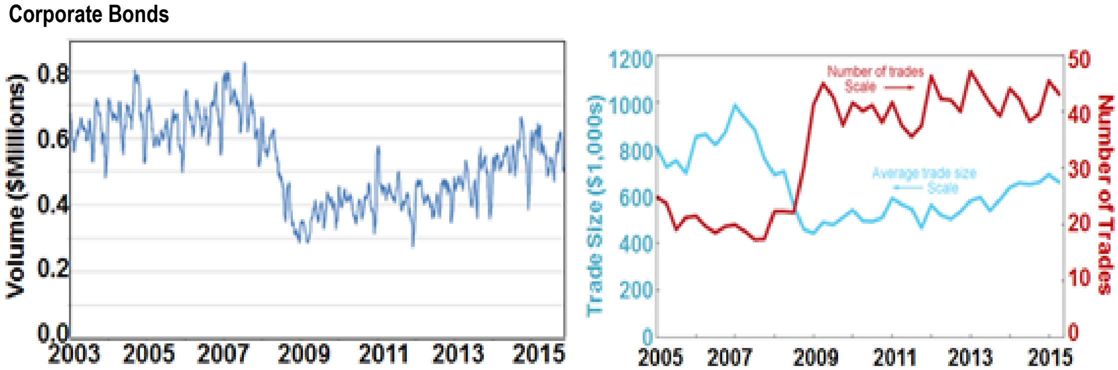


Source: Federal Reserve Board

Source: Investment Company Institute, Haver Analytics, T. Rowe Price, Federal Reserve Board

Trade Size: Trading volume reflects the product of the number of trades and average trade size. The left panel of Figure 6 shows that corporate bond trade volumes have declined through the financial crisis but have generally been increasing slowly since then. Still, trading volume when divided by size remains much lower than their pre-crisis peak. In fact, the right panel of Figure 6 shows that the actual number of trades has increased since the credit crisis, but that the decline in trading volume reflects the fact the that average trade size has decreased. Anecdotally, market participants have reported more difficulty executing large "block" size trades compared to the pre-crisis period (Liebshutz and Smith, 2016). Some market commentators see this trend as evidence that investors find it more difficult to execute large trades and so are splitting orders into smaller trades to lessen their price impact.

Figure 6. Left: 21-Day Moving Average of Average Trade Size Where Average Trade Size is Total Volume Divided by Number of Trades Each Day; Right: Average Trade Size and Average Daily Number of Trades by Quarter for All Corporate Bonds

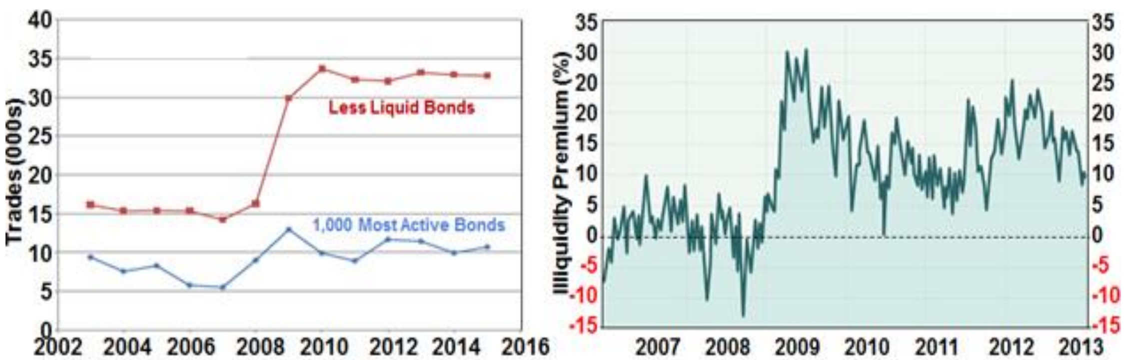


Source: FRBNY based on data from TRACE and Mergent FISD

Source: TRACE data

Bond Liquidity: The left panel of Figure 7 shows that while the number of trades for the 1,000 most liquid bonds has remained roughly constant over the last decade, the number of trades of less liquid bonds has more than doubled. Also, as shown in the right panel of Figure 7, the spread premium for illiquid bonds has increased roughly 20% since 2008.

Figure 7. Left: Average Daily Number of Trades of Liquid (Blue) and Less Liquid (Red) Bonds; Right: Goldman Sachs Estimate of Extra Spread for Illiquid Bonds



Source: Mizrach (2016)

Source: Goldman Sachs Investment Research

Summing Up the Debate: Although far from exhaustive, the results above represent the main arguments for and against the notion of changes in the liquidity of the corporate bond market. That is, proponents of the view of no evidence for changes in liquidity point to increased daily trading volumes and declines in average bid/ask to below pre-credit-crisis levels. In addition, despite the majority of buy- and sell-side market participants who report perceived declines in liquidity, the no-change proponents point to the lower price impact of given trade sizes to support their view. In fact, the balance of written reports on the subject of liquidity, albeit mostly from government sponsored sources, conclude that there is no compelling evidence of decreases in corporate bond liquidity since the credit crisis. In addition, those sources claim that whatever evidence that might suggest declining corporate market liquidity is not conclusive because the structure of the corporate bond market has changed greatly since the credit crisis. They argue that dealer ownership of corporate bonds has declined because dealers have shifted from a “principal” to an “agency” role and their decreased presence has been taken up by other market participants, including exchange traded funds, hedge funds, and electronic high-frequency-trading firms.

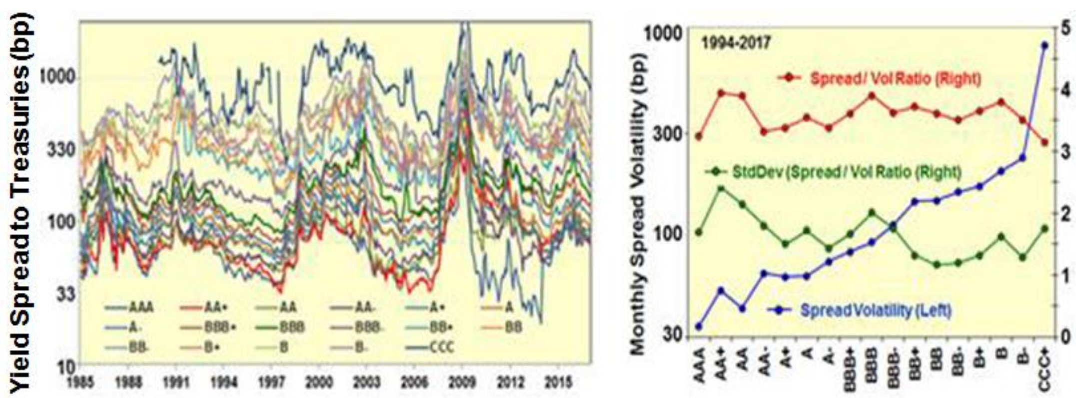
First, it is clear that dealer balance sheets and inventories have decreased amid increasing new bond issuance. In addition, although trade volume has increased, daily turnover percentages have decreased along with average trade size. Results indicate that the increase in number of trades have actually come from increases in number of relatively illiquid bonds traded and that the illiquidity premium for these bonds has increased since the credit crisis. Finally, although it is possible that changes in market structure where dealers have moved to more of an agency role, there is little evidence to support that claim or its role in maintaining pre-crisis liquidity.

The Corporate Bond Risk Premium and Liquidity

Amidst this background debate, consider now evidence regarding liquidity in the corporate bond market from an historical analysis of the price of risk in the corporate bond market. We define the daily corporate bond risk premium as the average amount of yield spread to Treasuries above the compensation for default risk as a function of bonds’ volatilities of durations-times-spreads (DTS). Because we have described the theory and method for calculating the corporate bond risk premium in great detail in several places (Benzschawel and Assing, 2012, Benzschawel, Su and Xin, 2015; Benzschawel, 2016) we describe them only briefly herein, preferring to focus on its relation to corporate bond liquidity.

Background: The Corporate Bond Risk Premium: : The notion that one can derive a single-quantity, the credit risk premium, to characterize the risk-reward properties of the corporate bond market comes from the Capital Asset Pricing Model (CAPM) of Sharpe (1964) as well as empirical analysis of corporate bond spreads. For example, the left panel of Figure 8 shows average bond spreads to US Treasuries by agency credit rating on a logarithmic spread axes.[2] That plot shows clearly that, to a large extent, bonds of all ratings move in tandem over time. That is, there is a single factor controlling spreads; the credit risk premium. Additional evidence for a unitary risk premium in the corporate market comes from an analysis of spread volatilities by agency credit rating as well as spread-to-volatility ratios as shown at the right in Figure 8. The red dots (right axis) show that average ratios of rolling five-year average yield spreads-to-spread volatilities are similar for all rating categories. This too supports the CAPM view that, to a large extent that, at least on average, the market pays the same amount per unit of volatility regardless of asset risk characteristics. Finally, the green dots (right axis) plot the average volatility of spread-to-volatility rations (the red dots) and those values are also similar for all rating categories.

Figure 8. Left: . Monthly Average Yield Spreads to US Treasuries by Rating Category on a Logarithmic Spread Axis, 1990-2016; Right: Blue (Left Axis): Average Monthly Spread Volatility by Agency Rating Category; Red (Right Axis): Ratios of Rolling 5-Year Average Spreads to Spread Volatilities by Rating; and Green (Right Axis) Volatility of Monthly Spread-to-Spread Volatility Ratios



Source: Citi

One complication in estimating the corporate bond risk premium comes for the fact that yield spreads for corporate bonds spreads contain a premium for expected losses from default. To account for this, we obtain estimates of firms' expected default-related losses from model-based default probabilities and recovery values (discussed below). That is, given estimates of default probabilities, p_T to durations T and recovery values in default, RV we can use the following approximation from the price-yield relationship to compute a bond's spread value of default, s_d, as:

$$s_d = -\frac{1}{T}\ln[1-(p_T \cdot LGD)], \tag{1}$$

and the remainder of the spread, called the *non-default* spread, s_λ as:

$$s_\lambda = s - s_d \quad . \tag{2}$$

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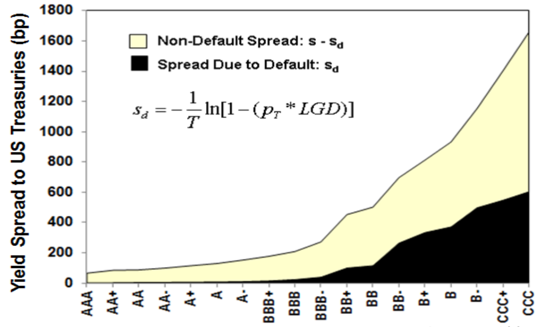
[2] Note that the relationship between bond price as a function of yield is linear on a logarithmic yield scale.

For perspective on the amount of default and non-default spread, consider Figure 9 that shows average spreads by agency credit rating model for the corporate bonds in Citi's Broad Investment Grade (BIG) and High Yield Indexes over the period from 1994 to 2010.[3] The dark area in Figure 9 shows the magnitude of the default spread, s_d, calculated using Equation 1, a value of T of 4.5 years,[4] cumulative 4.5-year default probabilities (PDs) by rating category from Sobehart and Keenan's (2002, 2003) Hybrid Probability of Default (HPD) model, and assuming a 40% recovery value in default. The light area represents average values of the non-default spread, s_λ. The average values of the non-default spread premium range from 69bp for triple-A-rated bonds to 727bp for triple C-rated ones, but is five-to-ten times larger than the average spread compensation for default regardless of rating category.

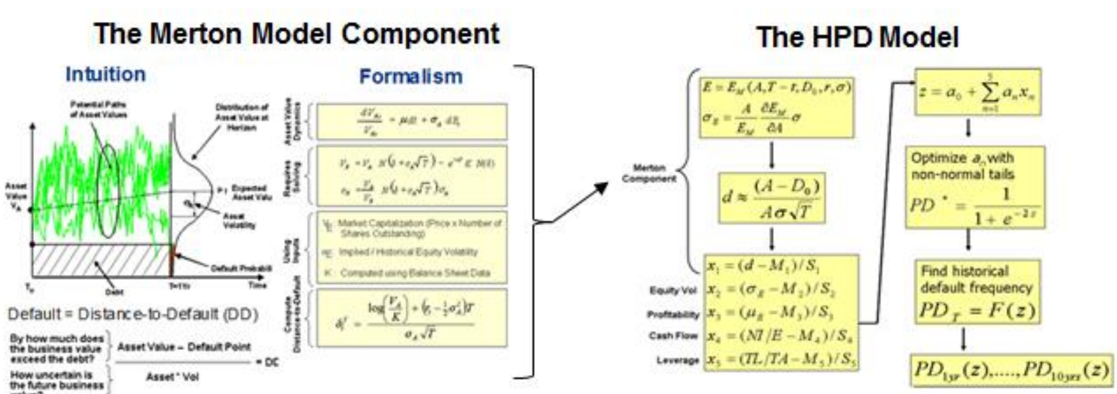
Figure 9. Average Spreads Versus Agency Ratings Showing Spread Compensation for Expected Default (Black Area) and Non-Default Spread, 1994-2017



Source: Citi

The HPD Model: Although Figure 9 shows average values of the risk premium, default rates vary over the credit cycle as do credit spreads. Thus, every day, we estimate bonds' PDs from their obligors' default rates determined from Citi's HPD model.[5] The HPD model consists of a Merton structural model (Merton, 1974) shown in the left panel of Figure 10. Merton developed this as a contingent claims model based on the relation between the value of a firm's assets, its equity, and debt. Within the model, ownership of common stock is seen as equivalent to being long a call option on the firm's assets while ownership of debt is equal to ownership of the firm's assets minus the value of the equity call. Default, then, results from equity holders failing to exercise their call (not paying off the face value of debt) and leaving bondholders with ownership of the assets. Importantly, because of its dependence on equity market information for generating PDs, one can obtain daily estimates of firms' default risk as equity market prices change.

Figure 10. Citi's Hybrid Probability of Default Model Consisting of a Merton Model Variable (Left Pane) and Market and Balance Sheet Information (Right Panel)



Source: Citi

[3] The credit spreads and bond indicative data come from the corporate bonds in Citigroup's Broad Investment Grade (BIG) Index and High Yield Cash Pay Index (see Citigroup Index, 2013).

[4] 4.5-year cumulative default rates were used as that term corresponds roughly to the average duration of the bonds in those indexes.

[5] The model is called a "hybrid" because it contains a Merton model component along with other statistical and balance sheet information.

As shown in the right panel of Figure 10, the HPD model also includes inputs from four other variables that include:

1. 12-month equity volatility;
2. 12-month equity return relative to the S&P 500 index;
3. Profitability ratio: *P/R = NI/E*; and
4. Book value of leverage, *TL/TA.*

The purpose of the four variables above is to penalize volatile, highly leveraged, and/or unprofitable companies thereby reducing their borrowing capacity. These latter variables are combined with the Merton model variable as shown in the right portion of Figure 10. Notice that the variables are fed into the model as z-scores, with each variable computed as the difference between the long-term average of the calibration universe divided by its standard deviation. Then, coefficients are applied to the five z-score inputs, with the resulting sum put through a non-linear transformation and then mapped to historical default probabilities.

Because the HPD model and its performance at predicting defaults are presented in great detail elsewhere (Sobehart and Keenan, 2002, 2003; Benzschawel, 2013), we limit our discussion of the model herein. The main point is one can obtain reliable estimates of firms' PDs everyday using the HPD model. In addition, to compute expected losses, we obtain estimates of firms recovery values in default form Citi's Decision-Tree default model (Benzschawel, Haroon and Wu, 2011).

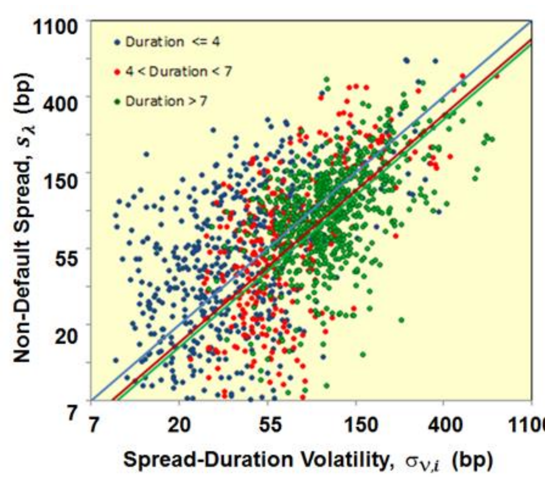
The Credit Risk Premium: If the hypothesis of a meaningful risk premium in the corporate market is correct, one ought to be able to model the non-default credit spread for bond i on day t as:

$$s_{\lambda,i} = \lambda_t \sigma_{\mathrm{v},i} \quad , \tag{3}$$

where $\sigma_{\mathrm{v},i}$ is the bond's duration-times-spread (DTS) volatility and λ_t is the daily average spread value per unit of spread duration volatility. If so, then on any given day the relationship between bonds' non-default spreads and their spread duration volatilities ought to be related by a constant value of λ_t.

In fact, the data in Figure 11 from a day in June 2015 shows that bonds' values of $s_{\lambda,i}$ as a function of $\sigma_{\mathrm{v},i}$ are well described by a line of slope 1.0 on log-log axis.

Figure 11. Bond's Non-Default Spreads s_λ versus Spread-Duration Volatilities $\sigma_{\mathrm{v},i}$. Points and Best-Fit Lines of Slope = 1.0 are Color-Coded by Duration Bucket, Jun-2015



Source: Citi

In practice, we calculate daily values of λ_t by first defining the market beta (i.e., *β=1*) as the average spread-duration volatility of the of bonds in the median bucket of agency rating and durations.[6] Then for individual bonds, we can compute their betas, β_i as

$$\beta_i = \frac{\sigma_{\mathrm{v},i}}{\sigma_{\mathrm{v},\beta=1}} \tag{4}$$

where $\sigma_{\mathrm{v},\beta=1}$ is the spread-duration volatility of the bond whose *β=1*. We also identify the median value of s_λ in the median bucket and the spread-duration of the bond in our calibration universe whose value of β_i is closest to 1.0 (i.e., having the minimum value of $\sigma_{\mathrm{v},i} - \sigma_{\mathrm{v},\beta=1}$). We designate the ratio of the median non-default spread to spread-duration volatility at *β=1* (i.e., its risk premium relative to duration-times-spread volatility) as

[6] A detailed description of the calculation of the daily risk premium can be found in Benzschawel, Su and Xin (2015).

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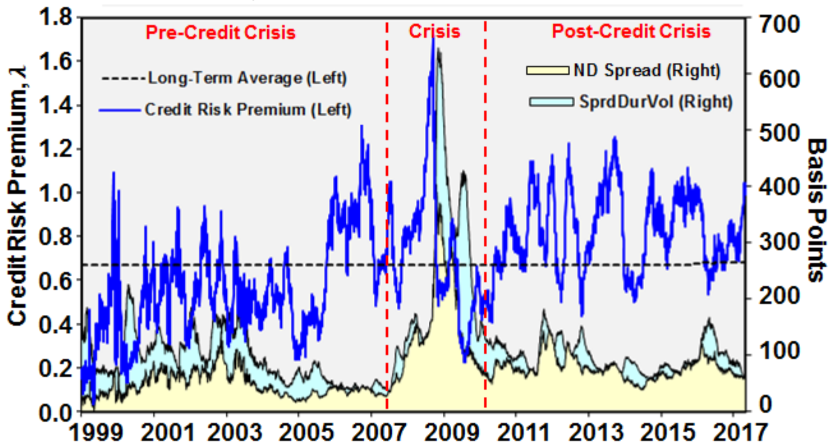
ψ_β and designate that value as the risk premium λ on day t. That is,

$$\lambda_t = \frac{s_{\lambda,i}}{\sigma_{\mathrm{V},\beta\cong1}} = \psi_\beta \quad . \tag{5}$$

Figure 12 shows daily values of the corporate credit risk premium from January 1999 to May 2017 (blue curve referenced to the left vertical axis). Daily values of non-default spreads, $s_{\lambda,\beta=1}$ and duration-times-spread volatility, $\sigma_{\mathrm{V},\beta=1}$ in basis points are also shown (referenced to the right vertical axis). The red vertical lines in Figure 12 serve to mark the period of the credit crisis of mid-2007 to 2010. Inspection of values of the risk premium during pre- and post-crises suggests that the corporate bond risk premium has increased since the credit crisis. That is, the average of daily values of λ_t appear to have risen since the end of the crisis in 2010.

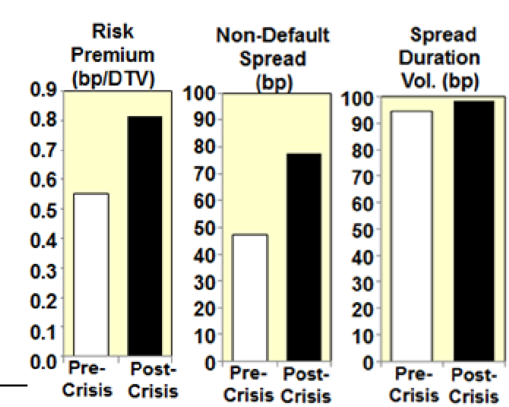
Figure 12. Time Series of Daily Values of the U.S. Corporate Bond Risk Premium, λ_t (Left Axis) and Component Values of Non-Default Spreads, $s_{i,\beta=1}$ and Duration-Times-Spread (DTS) Volatility, $\sigma_{v,\beta=1}$ (Right Axis), 1999-2017



Source: Citi

Figure 13. Average Values of the Credit Risk Premium λ_t, Non-Default Spreads, $s_{i,\beta=1}$, and Duration-Times-Spread Volatility, $\sigma_{v,\beta=1}$, Overall, Before, During, and After the Credit Crisis of 2007-2010

	2009-2017	Crisis		
		Pre	During	Post
Risk Premium, λ_t	0.68	0.55	0.73	0.81
Non-Default Spread (bp)	74	47	150	78
DTS Volatility, σ_v (bp)	116	95	237	99



Source: Citi

Figure 13 presents average values of the credit risk premium λ_t, non-default spreads, $s_{i,\beta=1}$, and duration-times-spread volatility, $\sigma_{v,\beta=1}$ overall from 1999-2017 as well as before, during, and after the credit crisis of 2007-2010. Values are shown in tabular form at the top and graphically below. The average value of the risk premium over the period from 1999 to May of 2017 is 0.68, rising to 0.73 during the credit crisis. The pre-crisis average is 0.55 and post-crisis is 0.81. Also, the average non-default spread $s_{i,\beta=1}$ is 74bp, rising during the credit crisis to 150bp. The pre-crisis average non-default spread is 47bp, with the post-crisis level falling from 150bp to 78bp, still well above the pre-crisis level. An *F-test* on the differences between pre- and post-crisis average values of the risk premium is highly significant (*F=1.60, p.< 0.001*),[7] indicating that there has been a change in the level of the risk premium since the end of the credit crisis.

[7] That is, there is a less than 1 in 1,000 chance that the observed difference between the pre- and post-crisis levels of the risk premium is due to chance.

Notice also in Figure 13 how levels of duration-times-spread volatilities have changed over the period. That is, the average value of the DTS volatility, $\sigma_{\nu,\beta=1}$, over the entire period is 74bp, rising to 237bp during the credit crisis. The pre-crisis level of DTS volatility is 95bp and fell back to those levels at 99bp post-crisis. The fact that volatilities of spreads are similar before and after the crisis, yet the average non-default spread has increased over 50% supports the notion of a decrease in credit market liquidity since the credit crisis.

Implications for Corporate Market Liquidity: The current results make clear that the price of risk in the corporate bond market has risen since the credit crisis. Nevertheless, the implications regarding corporate market liquidity are complicated. That is, it is not clear if the cause of the rise in the credit risk premium reflects decreases in bond market liquidity or some other factor such as investor risk aversion. Also, it might be suggested that the effect of increases in the relative proportion of illiquid bonds traded (see Figure 7), may underlie the increase in the measured value of the risk premium. However, the fact that the market is charging a greater yield premium for illiquid bonds is enough to suggest that liquidity has decreased. One possible explanation for the increase in risk premium since the crisis is that it has become more expensive for both dealers and investors to finance cash positions. That is, the increase in risk premium may reflect the decrease in available leverage in the financial system.

Summary

The objective of this report was to document the observed increase in the price of risk in the corporate bond market since the credit crisis of 2008-2010 as it impacts the debate regarding changes in corporate bond market liquidity. There is considerable disagreement as to whether corporate bond liquidity has decreased since the credit crisis and evidence was presented to support both views. Market participants overwhelmingly report decreases in liquidity. Yet nearly all authors of empirical reports fail to conclude that liquidity has decreased. These reports, most often supported by government or regulatory agencies, cite decreases in average bid/ask spreads, increasing trade volume, and decreasing impact of trade size as evidence for a liquidly functioning corporate bond market. Furthermore, while acknowledging decreases in dealer balance sheets and inventories, these authors argue that post-crisis changes in corporate market dynamics underlie whatever evidence would support the argument for decreases in liquidity.

Dealer inventories have fallen sharply amid record new corporate bond issuance. Also, although trading volume has increased since the crisis, the volume divided by size has decreased and the amount traded per unit face outstanding (i.e., the turnover) has also decreased. Even though bid/ask spreads have decreased, average trade sizes have also decreased serving to account, at least in part, for decreasing bid/ask spreads. In addition, the proportion of trading in illiquid bonds has increased and the premium for trading those bonds has increased. Add to this the fact that the price of risk in the corporate bond market has increased by over 50% since the credit crisis and it is hard to escape the conclusion that the dynamics of the corporate bond market have changed. Whether these changing dynamics are called changes in “liquidity” may be just a matter of semantics if one restricts the argument to measures of liquidity such as trading volume and bid/ask spreads. Finally, it was suggested without proof that the increases in the credit risk premium may reflect general decreases in market liquidity, reflecting increased costs of funding cash positions by dealers and investors.

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