Understanding Corporate Bond Spreads Using Credit Default Swaps

Alejandro Garcia and Jun Yang, Financial Markets Department

- *Since the beginning of the credit crisis, spreads on corporate bonds (the difference between the yields on a corporate bond and a government bond with identical cash flows) worldwide have widened markedly.*
- *This article decomposes Canadian corporate spreads into default and liquidity components for selected Canadian firms, using a model that extracts default information from credit default swaps.*
- *During the credit crisis in 2008, the liquidity component for speculative-grade bonds increased earlier than it did for investment-grade bonds, which is consistent with a "flight-to-quality" scenario.*
- *Although the results are based on a small sample of Canadian firms, they are consistent with recent research on how liquidity risk is priced in corporate bond markets.*

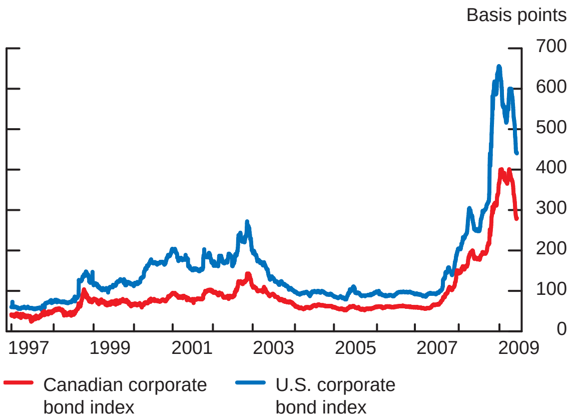
Since the beginning of the credit crisis in mid-2007, corporate spreads worldwide widened markedly. In Canada, the aggregate spread for investment-grade firms reached a maximum of 401 basis points (bps) in January and March of 2009, substantially more than the historical average of 92 bps; the spread on the equivalent index in the United States reached 656 bps in December 2008, also substantially more than its historical average of 153 bps **(Chart 1)**.[1] Owing to the problems in funding markets, corporations and financial institutions began to replace "risky" assets with "safer" ones; this "flight-to-quality" effect resulted in large price declines in equity and corporate bond markets and increases in prices in the government market.

In this article, the corporate bond spread is defined as the difference between the yields on a corporate bond and a government bond with identical cash flows. Under this definition, the corporate spread reflects the additional compensation required by investors to hold the corporate bond compared with the return on the default-free asset (the government bond). This additional yield compensates investors for two types of risk: (i) the risk of default, i.e., that the firm may not be able to meet the promised cash flows; and (ii) the liquidity risk, i.e., the risk that the investor may not be able to sell the bond quickly, before it matures, without a significant discount to the existing market price.

Since promoting financial stability is part of the mandate of central banks, they have a natural interest in understanding what drives changes in corporate spreads—default risk, liquidity risk, or both—since

1 The average spreads for Canada and the United States are calculated for the period from 31 December 1996 to 18 May 2009, using the Merrill Lynch corporate indexes for investment-grade firms. The new maximum spreads surpassed previous record highs for this period of 272 bps on 10 October 2002 for the United States and 143 bps on 24 October 2002 for Canada.

Chart 1: Corporate bond spreads in Canada and the United States



Note: Merrill Lynch spreads for broad corporate indexes. Corporate yield spreads are adjusted only for embedded options. Sample: 31 December 1996 to 18 May 2009.
Sources: Bloomberg, Merrill Lynch

their policy response will be different, depending on which factor is responsible. If, for example, rising corporate spreads result mainly from an increase in liquidity risk, and the central bank judges that this warrants intervention, then it might address the situation, at least in part, by providing liquidity. In contrast, if rising spreads are the result of increased default risk, the appropriate policy response may be quite different.[2] Decomposing corporate spreads is not easy, because both components are unobservable and possibly correlated.

This article is part of a series of papers that studies the risks—mainly default and liquidity—that are priced into corporate bond spreads.[3] Its contributions to this research agenda are as follows: (i) the use of information from the credit default swap and bond markets for Canadian firms; (ii) analysis that is performed at the firm level; and (iii) a focus on Canadian firms that access funding in the United States.[4]

Related Literature

For some time, researchers have been investigating how much of the corporate bond spread is attributable to default risk and how much stems from liquidity risk. Corporate spreads seem to be too high for default risk to be the only contributing factor; in addition, they are inconsistent with historical default rates and recoveries (Elton et al. 2001). Observed corporate spreads are also inconsistent with traditional structural models based on Merton (1974) (Huang and Huang 2003). As well, changes in spreads on corporate bonds are not well explained by changes in the factors affecting default risk (Collin-Dufresne, Goldstein, and Martin 2001), and the unexplained portion appears to have a common factor. Liquidity risk may therefore be an important factor affecting corporate spreads, since corporate bond markets are much less liquid than government bond markets. Various approaches are used in the literature to measure the two components of corporate bond spreads. These approaches are detailed next.

Liquidity component

Researchers have used different methods to measure the liquidity of corporate bonds and to study the relationship between liquidity, liquidity risk, and corporate spreads. Chen, Lesmond, and Wei (2007) use implicit bid-ask spreads and the frequency of zero returns to measure the liquidity of corporate bonds. Chacko (2005) and Mahanti et al. (2008) use the turnover of portfolios holding the bond, and others (Edwards, Harris, and Piwowar 2007; Goldstein, Hotchkiss, and Sirri 2007; Bao, Pan, and Wang 2008) use measures of the impact on prices. In general, they find a positive relationship between the illiquidity of corporate bonds and their yield spreads. Several recent studies (de Jong and Driessen 2006; Downing, Underwood, and Xing 2007; Acharya, Amihud, and Bharath 2008) analyze how liquidity risk is priced in corporate bond returns. They find that, relative to investment-grade bonds, speculative-grade bonds carry a higher liquidity-risk premium. Most of these papers estimate models focusing on one aspect of illiquidity, such as transactions costs, inventory risk, asymmetric information, or search costs. In addition, most papers relate their illiquidity measures to corporate spreads in regressions, and are therefore not suitable to decompose corporate bonds into liquidity and default components.

Default component

In general, researchers use two methods to estimate the default risk of corporate spreads. One way is to use historical default rates and recoveries; this method ignores the risk premium associated with

2 One reason why the policy reaction may be different for liquidity risk than for default risk is that the former may be the result of a "friction" (i.e., information), whereas the latter may be the result of systematic factors.
3 Garcia and Gravelle (2008) use a structural model with equity data to decompose Canadian corporate spreads.
4 Other work decomposing spreads for Canada focuses on the aggregate index spread, using equity-based structural models instead of prices on credit default swaps (see Garcia and Gravelle 2008).

default risk. Thus, in these models, no consideration is given to the extra premium that investors require to invest in risky securities whose returns are correlated with systematic factors. Another method is to determine default risk relative to other traded financial instruments, such as equity and credit derivatives. According to Merton (1974), equity can be treated as a call option on firm values. Corporate bonds can be treated as a portfolio holding an equivalent risk-free government bond and shorting a put option. Equity prices can be used to extract information about the firm's valuation process, which can then be used to price corporate bonds. The validity of this method requires that the structural models be correctly specified. Huang and Huang (2003) show, however, that since most structural models are misspecified, their results cast doubts on the value of using structural models to decompose corporate spreads.

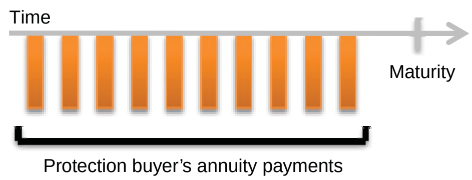
With the growth of markets for credit derivatives in recent years, researchers have started to use credit derivatives, such as credit default swaps, to estimate the default component of corporate spreads (Longstaff, Mithal, and Neis 2005). We use credit default swaps to decompose the spreads on Canadian corporate bonds because, as discussed in the next section, their lower susceptibility to liquidity effects makes them a much purer measure of default risk. In addition, the reduced-form approach we use to evaluate credit default swaps is less prone to misspecification.

Credit Default Swaps

A credit default swap (CDS) is a contract that provides insurance against the default of a particular company. The company is known as the *reference entity*, and a specific bond of the company is known as the *reference obligation*. The quantity of the reference obligation to which the derivative contract applies is known as the *notional principal*.[5] In a CDS, there are two parties to the contract: the *buyer* of credit protection makes periodic payments to the *seller* of the credit protection until either the contract matures or there is a default event by the company. In exchange for the periodic payments made by the buyer, the seller agrees to pay the buyer the difference between the face value and the market value of the reference obligation if a credit event occurs. If no default occurs, the protection buyer still makes all the agreed-upon payments. There is a payment to compensate for default losses only in the case of a default.

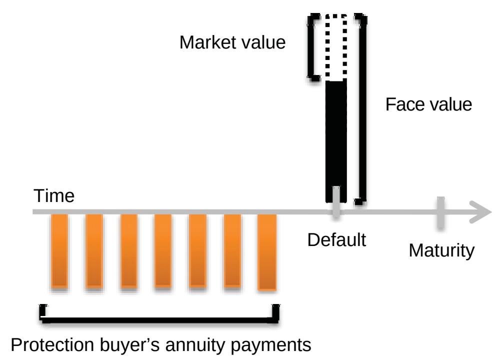
Figure 1 shows the cash flows for a typical CDS when no default occurs, while **Figure 2** shows cash flows in a default scenario. The orange boxes represent the annuity payments made by the protection buyer, while the black box in Figure 2 represents the payment that the protection seller makes to the protection buyer upon default.

Figure 1: Credit default swap: Cash flows when there is no default



Note: The orange boxes represent the payments made by the protection buyer to the protection seller.
Source: Bank of Canada

Figure 2: Credit default swap: Cash flows when default occurs



Note: The orange boxes represent the payments made by the protection buyer to the protection seller. The black box represents the payment made by the protection seller to the protection buyer at default.
Source: Bank of Canada

As in any swap, the premium (which determines the annuity payments) is the rate that equates the expected streams of cash flows that the buyer and the seller make. The CDS premium therefore contains information on the default probability associated with a reference entity, since this information is embedded in the expected payment made by the protection seller.

CDS contracts are commonly used to extract proxies for default risk for several reasons. As contracts, not securities, CDSs are far less sensitive to liquidity

5 The total outstanding notional principal of CDS contracts for a given reference entity can exceed the total amount outstanding of the reference obligation.

effects, since securities are in fixed supply, while the supply of CDSs can be arbitrarily large. Because of this reduced sensitivity, CDSs provide a better measure of default risk. As well, it is less costly for investors to liquidate CDSs prior to maturity than to liquidate a corporate bond, since investors simply enter into a swap contract in the opposite direction. Further, CDSs are not likely to become “special” like treasury bills, or “squeezed” like corporate bonds.[6] In principle, therefore, CDSs should contain mainly default information about the reference entity. However, they are not totally immune to liquidity effects, since search costs may be high for illiquid CDS contracts.[7]

In principle, CDSs should contain mainly default information about the reference entity. However, they are not totally immune to liquidity effects.

It is difficult to obtain data from the Canadian-dollar CDS market for Canadian reference entities, since this market is underdeveloped and illiquid compared with the U.S. market. Moreover, because of the illiquidity of the market, these data are likely to contain a non-negligible liquidity component, which violates our basic modelling assumption. An alternative is to use data from CDSs issued in U.S. dollars for Canadian entities. Although better than data from the Canadian-dollar CDS market, these data are available for a limited number of firms, only some of which may have liquid contracts. A caveat persists as well with respect to the degree of liquidity risk embedded in CDS prices—anecdotal evidence suggests that, during a crisis, CDS prices, like corporate bonds, might carry a liquidity-risk premium. In this study, we use the most liquid CDS contracts to decompose Canadian corporate spreads and make every effort to minimize any decomposition bias resulting from potential illiquidity in CDS contracts. In the next section, we present the data used to conduct our analysis, as well as the controls that helped to focus on the most liquid CDS contracts in our sample.[8]

Data

In practice, the CDS quote can be different from the CDS transaction price. The CDS quote reflects the risk characteristics of the reference entity, whereas the transaction price can also reflect the differential in counterparty risk between the protection buyer and the seller. For this article, we use quote data obtained from Markit Inc., the leading provider of CDS data.

We obtained a dataset of Canadian firms for which there are CDS contracts and bonds with a maturity greater than one year. Because of the aforementioned data limitations on Canadian-dollar-denominated CDSs, we use U.S.-dollar-denominated securities (CDSs and bonds). We also need data for the yields on U.S. risk-free zero-coupon bonds, which are obtained from the study by Gürkaynak, Sack, and Wright (2006). Our initial dataset included 38 Canadian firms. Filtering out Canadian Crown corporations, firms with too few CDS or corporate bond quotes, firms without senior unsecured debt, and firms for which the number of common dates between the CDS data and the corresponding bonds are less than a year, we are left with a set of eight large Canadian firms from various sectors of the economy. Six of the firms are rated BBB, while the other two are rated CC (see **Table 1** for selected statistics on the firms' bond data). The bond and CDS data used in the article cover different samples for each firm, beginning as early as June 2006 and ending as late as November 2008.[9]

For the Canadian firms selected, we prepared the data by selecting bonds and CDS prices that had two or more quotes per week and interpolating them linearly, when necessary, to obtain a common day of the week used to change the frequency of the data from daily to weekly. We did this to obtain a dataset where, at each moment in time, there is an observation for the CDS and the bond prices, which allows

6 “Specials” are specific repo rates significantly below prevailing market interest rates for loans of similar maturity and credit risk. “Squeezed” refers to a shortage of supply relative to demand for a particular security, as evidenced by a movement in its price (or its repo rate) to a level that is not in line with the prices of comparable securities.

7 Longstaff, Mithal, and Neis (2005) use the most liquid CDS contracts in their study.

8 Note that default risk on Canadian-dollar and U.S.-dollar bonds issued by the same Canadian entity may differ, to the extent that they could be subject to different rules governing default or debt workouts in different jurisdictions.

9 The sample data available for the eight firms used here are for the following periods: Firm 1, 30 June 2006–14 November 2008; Firm 2, 23 June 2006–31 October 2008; Firm 3, 8 June 2007–24 October 2008; Firm 4, 22 June 2007–31 October 2008; Firm 5, 14 July 2006–7 November 2008; Firm 6, 30 June 2006–7 November 2008; Firm 7, 10 November 2006–14 November 2008; and Firm 8, 30 June 2006–31 October 2008.

Table 1: Firms' bond data

Rating	BBB	CC
Number of firms	6	2
Minimum number of bonds	2	3
Maximum number of bonds	3	4

Note: Data from Markit Inc. cover the period June 2006 to November 2008. The BBB rating includes all ranges within the BBB category. CC-rated firms were downgraded to D in April 2009.
Source: Markit Inc.

the model to extract information simultaneously from all prices and thus to decompose the spread.

Table 2 provides descriptive statistics for each CDS contract. The CDS premiums show that the eight firms in our sample can be separated into two groups: sub-investment (or speculative-) grade firms, which includes Firms 1 and 2; and investment-grade firms. Firms in the first group have higher and more volatile CDS premiums, while those in the second group have lower and more stable premiums.

Table 2: Contract data for credit default swaps

	Premiums on credit default swaps (in basis points)			
	Mean	Standard deviation	Maximum	Rating
Firm 1	1,665	1,612	6,984	Speculative
Firm 2	1,082	967	5,995	Speculative
Firm 3	87	64	405	Investment
Firm 4	350	90	538	Investment
Firm 5	108	50	213	Investment
Firm 6	141	57	306	Investment
Firm 7	75	66	337	Investment
Firm 8	71	69	403	Investment

Note: All CDS contracts have a 5-year maturity.
Source: Bank of Canada

Methodology

We use a reduced-form model based on the framework of Jarrow and Turnbull (1995); Lando (1998); and Duffie and Singleton (1999). In this model, investors demand a return for holding corporate bonds that includes the risk-free rate, the default risk of the issuer, and the liquidity premium associated with the security. Similarly, investors demand compensation for selling the CDS that includes the risk-free rate and the default risk associated with the reference entity (bond issuer). Note that, in the model, we assume that the bond yield includes compensation for liquidity and default risk, whereas the CDS includes compensation only for default risk.[10]

The methodology can be summarized as follows. We have two unobserved variables, liquidity and default, as well as time series for the CDSs and several bond prices for the same reference entity. From the CDSs, we obtain the default factor, which is used to obtain the liquidity factor from the bond prices. We are able to determine both factors by estimating the parameters of the model to minimize pricing errors.[11] We proceed to create a synthetic zero-coupon 5-year bond. For the synthetic bond, we find the corresponding yield to maturity and subtract the risk-free rate to obtain the corporate spread. The corporate spread thus obtained is then decomposed into its default component, such that the yield to maturity includes only the risk-free rate and the default compensation, and its liquidity component (the difference between the corporate spread and the default component).

Results

We first analyze the results around three key events: (i) the Bear Stearns liquidation of two hedge funds that invested in various types of mortgage-backed securities on 31 July 2007; (ii) the announcement by the Federal Reserve Bank of New York that it would provide term financing to facilitate the acquisition by JPMorgan Chase of The Bear Stearns Companies on 24 March 2008; and (iii) Lehman Brothers filing for Chapter 11 bankruptcy protection on 15 September 2008.[12] **Chart 2** shows the decomposition for the average firm from the investment-grade category, and **Chart 3** shows the results for the average firm from the speculative-grade category.

The liquidity component of both investment- and speculative-grade firms started to increase right after the liquidation of the Bear Stearns hedge funds, consistent with the overall market conditions. After the acquisition of Bear Stearns, the investment-grade firms' liquidity and default component decreased slightly, and the speculative-grade firms' components also decreased for a short period. Both of these effects possibly reflect the awareness of government support for troubled firms. After the filing by Lehman,

10 This assumes that the CDS liquidity compensation is negligible.
11 See the **Box** on p. 28 and Longstaff, Mithal, and Neis (2005) for details on the model and the estimation.
12 Another key event was the halt on redemptions on three investment funds on 9 August 2007 by BNP Paribas, France's largest bank. This, with the Bear Stearns acquisition, triggered subsequent events that led to the financial crisis.

Estimating the Model

Let r_t denote the risk-free rate, λ_t the intensity of the Poisson process governing default, γ_t a liquidity premium, and c the continuous coupon rate paid by the corporate bond. Each of the processes r_t, λ_t, and γ_t is stochastic. Following Lando (1998), we assume that a bondholder recovers a fraction $1-w$ (fixed at 50 per cent) of the par value of the bond in the event of default. Then a corporate bond that pays a continuous coupon rate c is priced as follows:

$$\begin{aligned} P_{bond} &= E^Q\left[c\int_0^T e^{-\int_0^t (r_s+\lambda_s+\gamma_s)\,ds}\,dt\right] \\ &+ E^Q\left[\int_0^T e^{-\int_0^t (r_s+\lambda_s+\gamma_s)\,ds}\,dt\right] \\ &+ (1-w)E^Q\left[\int_0^T \lambda_t e^{-\int_0^t (r_s+\lambda_s+\gamma_s)\,ds}\,dt\right], \end{aligned} \tag{1}$$

where T is the time to maturity. Let s denote the continuous premium paid by the CDS buyer. The present value of the premium leg of a credit default swap *(Pre)* can be expressed as,

$$Pre = E^Q\left[s\int_0^T e^{-\int_0^t (r_s+\lambda_t)\,ds}\,dt\right]. \tag{2}$$

The value of the protection leg of a CDS *(Pro)* can be expressed as:

$$Pro = E^Q\left[w\int_0^T \lambda_t e^{-\int_0^t (r_s+\lambda_t)\,ds}\,dt\right]. \tag{3}$$

From equating both payment legs, we obtain the expression for the CDS premium as:

$$s = \frac{E^Q\left[w\int_0^T \lambda_t e^{-\int_0^t (r_s+\lambda_t)\,ds}\,dt\right]}{E^Q\left[\int_0^T e^{-\int_0^t (r_s+\lambda_t)\,ds}\,dt\right]}. \tag{4}$$

To obtain closed-form evaluations for both corporate bonds and CDSs, we specify the risk-neutral dynamics for default-intensity process λ_t and liquidity process γ_t as follows:

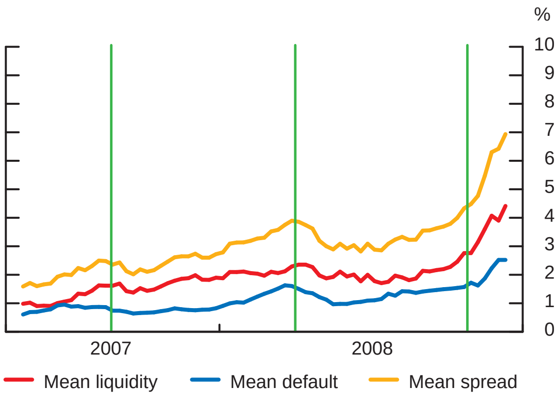
$$\begin{aligned} d\lambda_t &= (\alpha-\beta\lambda)dt+\sigma\sqrt{\lambda}\,dZ_t \\ d\gamma &= \eta\, dZ_t. \end{aligned} \tag{5}$$

The closed-form formula for both corporate bonds and CDS premiums can be found in Longstaff, Mithal, and Neis (2005). To estimate the model, we minimize the pricing error for the CDS premiums and the bond prices associated with a given firm. We recover λ_t from time-series observations of CDS premiums;[1] then, at each time t, we recover γ_t by minimizing the percentage pricing errors from at least two corporate bonds at time t. We find maximum-likelihood estimates for those parameters by minimizing the sum of corporate bond pricing errors over the entire sample.

1 The initial values used for the parameters are reasonable estimates, based on the literature and recent evidence.

Chart 2: Corporate bond spreads for an average investment-grade firm

Synthetic zero-coupon 5-year bond

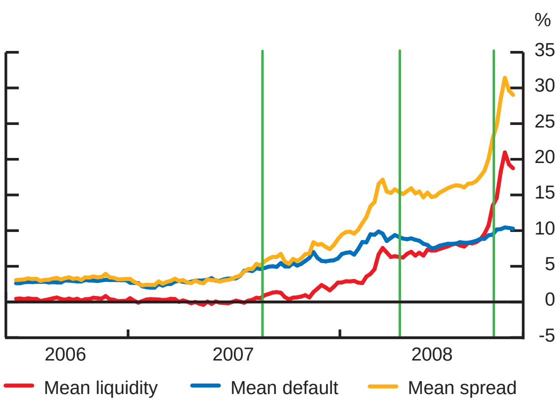


Note: The green lines represent the dates when Bear Stearns liquidated two hedge funds that had invested in mortgage-backed securities (31 July 2007), the Federal Reserve Bank of New York announced that it would provide term financing to facilitate JPMorgan Chase's acquisition of Bear Stearns (24 March 2008), and Lehman Brothers filed for Chapter 11 bankruptcy (15 September 2008).

Source: Bank of Canada estimates

Chart 3: Corporate bond spreads for an average speculative-grade firm

Synthetic zero-coupon 5-year bond



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Source: Bank of Canada estimates

the default component of the average investment- and speculative-grade firm started to increase, while the liquidity component for both increased substantially. It is difficult to determine the medium-term impact of the filing by Lehman, since there are only a limited number of days for which the CDS data for Canadian firms are still reliable. After September 2008, the CDS data quickly become unreliable as a pure source of default risk, owing to reduced trading—or no trading at all—in the market. Right after the filing by Lehman, however, we notice that, for both types of firm, it is the increase in the liquidity component that dominates the change in the spread. This is in line with the drastic deterioration in North American credit markets.

In more general terms, our results show that, for investment-grade firms, the majority of the spread corresponds to liquidity; on average, the liquidity component accounts for 63 per cent of the spread. For speculative-grade firms, it is the reverse—the majority of the spread corresponds to default, with the default component accounting for 77 per cent of the spread, on average.[13] In addition, our results provide evidence that the liquidity component increased earlier for the speculative-grade firms.

For investment-grade firms, the majority of the spread corresponds to liquidity. For speculative-grade firms, the majority of the spread corresponds to default.

These results are consistent with those of de Jong and Driessen (2006) and Acharya, Amihud, and Bharath (2008) in finding that the credit crisis has had a larger impact on speculative-grade than on investment-grade bonds. As shown in Charts 2 and 3, the overall spread is much higher and the liquidity component (red line) increased markedly and earlier for speculative-grade firms.[14] For the average investment-grade firm, the increase in the liquidity component was less drastic than the corresponding increase for the average speculative-grade firm, at least prior to the Lehman filing, after which it dominates the change in the spread. At this point, however, the CDS data are a less-reliable source of default risk.

Similarly, a comparison of the volatility of the liquidity component across firms shows that spreads for (speculative-grade) firms 1 and 2 exhibited larger volatilities in their liquidity component than did (investment-grade) firms 3 to 8 **(Table 3)**. Although firm 7 has a mean liquidity component higher than that of firm 2, the associated standard deviation is much smaller.

13 For speculative-grade bonds, the liquidity premium is a smaller share of a wider spread, and thus is larger in absolute terms.

14 Note that the vertical axis in Chart 3 is more than three times larger than the one in Chart 2.

Table 3: Volatility of the liquidity component (%)

	Mean	Standard deviation	Rating
Firm 1	4.13	5.74	Speculative
Firm 2	2.14	3.85	Speculative
Firm 3	1.58	0.37	Investment
Firm 4	1.57	1.04	Investment
Firm 5	1.39	0.74	Investment
Firm 6	1.98	1.12	Investment
Firm 7	3.00	0.63	Investment
Firm 8	0.93	0.98	Investment

Note: The level of the liquidity component is obtained from the total spread minus the spread with only default taken into account.
Source: Bank of Canada

Conclusion

In this article, we used a reduced-form credit-risk model to decompose the spread for Canadian firms that issue bonds in the U.S. market. Our main results suggest that the proportion of liquidity and default risk varies across firms and over time, and that the nature of the variation depends on the nature of the shock to the economy. More-specific results that apply to the credit crisis of 2007–08 are: (i) the relative size of the liquidity component in corporate bond spreads is larger for investment-grade bonds than for speculative-grade bonds; (ii) both the liquidity and default components of corporate spreads for speculative-grade bonds increased markedly after the beginning of the crisis; and (iii) the liquidity component increased more for speculative-grade bonds during the credit crisis, which is typical of a “flight-to-quality” phenomenon. While these findings are consistent with intuition, they should be verified with a larger sample of firms once more data become available as the market for CDSs for Canadian firms develops further.

The proportion of liquidity and default risk varies across firms and over time, and the nature of the variation depends on the nature of the shock to the economy.

A key implication of these results is that, in designing policies to address problems in credit markets, it is important to consider that the liquidity component in corporate spreads for investment- and speculative-grade bonds behaves differently than the default risk, especially during crisis episodes.

Future work on the decomposition of corporate bond spreads should focus on: (i) the study of Canadian-dollar-denominated corporate bond markets, (ii) comparing different methods of decomposing Canadian corporate spreads, and (iii) incorporating time-varying default- and liquidity-risk premiums in the analysis. In addition, appropriate policy responses under different conditions should be investigated.

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