IFRS 17 Series

OCTOBER 2019

Authors

Alasdair Thompson

Nick Jessop

Moody's Analytics Research

Contact Us

Americas
+1.212.553.1658
clientservices@moodys.com

Europe
+44.20.7772.5454
clientservices.emea@moodys.com

Asia (Excluding Japan)
+852.2916.1121
clientservices.asia@moodys.co

Japan
+81.3.5408.4100
clientservices.japan@moodys.com

IFRS 17 Credit and Illiquidity Premia Sensitivity and Backtesting

Executive Summary

Any methodology to set credit and illiquidity premia for the purpose of defining liability discount curves must be able to produce coherent and stable results over time to be of practical use for insurers. This paper analyzes the sensitivity to changes in underlying assumptions for Moody's Analytics discount curve methodology with respect to IFRS 17 and performs backtesting of the method to understand how corporate credit spreads would have been decomposed into credit and illiquidity risk at key points in time.

CONTENTS

Introduction

Under IFRS 17, insurers are required to discount the value of their liabilities using a discount curve that reflects the cash flows and liquidity of those liabilities. The standard does not prescribe the method by which this discount curve is calculated, but does offer general principles for constructing a curve by either a “bottom-up” or “top-down” method. In a previous white paper (Thompson and Jessop 2018), we offered one method by which this calculation could be performed by using Moody’s Analytics Expected Default Frequency (EDF™) model of real world defaults to calculate credit adjustments on a portfolio of corporate bonds. Although this method can be most easily classified as a top-down approach to calculating the discount curve, we believe the implied illiquidity premia that can be derived using our method are also applicable to insurers following a bottom-up approach.[1] A follow-up paper (Thompson and Jessop 2019) applied this method to a range of economies across Europe, Asia, and North America and calculated credit risk and illiquidity premia, showing how this could be decomposed across ratings, sectors, and maturities.

For a method to be of practical use by insurers, it must produce sensible and interpretable results over time, and it must understand changes in the decomposition of market spreads between credit and illiquidity risk. Recently, a number of works have shown that the assumptions made about discount rates and how they are applied can have significant implications for an insurer’s balance sheet, future profits, and volatility (Conn 2019, Morrison 2019).

In this paper, we calculate the sensitivity of the implied illiquidity premium to a range of stresses to underlying data that we input into our model. We then analyze the historic correlations between these risk factors and finally perform a full backtest of the model for a selected range of dates and economies.[2]

---

[1] Indeed, since illiquidity premia are not something that can be observed directly on the market, we believe that most bottom-up calculations will need to use a hybrid method where the cost of liquidity is derived from a top-down analysis. The volatility adjustment under Solvency II could be seen as one such hybrid method where the volatility adjustment is derived by EIOPA by making a credit adjustment to a top-down portfolio, but it is then applied bottom-up by insurers by adding it to a risk-free curve.

[2] For the purposes of this paper, we use dates and economies for which we already hold data as part of our standard ESG calibration process.

Stress Sensitivity Analysis

Understanding the sensitivity of the credit and illiquidity premia to changes in the underlying risk drivers allows us to gain confidence in the model and to predict how it will behave under different market conditions. We conduct a simple sensitivity analysis of our credit risk model by stressing each of the core risk factors in turn on a univariate basis and examining how the average implied illiquidity premia across a portfolio of corporate bonds moves under each test.

A series of multiplicative stresses are applied to each variable, so that for every bond in a given sample, the same multiplicative stress is applied—for example, every EDF increases by 10%. For each stress scenario, we run the portfolio of bonds through our credit adjustment algorithm to determine the stressed cost-of-capital, stressed market implied returns, and stressed credit risk premia. The linear sensitivity to the stress is then calculated as the gradient of the implied illiquidity premia versus the stressed risk factor. The results of univariate stresses to spread, EDF, loss given default (LGD), and equity risk premium (ERP) are shown in Table 1. These should be interpreted as saying that a 10 bp increase in average spread levels will lead to around a 9 bp increase in illiquidity premium, while a 10 bp increase in LGD will lead to a 0.1-0.3 bp decrease in illiquidity premium.

Table 1 Stress sensitivities for implied illiquidity premia to underlying risk factors

	USD	CAD	EUR	AUD	GBP	HKD	CNY	SEK
Spread	94%	92%	92%	86%	87%	96%	92%	89%
EDF	-16%	-27%	-23%	-13%	-16%	-19%	-20%	-13%
LGD	-1%	-1%	-2%	-2%	-2%	-3%	-2%	-1%
ERP	-11%	-11%	-14%	-10%	-15%	-14%	-6%	-10%

Note that all calculations presented here are in terms of the residual illiquidity premia on an asset portfolio. The sensitivity of the final illiquidity premium applied to discount liabilities under a bottom-up approach would be multiplied by an application ratio that reflected the difference in liquidity characteristics between the asset and liability instuments. This could dampen the impact of changes in the underlying risk factors (assuming the application ratio was less than one).

High sensitivity to spreads, where everything else is kept constant, makes intuitive sense for our model: a change to spreads will not affect the expected loss and will change the unexpected loss only through an increase in the cost-of-capital, which in current market conditions is dominated by the equity term.[3] Hence, most of the impact of a spread stress is passed through to the implied illiquidity premium. The sensitivity to spread changes will be of particular importance when considering the impact of a change in risk-free basis—for example, between government and swap rates or between inter-bank offered rates and overnight indexed swaps. The high sensitivity to spread changes indicates that the change in IP from a change in risk-free basis will be very close to the average basis spread.

In contrast, the relatively low sensitivities to other risk drivers may be less obvious. We can estimate the correct sensitivity by examining the formula for the expected loss:

$$EL = -\frac{1}{T} \cdot \ln(1 - EDF \cdot LGD).$$

Calculating the partial derivatives of this expression gives the sensitivities of the expected loss. To first order in EDF:

$$\frac{\partial EL}{\partial EDF} = \frac{LGD}{T} + \mathcal{O}(EDF),$$

$$\frac{\partial EL}{\partial LGD} = \frac{EDF}{T} + \mathcal{O}(EDF^2).$$

---

[3] Within our model we use a weighted average cost-of-capital (WACC) which is given by the leverage weighted sum of the cost-of-debt and cost-of-equity: WACC=Leverage • Cost of Debt+(1-Leverage) • Cost of Equity. The cost-of-debt and cost-of-equity are, respectively, taken to be the average bond spread across the portfolio and the equity risk premium.

Plugging in the average duration and LGD for the USD portfolio gives a sensitivity for the expected loss of around 7%. If the unexpected loss changes by a similar level, then the total sensitivity for the illiquidity premium should be approximately given by:

$$\frac{\partial IP}{\partial EDF} \approx -\frac{LGD}{T} \cdot \left(1 + \frac{EL}{UL}\right),$$

$$\frac{\partial IP}{\partial LGD} \approx -\frac{EDF}{T} \cdot \left(1 + \frac{EL}{UL}\right).$$

Inserting the average values for the USD portfolio gives an illiquidity premium sensitivity to LGD of -1.3% and a EDF sensitivity of -19%, both very close to the empirical results in Table 1.

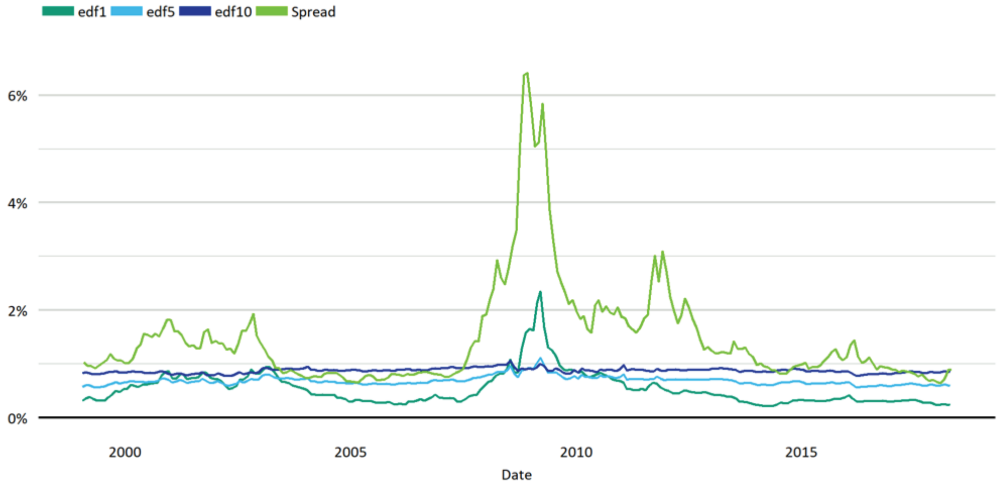
Note that within our calibrations, the global equity risk premium is always 4%. Individual economy equity risk premia will change over time, but the movements will not be large. We include the sensitivity to the choice of equity risk premia here for completeness.

Finally, the variation in sensitivity between different economies reflects the point-in-time nature of these sensitivity results. It also shows the fact that each sensitivity depends on the levels of both the variables under consideration (the relationship between the independent and dependent variables is not necessarily linear) and the level of the other variables: when the EDF is higher, the sensitivity to LGD will be higher, and vice versa.

Historic Correlations

The sensitivity analysis in the previous section revealed how the credit and illiquidity premia vary in response to univariate changes in the underlying risk drivers. In reality, however, these risk drivers are far from independent. In practice the EDF will be correlated with spreads and is directly driven by changes in leverage and volatility. Figure 1 shows a strong correlation between average 1-year EDF and spreads (in particular, the figure shows 5-7 year A rated spreads, though spreads themselves show a high correlation across ratings and maturities), but the correlation is significantly less pronounced for longer-term default probabilities.[4] Note that the average EDF term structure actually inverts around the financial crisis in 2009, with 1-year default probabilities higher than 5- or 10-year. The 10-year EDF in particular is, on average, almost completely constant over time.

Figure 1 Average EDF at 1-, 5-, and 10-year horizons for US issuers alongside USD 5-7 year A rated spreads.



For other economies there is a similar effect. Table 2 shows the correlations between mean 1- or 5-year annualized EDF and year A 5-7 spreads for a range of economies.

Table 2 Correlation between 5-7 year A rated spreads and annualized monthly EDF

	EUR	GBP	USD
1 Year EDF	65%	29%	83%
5 Year EDF	22%	-3%	79%

Changes in EDF are not strongly correlated with changes in spread over short time periods, but generally a stronger correlation is observable when considered over longer time periods: for example, correlation between log changes in EDF and log changes in spreads over 1, 3, 6, or 12 months are listed in Table 3. Figure 2 shows the time series of annual log changes in 1-, 5-, and 10-year EDF compared to year A 5-7 spreads. There is a significant correlation between changes in 1-year EDF and spreads, but very little correlation for longer-term EDF. Notably there is also a lag between changes in spreads and changes in EDF, with annual log changes to mean 1-year EDF correlating most highly with spreads at a lag of 2-4 months. Log changes to 5-year EDF have a less consistent optimal lag and a lower correlation.

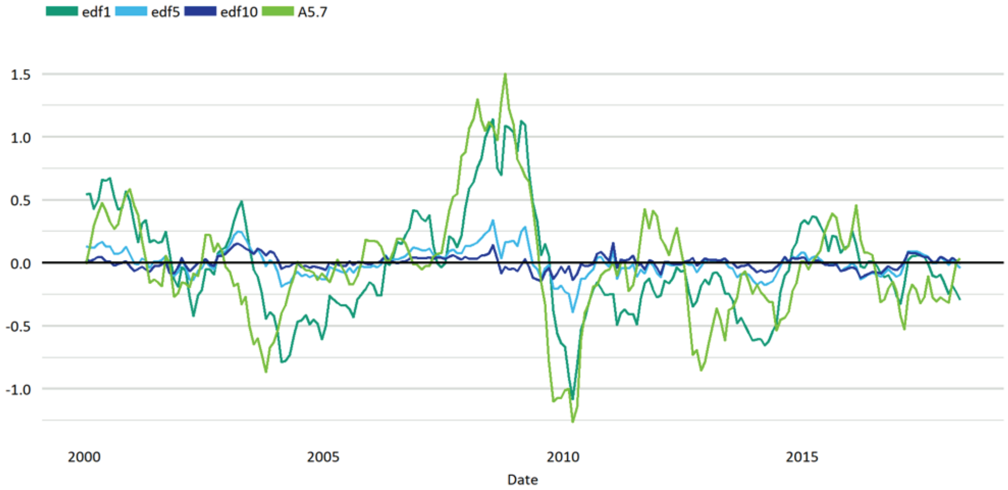
---

[4] Moody's Analytics EDF model estimates a term structure for default probability at horizons from 1 to 10 years. Over the short term, default frequency is driven by both idiosyncratic and systemic factors, while over the longer term idiosyncratic risk dominates, giving a more acyclical result and a more stable probability of default. See Nazeran and Dwyer (2015).

Table 3 Correlation between log changes over different periods for 5-7 year A rated spreads and 1-year EDF

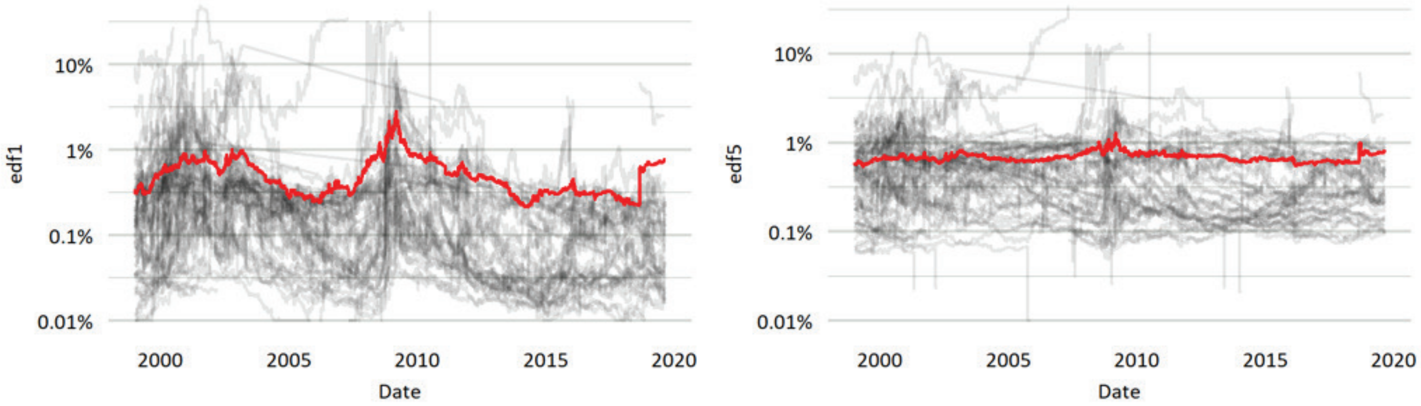
	EUR	GBP	USD
1 Month Change	38%	20%	46%
3 Month Change	48%	29%	55%
6 Month Change	56%	34%	65%
12 Month Change	59%	37%	73%

Figure 2 Annual log changes in average EDF for US issuers and USD 5-7 year A rated spreads



At an individual issuer level, the 1-year and 5-year EDF are highly correlated, reflecting the nature of the EDF term structure model. However, at an aggregated level the correlation is less pronounced, given the greater influence of systematic risk factors within the model at one year than at five years. Figure 3 shows the variation over time of 1-year EDF (left) and 5-year EDF (right) for a random sample of 100 issuers (grey) plus the average across all issuers (red).

Figure 3 EDF for selected US issuers and average US issuer at 1-year horizon (left) and 5 years (right)



These figures show that 1-year EDF varies substantially over time, across several orders of magnitude for individual issuers and over one order of magnitude at an aggregated, average level. At both an individual issuer level and on average variation is much lower for 5-year EDF.[5]

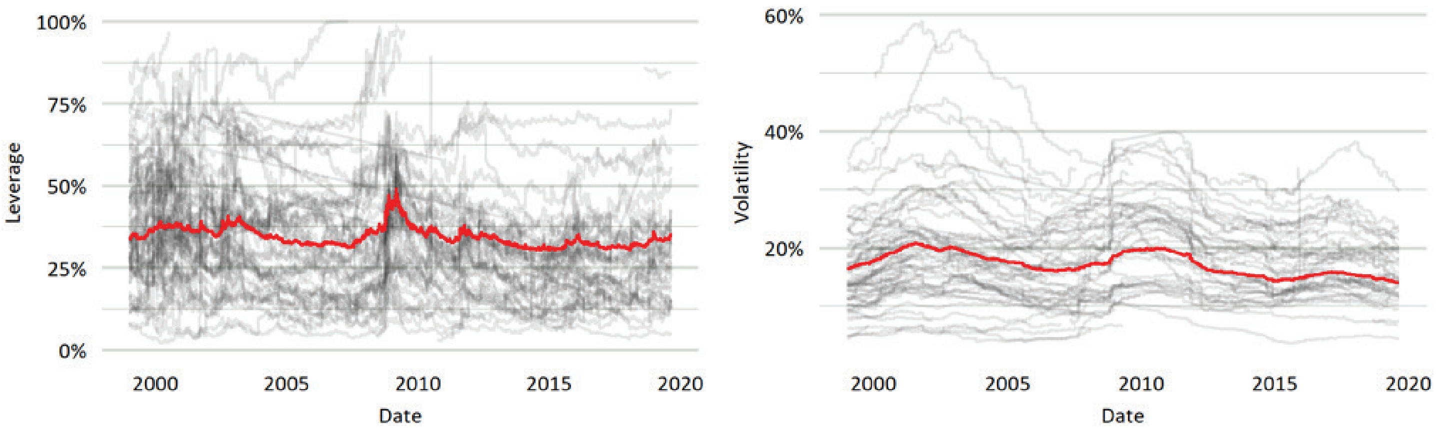
---

[5] At the individual issuer level, the 1-year EDF has a standard deviation around 80% of the mean. This compares to just 38% of the mean value for the 5-year EDF. At the aggregated, average level the 1-year EDF still has a standard deviation of 60% of the mean, while the average 5-year EDF has only a standard deviation of 17% of the mean. All data is for US issuers.

The EDF model itself is driven by a number of risk factors, primarily leverage and volatility. As volatility is calculated over a 3-year rolling window, and does not vary rapidly over time for a given firm (though it does vary between sectors, for example, between financial and non-financial firms), at an aggregated level the main driver for changes in the average EDF will be market leverage.[6]

Figure 4 shows the time series for market leverage and asset volatility for a random sample of US issuers (grey) alongside the mean across all US issuers (red). As expected, while there is noticeable variation between issuers for volatility, for any given issuer or for the average there is little variation over time. Leverage shows slightly higher variation over time for any given issuer but even less variation on average, even though there is widespread variation between issuers.[7]

Figure 4 Leverage (left) and volatility (right) for selected US issuers and average US issuer



Recovery Rate

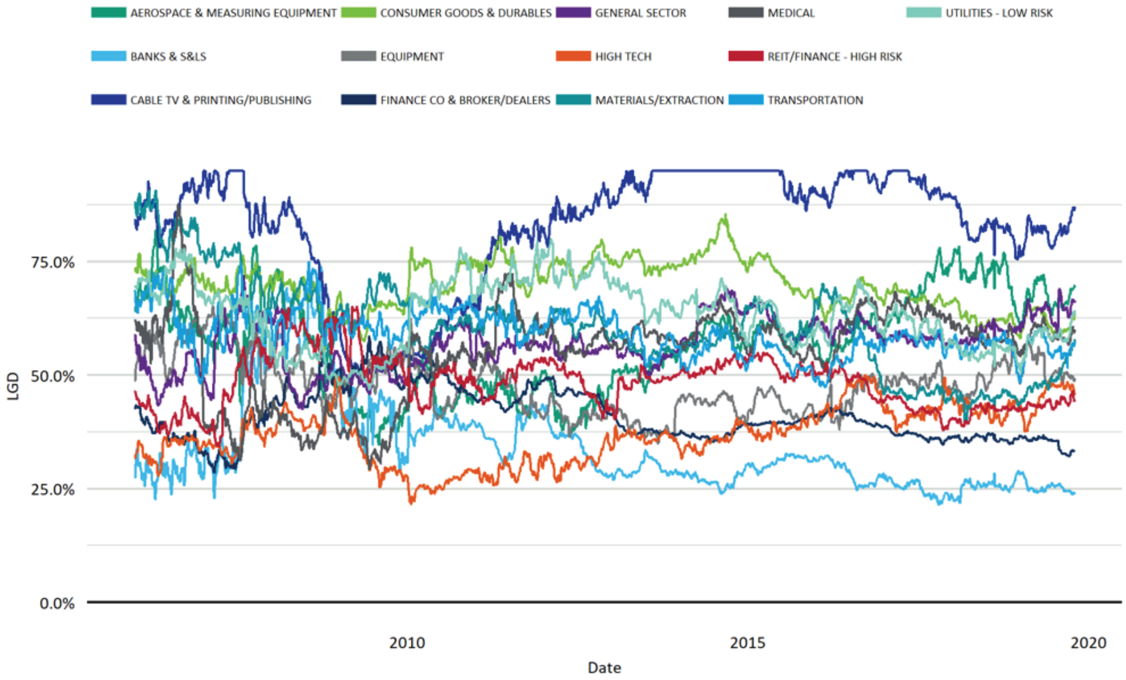
The credit and illiquidity premia will also depend on the assumptions made about recovery rates and in the previous section we calculated the sensitivity to changes in the LGD. Within the CreditEdge™ model, LGD values are calibrated at a sectoral level. The calibration process proceeds by first setting all LGDs to 55% to calculate an overall market price of risk. Once this is set, sectoral LGD values are calibrated for senior and subordinated debt. Since the average LGD is always 55%, we do not expect changes in recovery rates to have a substantial impact over time at an aggregated level. The LGD for particular sectors can vary over time however, as shown in Figure 5. Note that the distribution of the recovery rates between sectors narrows considerably around the financial crisis.

---

[6] See Nazeran and Dwyer (2015) for more details about the drivers of the EDF model.

[7] Average standard deviation of leverage across individual US issuers is 20% of the mean, while the average leverage has a standard deviation of 9% of the mean. For volatility the equivalent figures are 13% and 11%.

Figure 5 Sectoral senior LGD over time

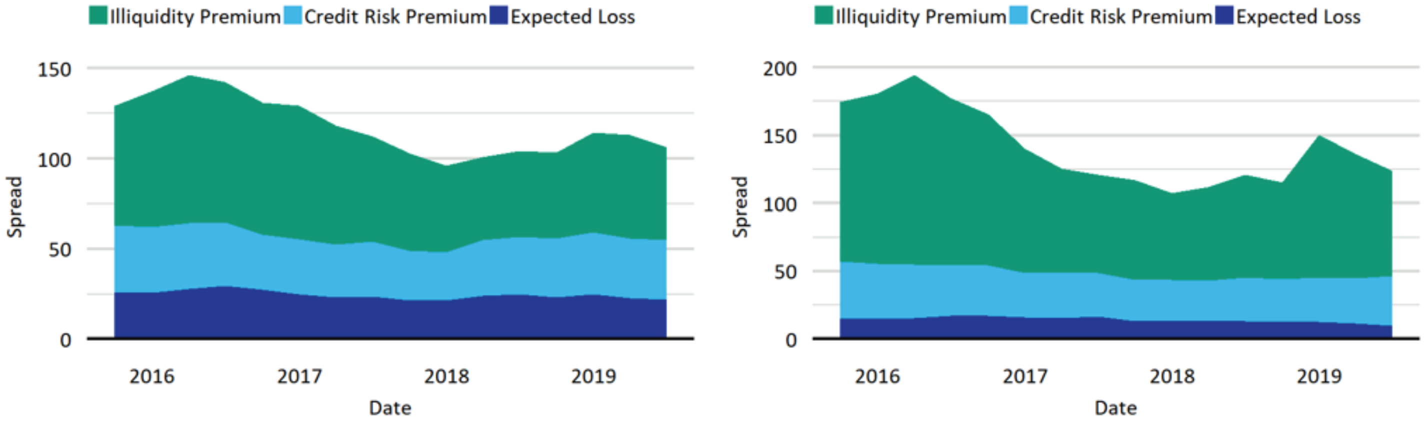


Backtesting the Model

The analysis in the previous two sections suggests that our model should produce illiquidity premia that have a strong, but not perfect, correlation with overall market spreads. We also expect that the credit risk component of shorter dated bonds will be more dynamic than for bonds of a longer duration. A static analysis of univariate sensitivities and a view of historic correlations between these factors can tell us only so much, however. To get a clearer picture of the overall stability of the model and the dynamics of the decomposition between credit and liquidity risk, we now turn to a full backtest of the model.

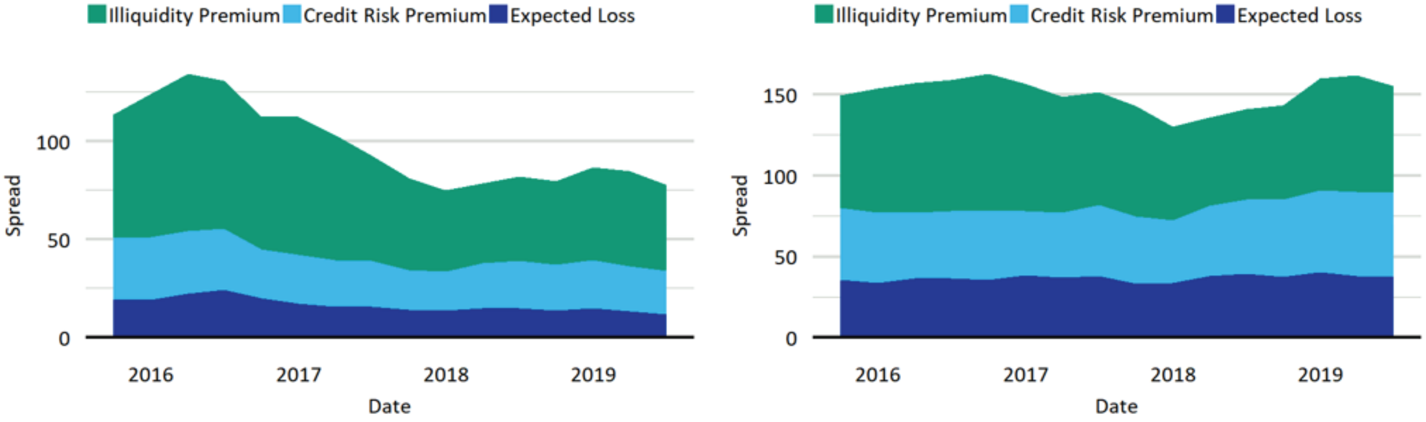
First, we consider the behavior of the model under recent market conditions, absent of any particular market-wide credit event. Figure 6 shows the evolution over the last four years (16 quarters) of the spread decomposition for an AUD (left) and CAD (right) denominated portfolio of investment-grade corporate bonds. In both cases, movements in spread are explained primarily by changes in illiquidity premium. For the CAD portfolio in particular, the credit component of the spread is almost constant over time. For the AUD portfolio, there is a higher correlation between the credit and total spreads.

Figure 6 Components of average (median) spread across an investment-grade portfolio for AUD (left) and CAD (right)



Our analysis of the dynamics of average 1-year, 5-year, and 10-year EDFs revealed that the 1-year EDF exhibited more point-in-time behavior, with a clear correlation to average spreads, while 5-year and 10-year EDFs are more through-the-cycle. We therefore expect that more of the variation in spreads over time will be explained by changes in credit risk for shorter dated bonds, while for longer dated bonds spread changes will be associated with changes in illiquidity premium. Figure 7 shows the decomposition of spread over time for a portfolio of AUD denominated bonds. On the left the portfolio has been filtered to just take the average over all bonds with a duration less than three years, while on the right the averages are calculated over bonds with a duration greater than five years. The average durations of the subsamples are around 1.5 years and 10 years, respectively. The long dated sample shows a very stable total spread and credit component over time, while the shorter dated sample has more variability in both illiquidity and credit components.

Figure 7 Components of average (median) spread across an investment-grade portfolio for short dated (left) and long dated (right) AUD bonds



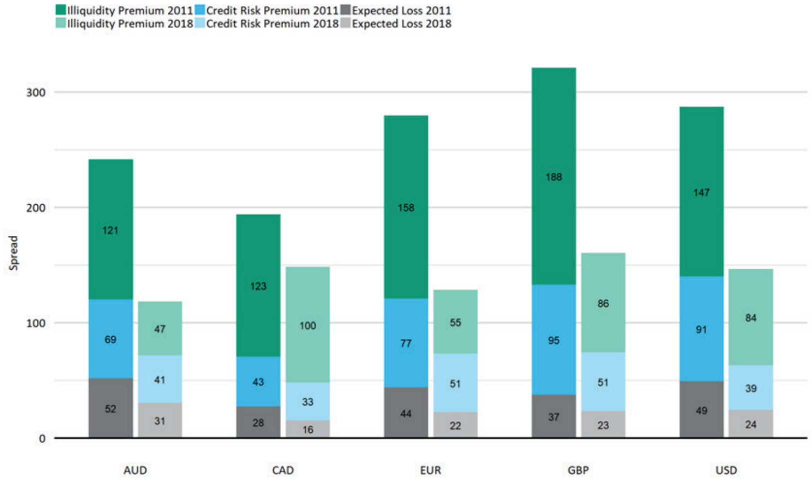
Under stable market conditions, the model produces stable estimates of credit risk and slowly varying illiquidity premia. Under stressed market conditions, the behavior could be significantly different, and the credit risk premium should be significantly larger. In Figure 8 we compare the decomposition of spreads for five economies at two dates: the end of September 2011 (at the height of the Euro sovereign debt crisis) and the end of December 2018. Overall spreads are noticeably higher in 2011 than in 2018 across all economies. Both credit and illiquidity components are higher in 2011. Looking specifically at EUR, we have:

$$\begin{aligned} 2011\text{: } IP &= 67\% \cdot (spread - 44bp) \\ 2018\text{: } IP &= 52\% \cdot (spread - 22bp) \end{aligned}$$

Expected loss was approximately double during the crisis, compared to current conditions.

Comparing 2011 vs. 2018 and working out the increase in the illiquidity premium as a percentage of the increase in spreads, GBP shows 64% and EUR shows 68%. To reconcile these sensititivies with the results in Table 1, note that in the earlier section we considered only univariate stresses, while in this real example the probability of default, the average leverage, and assert volatility will all have changed, which offsets some of the change due to the increase in spreads. In addition, there may BNE distributional, convexity type effects, as the univariate stresses assumed all spreads moved uniformly, while in the real data the shape of the distribution will also have altered.

Figure 8 Spread decomposition for selected economies at the end of September 2011 and the end of December 2018



The ratio of average illiquidity premium to average total spread is shown for each economy in Table 4. The ratio is higher in 2011 for AUD, EUR, and GBP, but lower for CAD and USD. On average, the ratio of credit to illiquidity risk is approximately constant between benign and stressed periods. In two of the five economies the liquidity was a larger component in 2018 while in three it was smaller than in 2011. In addition, the median ratio of illiquidity premia to spread was 57% in 2011 and 54% in 2018.

Table 4 Average illiquidity premia to spread ratio for selected economies between the end of September 2011 and the end of December 2018

	AUD	CAD	EUR	GBP	USD
2011	50%	64%	57%	59%	51%
2018	39%	68%	43%	54%	57%

Conclusion

In this paper, we have attempted to examine the sensitivity and stability of our credit spread decomposition. We have also tried to verify that it can form an appropriate and usable method to define illiquidity premia for the purpose of setting discount curves under IFRS 17. The analysis shows that over short time periods, the majority of movement in spreads will be attributable to changes in liquidity. This is particularly true for long duration bonds, but even for short duration bonds there is a significant sensitivity of illiquidity premia to spread changes. Over longer time periods or under more significant market-wide movements, the credit component will vary such that rather than keeping a constant absolute credit adjustment, there is a consistent ratio of credit adjustment to overall spread.

Compared to a simple proxy that defines the illiquidity premium as a constant fraction of the market spread, our method explains more short term variation in spreads due to changes in liquidity. It also offers a more sophisticated breakdown between portfolios of different durations. This is important as different types of business, whether general insurance or life, for example, will likely be backed by different asset portfolios with different average credit quality and duration. In line with the requirement under IFRS 17 that the illiquidity premium should reflect the characteristics of the liabilities under valuation, our method offers a way to take account of these differences.

Many insurers will want to align their approach to IFRS 17 with existing regulatory or economic capital calculations. In Europe this is likely to mean starting with the Solvency II regulations and internalizing and adapting the calculations as required. For some parts of the calculation, aligning methodology between Solvency II and IFRS 17 may be straightforward—for example, the choice of risk-free rate or the interpolation and extrapolation method and ultimate forward rate. For other parts, such as the credit-risk adjustment, alignment may be more difficult. The European Insurance and Occupational Pensions Authority (EIOPA) specifically adjusts for probability of default and cost of downgrade, but applies a minimum of 35% of the long-term average spread. EIOPA then scales the credit-adjusted spread by a factor of 65% to derive the final volatility adjustment. An insurer that wants to internalize this method would need to justify the use of the 35% floor and 65% application ratio, and the specific choice of those numbers. Furthermore, the EIOPA volatility adjustment provides only a single reference point and a flat term structure that does not account for the differing credit decomposition dynamics across duration and over time.

Further Reading

Conn, Gavin and Steven Morrison, “Profit Emergence Under IFRS 9 and IFRS 17: The impact of choice of liability discount rate,” Moody’s Analytics White Paper, 2019

Morrison, Steven, “Implementing IFRS 17 Discount Curves: Theoretical and Practical Challenges,” Moody’s Analytics White Paper, 2019

Nazeran, Pooya and Douglas Dwyer, “Credit Risk Modeling of Public Firms: EDF9,” Moody’s Analytics White Paper, 2015

Thompson, Alasdair and Nick Jessop, “A Cost of Capital Approach to Estimating Credit Risk Premia,” Moody’s Analytics White Paper, 2018

Thompson, Alasdair and Nick Jessop, “Illiquidity and Credit Premia for IFRS 17 at End December 2018,” Moody’s Analytics White Paper, 2019.

CONTACT DETAILS

Visit us at **moodysanalytics.com** or contact us at a location below.

AMERICAS
+1.212.553.1653
clientservices@moodys.com

EMEA
+44.20.7772.5454
clientservices.emea@moodys.com

ASIA (EXCLUDING JAPAN)
+852.3551.3077
clientservices.asia@moodys.com

JAPAN
+81.3.5408.4100
clientservices.japan@moodys.com

© 2019 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. AND ITS RATINGS AFFILIATES ("MIS") ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND MOODY'S PUBLICATIONS MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT OR IMPAIRMENT. SEE MOODY'S RATING SYMBOLS AND DEFINITIONS PUBLICATION FOR INFORMATION ON THE TYPES OF CONTRACTUAL FINANCIAL OBLIGATIONS ADDRESSED BY MOODY'S RATINGS. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS AND INAPPROPRIATE FOR RETAIL INVESTORS TO USE MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS WHEN MAKING AN INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY ANY PERSON AS A BENCHMARK AS THAT TERM IS DEFINED FOR REGULATORY PURPOSES AND MUST NOT BE USED IN ANY WAY THAT COULD RESULT IN THEM BEING CONSIDERED A BENCHMARK.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY CREDIT RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Moody's Investors Service, Inc., a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by Moody's Investors Service, Inc. have, prior to assignment of any rating, agreed to pay to Moody's Investors Service, Inc. for ratings opinions and services rendered by it fees ranging from $1,000 to approximately $2,700,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at www.moodys.com under the heading "Investor Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

Additional terms for Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001. MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail investors.

Additional terms for Japan only: Moody's Japan K.K. ("MJKK") is a wholly-owned credit rating agency subsidiary of Moody's Group Japan G.K., which is wholly-owned by Moody's Overseas Holdings Inc., a wholly-owned subsidiary of MCO. Moody's SF Japan K.K. ("MSFJ") is a wholly-owned credit rating agency subsidiary of MJKK. MSFJ is not a Nationally Recognized Statistical Rating Organization ("NRSRO"). Therefore, credit ratings assigned by MSFJ are Non-NRSRO Credit Ratings. Non-NRSRO Credit Ratings are assigned by an entity that is not a NRSRO and, consequently, the rated obligation will not qualify for certain types of treatment under U.S. laws. MJKK and MSFJ are credit rating agencies registered with the Japan Financial Services Agency and their registration numbers are FSA Commissioner (Ratings) No. 2 and 3 respectively.

MJKK or MSFJ (as applicable) hereby disclose that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MJKK or MSFJ (as applicable) have, prior to assignment of any rating, agreed to pay to MJKK or MSFJ (as applicable) for ratings opinions and services rendered by it fees ranging from JPY125,000 to approximately JPY250,000,000.

MJKK and MSFJ also maintain policies and procedures to address Japanese regulatory requirements.