IFRS 17 discount rates

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IFRS 17 Insight Series

Author
Nick Jessop
Senior Director
Research

Contact Us
Americas
+1.212.553.1653
Europe
+44.20.7772.5454
Asia-Pacific
+852.3551.3077
Japan
+81.3.5408.4100

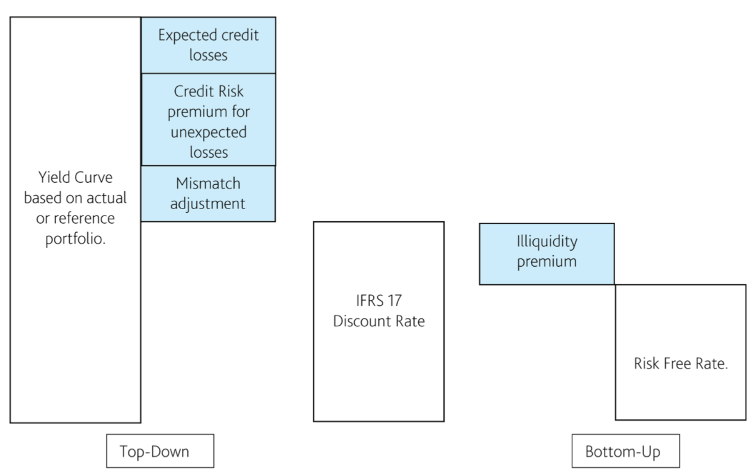
Permitted approaches for constructing IFRS 17 Discount Rates

Introduction

IFRS 17 introduces a requirement for insurers to use fair value and market-consistent approaches to liability valuations as the basis for reporting their accounts. Insurers face a significant challenge in clearly differentiating between the separate components of their balance sheet, and in doing so without introducing artificial noise or volatility into their reporting.

There is likely to be significant scope for accounting mismatches arising from the varied treatment of different aspects of their business. These accounting mismatches, in theory are minimal when assets are measured using fair value options (as opposed to amortized costs[1]). However, careful consideration has to be made of the approach to constructing the discount rates for the insurance contracts to ensure that the net finance results clearly (and exclusively) reflect changes in economic conditions. IFRS 17 allows for two different approaches to yield curve construction and discounting, which in theory, although not necessarily in practice, produce equivalent results. The two approaches are referred to as 'top-down' or 'bottom-up', and are shown in Figure 1.

Figure 1: IFRS 17 yield curve constructing approaches



This paper outlines the key considerations to be addressed when using each approach.

1. Given that the IFRS 17 regulation specifies fair value & market-consistent treatment of liabilities, there is a strong incentive for insurers to use the option of reporting fair value through OCI for assets, even when they are classified as 'held to maturity'. This is in order to avoid accounting mismatches leading to significant volatility in the net financial results (e.g. investment income from assets plus insurance finance expenses from liabilities).

The Bottom-Up Method

Defining a Basis for the Risk-Free rate

A fully liquid risk free yield curve is the foundation for the 'bottom-up' approach outlined in Figure 1. The IFRS 17 standard does not explicitly define the basis for deriving a risk free yield curve. However, it references traded instruments which contain negligible levels of credit risk, are highly liquid, with reliable prices, and cover a broad range of maturities, including longer dated durations and terms. The most common two bases for defining risk free curves used by insurers are either government bond markets, or inter-bank swap rates. However, several alternative bases could potentially be used. Overnight interest rate swaps (OIS swaps) have become increasingly standard in the banking sector. Other options include treasury futures, which are traded over exchanges in increasing volumes, CDS insured government debt, or even low risk (secured) corporate bonds.

In, Europe the two regulatory regimes of Solvency II (SII) and the Swiss Solvency Test (SST) specify swaps and government bonds respectively. For many insurers operating in these regions, consistency might prove a critical consideration in their choice of risk free basis. In other markets, like Canada and the Asia Pacific region, available instruments and market transparency might prove more significant, and industry approaches might be more heterogeneous.

Unlike SII and the SST, where the risk-free or risk-neutral valuation bases are prescribed, there might be scope to use different approaches, or even combine approaches across different portfolios, given that the liquidity adjustment can be estimated relative to different risk-free bases.

Constructing (Fitting) the Risk-Free Curve

The method for fitting the risk-free curve is not explicitly defined in the IFRS standards. Several non-parametric approaches to curve fitting are potentially available, including bootstrapping and fitting cubic or quadratic splines. These approaches do not necessarily guarantee smooth curves, particularly when there is a requirement for the forward rates to be smoothed. But they can be adapted to this purpose when, and if, it is considered appropriate. Fitting a curve through each and every government bond, in particular, can lead to spurious yield curve 'kinks' when there are many different issuances grouped close together in maturity. Parametric approaches to fitting the curves are also possible, of which the most common are variants of the Nelson-Seigel model and the Smith-Wilson technique, which was the curve fitting approach adopted for SII and International Capital Standards.

Adjustments To The Risk-Free Curve

The most common adjustment applied to curves is likely to be a credit adjustment, for example, when it is clear that the instruments being used carry some level of credit risk, as with high-quality corporate bonds or lower quality sovereigns. Simple adjustments like removing a small number of basis points from all maturities to account for credit risk are relatively common, as in the SII credit adjustment. More sophisticated adjustments might include using historical databases on probability of default (PD), transitions and loss given default (LGD), or structural models forecasting term structure for PD and LGD. Another approach could involve using CDS spreads to adjust the curve to represent 'default insured' bonds. These approaches are discussed at further length in the relevant section on the top-down approach.

Estimating Illiquidity Premium for the Liabilities

The most challenging aspect of the bottom-up approach is most likely to be calculating the illiquidity premium adjustment. At a superficial level, the adjustment looks similar to the SII volatility and matching adjustments, known as VA and MA adjustments respectively. However, these adjustments are essentially illiquidity premia estimated for asset portfolios and then carried over, or transferred to the liabilities discount curve. The fundamental approach in IFRS 17 is more explicitly defined. It is an illiquidity adjustment appropriate for the liabilities, while the mechanism for calculation and justification is much more open to interpretation.

In practice, we would expect the problem to be broken down into two steps:

- First, assess, and quantify the degree of liability illiquidity in a contract or group of contracts.
- Second, calibrate the illiquidity premia to a market estimate of liquidity premia.

Estimates of the degree of liability illiquidity should be based on the features of the portfolio of contracts under consideration. For example, how easy and likely is it that the contracts surrendered? While the calibration of the level of the illiquidity adjustment could be inferred from asset portfolios, which are most likely fixed income due to the predictability of their cash flows.

Assuming this approach is used, the market calibration of illiquidity level has significant scope to borrow/leverage from the top-down methods. Unlike Solvency II's Matching Adjustment, where business is defined as matched or not, the degree of liquidity is important. The degree of liability illiquidity might end up being banded: for example, fully liquid or illiquid, 25% or 50% illiquid contract portfolios. This would mean that a single term structure of illiquidity levels estimated from market data could be applied across a range of different portfolios of contracts with different illiquidity characteristics.

The Top-Down Method

Defining a Yield Curve Based on Actual or Reference Portfolio

At first glance, calculating the starting point for the top-down approach might seem a straightforward technical task. Assuming the backing assets for a particular portfolio of contracts are clearly defined, then it should be relatively straightforward to obtain a market price for the portfolio as a whole by building up the constituent holdings. Similarly, it would then be possible to infer the effective portfolio yield using an internal rate of return calculation applied to contractual cash flows. However, usually a flat discount curve is not likely to be suitable or acceptable for IFRS 17 discounting. Constructing the term structure of a yield curve based on a diverse portfolio of holdings is not as simple or straightforward as fitting a risk-free curve. Determining spread curves for a universe of credit risky bonds is a closely analogous exercise. While it is possible to source these types of curves from data vendors like Bloomberg, and from broker-dealers or trading desks, the techniques applied can be as diverse as the resulting curves. For the IFRS 17 application, a key consideration is that the yield curve should ideally replicate the overall price of the portfolio when applied to the assets. It does not, necessarily, however, need to replicate prices of the individual holdings. This distinction is important to avoid accounting mismatches and volatility arising between assets which are marked directly to market and contract liabilities, which are discounted using curves.

At the moment, we are not aware of a standardized and effective method which insurers can use for this part of the curve construction. Insurers are likely to leverage existing methods which might not be ideal for the purpose at hand. This part of yield curve construction is ripe for improvement and a focus for industry-wide research and development.

Estimating Expected Credit Loss and Adjusting for Unexpected Losses (Credit Risk Premia)

Having defined the asset portfolio yield curve, the components of credit risk need to be removed. This can be done in two steps – first estimating expected losses due to default, and then adjusting for unexpected losses (for example, the associated credit risk premium).

The five most common approaches which might be applied are:

1. Using structural modeling techniques (for example, Merton, Kealhoffer- Vasicek or similar). Moody's Analytics EDF™ (Expected Default Frequency) is a widely used industry standard. If estimates for probability of default (PD) and loss given default (LGD) are combined, estimates of credit risk premia[2] (allowing for liquidity and other non-credit contributors to spread netted off) could form the basis of the credit adjustment. Two key advantages of choosing this approach would be broad sector coverage (for example, spanning well beyond rated issuances) and issuer-specific estimates of credit risk (rather than generic proxies).
2. Historical analysis. Many historical databases of default, transitions, and LGD exist, including some produced by rating agencies like our sister company, Moody's Investors Service (for example, the Moody's Investors Service historical default database). This approach is the basis for the SII Volatility and Matching Adjustment estimates and so might be preferred by insurers in Europe. Adjusting for credit risk premia again needs to be done and might be based on expected losses in the tail. One downside of this technique is that the databases tend to be available for only a narrow range of credit sectors, for example, corporate bonds. In addition, there may be questions over the representativeness of the data for forward looking forecasts, and the adjustments tend to be through-the-cycle, for example, not adjusted to the current market or economic environment.

2. The use of a risk premia to explain market prices can be somewhat unintuitive to those used to the strictly risk-neutral valuation framework widely used in option and derivative pricing work. However, the use of risk premia to explain market prices (for example, market spreads) remains relatively common in credit and has its roots in the original Merton (1974) credit model. Some researchers are tempted to argue that the use of risk-premia in pricing the credit default option relies on somewhat weak justification relating to the difficulty in hedging the underlying asset risk. That said, it avoids the need to introduce another (more ad-hoc) explanatory variable, namely the 'implied volatility' concept used broadly in option pricing. Note that a more heuristic derivation (following say the lines of Taleb 2017) leveraging put-call parity cannot really be used as the underlying firm asset value does not trade independently (rather firm equity and debt are priced separately by markets).

3. Market-based methods. Credit Default Swaps might potentially be used to estimate credit risk, as might spreads on highly liquid bonds. One significant problem with this technique is that these markets can be as susceptible to pricing effects like illiquidity as the reference asset portfolio itself. As a result, these techniques might have issues in terms of overstating the credit adjustment or not being adequately representative of credit risk in the portfolio.
4. Simpler proxy techniques. Given the difficulties in estimating and isolating the credit risk premia, it is relatively common to apply simple scaling relationships to the spread levels themselves. For example, one could take away several basis points and then multiply the remaining spread by a multiplier less than 1. The SII VA and MA methodologies apply these types of adjustment as a conservative backstop to the historical analysis without much in the way of explanation. While a simple proxy is easy to implement and to apply, the techniques are highly subjective and do not easily lend themselves to rigorous justification, even if they can be robustly validated and tested.
5. Regression-based estimates of either credit losses or liquidity premia as a function of other explanatory variables. For example, Van Loon et al (2015) estimate liquidity premia as a function of standard bond characteristics including credit quality, sector and maturity.

Asset-Liability Mismatch Adjustments

Having determined the credit adjustment, the insurer must then make an adjustment for asset-liability mismatches. To do so, they must first calculate duration mismatches, or key rate duration mismatches, and higher-order effects like convexity mismatches. These economic risk exposures can then be converted into a mismatch adjustment by estimating probabilistic tail losses that then result from adverse yield curve moves.

Scope for Methodological Consistency and Standardization.

Most aspects of the two yield curve construction approaches are specific to one approach or another. One area ripe for the emergence of an industry-standard consistent approach might be around the method for constructing a yield curve based on a (potentially diverse) actual or reference portfolio. This step in the top-down approach is likely to be important in the context of eliminating accounting mismatches. Other aspects of the discount curve approaches are inevitably liability-specific.

Calculations of the mismatch adjustments, and the degree of illiquidity in liabilities are inevitably done by insurers on a portfolio-by-portfolio basis.

While the corrections for credit losses and credit risk adjustments are associated with the top-down approach, the need to estimate the level of illiquidity premia for bottom-up adjustments could leverage similar underlying modeling approaches. Insurers who choose to use a combination of bottom-up and top-down, in particular, might prefer consistent methodological approaches. Across the industry, there is significant scope for divergence of approach in these areas and a lack of industry consensus/standard. Modeling of expected defaults and losses given default is an area of expertise for Moody's Analytics, and we can supply both standard and customized solutions.

Considerations Common to Either Approach

General Principles

There are some core principles used in constructing yield curves. For yield curve fits we would generally consider the following points:

- Accuracy: liquid markets should be accurately priced
- Continuity: the forward curve should be continuous
- Smoothness: the forward curve should be smooth, for instance, the first derivative should be continuous
- Neutrality where data is missing: avoid extrapolating or interpolating spurious features or views, such as oscillations, humps, or bumps

While not all these points are explicitly stated in the IFRS 17 standard, we believe they must be considered carefully when developing a yield curve method.

Inflation-Linked Liabilities (Including Different Types of Inflation)

When cash flows are not specified in nominal terms, but rather as more than inflation, it is appropriate to use real yield curves for discounting. Market instruments used to construct these curves would typically be government-issued inflation linked bonds, or inflation swaps. In most markets, government bonds are likely to be more liquid, although there can be exceptions in countries like the UK and Netherlands, where defined benefit pension funds are frequent traders in the inflation swap markets. Most of these market instruments are linked to CPI or RPI measures. It is directly relevant for many annuity contracts, but most general insurance contracts might be more closely linked to other inflationary measures, leading to a need to adjust the curves or expected cash flows accordingly.

Yield Curve Extrapolation

One problem specific to long dated contracts like annuities, is extrapolation of yield curves well beyond the longest dated liquid market maturities. Having defined a 'Last Liquid Point' for market quotes there are several possible approaches to use for longer maturities - extrapolating 'flat' based on last liquid spot or forward rate or extrapolating to an 'ultimate' spot or forward rate. The latter approach has become the most common and is the basis for the SII EIOPA specified yield curves. Using this approach, it is necessary to set both an ultimate forward rate level and an extrapolation method. The ultimate forward rate level is based on economic expectations for long term real and inflation rates, possibly including higher order term premia and convexity adjustments. The extrapolation technique is parametric, with Nelson Seigel and Smith Wilson being two examples. As noted previously, Smith Wilson has been adopted for SII.

One point which might well require methodological innovation is extrapolation for the top-down basis. Given the challenges inherent in fitting a curve to an asset portfolio (one which Smith Wilson, for example, is likely not well suited to), it is probable that the extrapolation needs to be explicitly separated from the method used to fit market data.

Incorporation in Stochastic Scenarios

For a portfolio of contracts which must be addressed using the variable fee approach, several different options for contract valuation are needed, including simple analytical approximations and the use of replicating portfolios. One of the most flexible solutions is the use of stochastic market-consistent scenarios generated using an Economic Scenario Generator (ESG). The IFRS 17 standard states that insurers can choose to divide the cash flows generated by variable fee business into separate deterministic cash flows (which can be modeled using yield curves defined as in the 'standard approach'), and stochastic market linked cash flows which must be modeled using option-based valuation techniques. An alternative and possibly more parsimonious approach might be to produce customized IFRS ESG calibrations which embed the IFRS valuation curves as the 'risk-free' basis for valuation. Given the scope for proliferation of different curves for different portfolios of business, this approach might lead to a requirement for many different ESG calibrations. Automation of the process could prove important.

Discussion and Conclusions

The IFRS 17 discount rates (yield curves) are an important component of the new standard. The discount curves affect the values which are shown on the balance sheet: both present value of fulfillment cash flows and contract service margin. They also affect profit and loss and other comprehensive income (OCI), determining the level of insurance finance expenses. The methods applied for yield curve are therefore an important consideration for all insurers following the guidelines.

With IFRS 17, insurers are required to clearly separate out profit and loss or OCI from assets (investment portfolios held) and liabilities (contracts issued). They are also required to report the effect of changes in economic market conditions which lead to changes in market yield curves, on both investment income and insurance financial expenses. For insurers who closely match their asset portfolios to their liability exposures, it should be expected that these separate lines largely net out. However, the extent to which the residual market risk exposures represent the results of true economic mismatches, rather than accounting mismatches (arising from discrepancies in methodology applied to the contract liabilities), depends in no small way on the methods used for yield curve construction.

Our assessment of the different components and options of the yield curve methods lead us to recommend that insurers think carefully about the following points:

» Construction of yield curves for associated (or reference) asset portfolios.

» Estimate of credit risks and especially the associated credit risk premia.

» Estimate of illiquidity (both the degree of liability illiquidity and market price or illiquidity).

Given the requirements for granular modeling of different portfolios of contracts, practical considerations such as proliferation of yield curves, reusability of analytics produced in each step of the calculation, data availability, and suitability and ease of automation (particularly where a correction has to be made specific to a particular line and cohort of business) are also important.

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Authors

Gavin Conn
Director-Research

Steven Morrison
Senior Director-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

Profit Emergence Under IFRS 9 and IFRS 17: The impact of choice of liability discount rate

Introduction

With the introduction of the IFRS 17 accounting standard, it is important that insurers understand the patterns of profit emergence that arise for their business under the standard, and how business and methodology decisions available to the insurer affect such patterns. As a principles-based standard, insurers have several immediate decisions to make in their specific implementation, and such decisions can have a major impact on the timing of reported profit and loss.

In previous papers, we considered some aspects of profit emergence under IFRS 17. The first used an agile modeling methodology to project the IFRS 17 income statement, illustrating the year-on-year volatility of the insurance service result for a group of annuity contracts. The second turned its attention to the variable fee approach and examined financial risk and its impact on contracts with participation features. In this paper, the third in the series on profit emergence, we look at the interaction between IFRS 9 and IFRS 17, illustrated by a case study using an IFRS 17 contract group consisting of immediate annuities. In particular, we consider the impact of different choices of liability discount rate on expected profit emergence and earnings volatility.

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IFRS 17

IFRS 17 introduces changes to the accounting of insurance contracts and replaces IFRS 4, which was intended as an interim standard. IFRS 17 considers the classification and reporting of insurance liabilities and therefore has an impact on the liability side of the balance sheet. To assess the complete picture, we must also consider the changes taking place with the implementation of IFRS 9 which covers the measurement of financial instruments. To evaluate the effect of the new accounting standards on P&L, insurers must be aware of the potential for accounting mismatches if the classification choices under IFRS 9 are inconsistent with the treatment and classification under IFRS 17.

IFRS 9

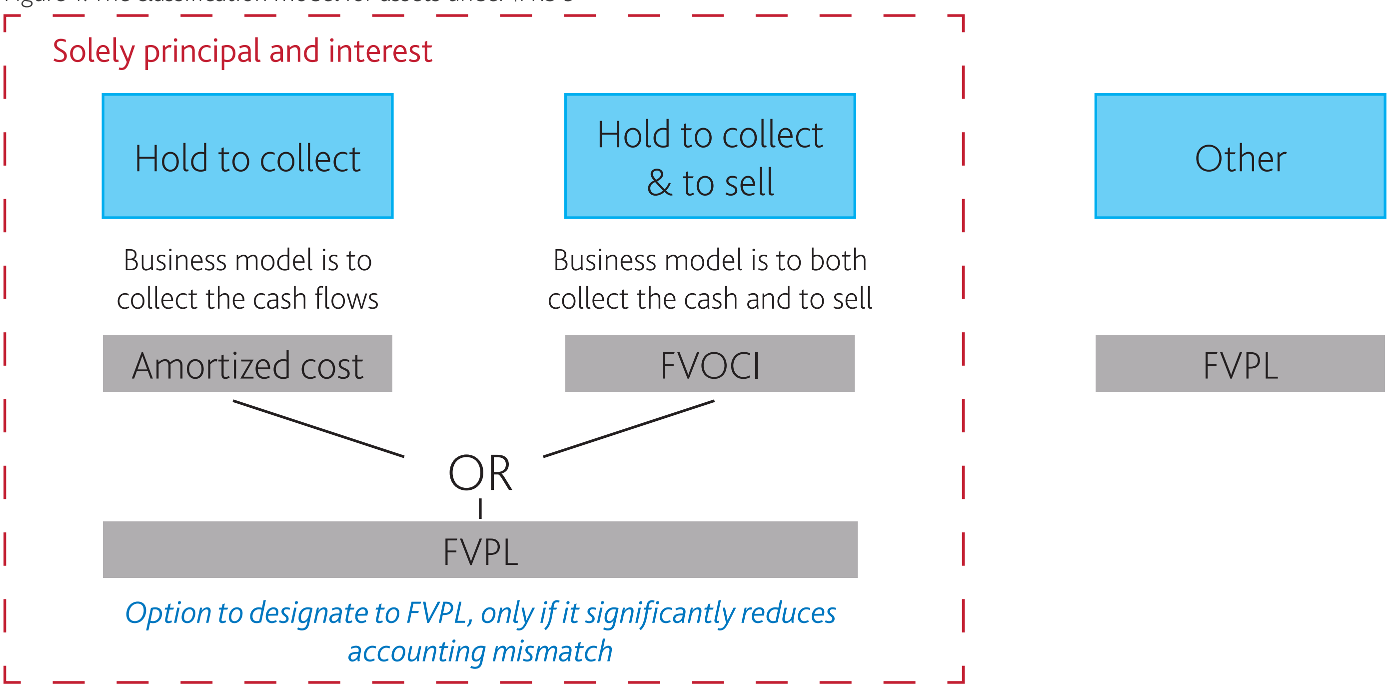
IFRS 9 Financial Instruments replaced IAS 39 effective 1 January 2018. However, there was an option for insurers to defer implementation of IFRS 9 to align with the introduction of IFRS 17. Most insurers have chosen this option and thus deferred implementation of IFRS 9 to coincide with the IFRS 17 start date.

Under IFRS 9, there are three categories for asset classification:

Category	Description
FVPL Fair value through profit and loss	Assets are reported on the balance sheet at fair value and all gains and losses are recognized in profit and loss (P&L) as they arise.
Amortized Cost	Assets are measured on an amortized basis. P&L is driven by the interest income, which is based on the book value of the asset (effective interest method).
FVOCI Fair value through other comprehensive income	Assets are held on the balance sheet at fair value. Changes in fair value are initially recognized in other comprehensive income (OCI). Upon sale of an FVOCI asset, the change in fair value previously recognized in OCI is recycled to P&L.

Figure 1 illustrates the classification model for assets under IFRS 9. Insurers must consider the "solely payments of principal and interest" (SPPI) test which, along with the business test, determines the classification.

Figure 1: The classification model for assets under IFRS 9



If an asset meets the SPPI test, there are two possible measurement models depending on the business model:

» *Held to collect*: If the asset portfolio is held to collect contractual cash flows, then measurement is at amortized cost. This applies where the selling of assets is incidental to the business model objective.

» *Held to collect and to sell*: If the portfolio is held both for collecting contractual cash flows and selling the financial assets, then measurement is at FVOCI. For example, this applies where an insurer collects bond cash flows to meet insurance liabilities. However, to ensure that cash flows are sufficient to settle the liabilities, the insurer also regularly rebalances the portfolio and therefore undertakes regular buying and selling of the bonds.

Crucially, there is also an option to designate at FVPL. Insurers can choose to classify financial assets at FVPL if, by doing so, they eliminate or significantly reduce the accounting mismatch, more formally referred to as a measurement or recognition inconsistency. This mismatch arises when gains and losses from assets and liabilities are recognized on different bases, which could be the case upon transition to IFRS 17. In this paper, we consider the case where the insurer has applied the option to designate at FVPL and therefore the assets are reported at FVPL.

Case study

To illustrate the interaction between IFRS 9 and IFRS 17, we consider an IFRS 17 contract group consisting of immediate annuities. The general measurement model is applied and the analysis considers the impact of different liability discount rates on the projected P&L.

In terms of classification approach, we consider the case where the insurer elects the same accounting option for assets and liabilities, which is to book both at fair value through P&L. The impact of interest rate changes on the value of the insurance contracts are recognized at FVPL and the asset movements are also classified at FVPL. Assuming asset and liability cash flows are well matched, it is reasonable to assume that this option lowers the P&L volatility, relative to reporting the asset at amortized cost. There is also the option to classify the assets at FVOCI, which might be another feasible choice for insurers, subject to the business model test outcome.

In this paper, we use an agile[1] valuation model to project the financial statements, in particular the P&L, and to analyze the effect of different scenarios. This enables the impact of decisions such as discount rate methodology to be assessed. The case study uses stochastic models. The projected asset returns and liability discount factors are generated using an Economic Scenario Generator. The assets are assumed to be invested in corporate bonds, which are cash flow matched to the expected liability outgo, with an additional holding in cash. The liability discount curve is based on a risk-free yield curve with an adjustment for an illiquidity premium, and this paper illustrates sensitivities to the size of the illiquidity premium. The demographic risks are also modeled stochastically with the annuitant mortality rates generated using a stochastic mortality model.

P&L reporting under IFRS 17

Under IFRS 17, the profit and loss disclosure attempts to differentiate between the source of profit or loss arising from providing the insurance coverage and that arising from investment income. The P&L must be separated into the *insurance service result* and the *net financial result*.

Insurance service result

» The Insurance Service Result includes the release of the risk adjustment and release of the contractual service margin (CSM). The CSM is released over time in proportion to the chosen coverage units.

» Changes in the mortality assumptions have an effect on the insurance service result. The impact of longevity improvements can be absorbed, up to a point, by the initial CSM. In the scenario where the CSM is wiped out completely, subsequent changes in mortality expectations result in immediate P&L.

Net financial result

» The net financial result is composed of the investment income and the insurance finance expenses. The former represents the investment income from the assets. Insurance finance expenses incorporates the effect of changes in the discount rate on the fulfillment cash flows, and the impact of the unwind of the liability discount rate.

» Interest accreted on the CSM is included in the net financial result.

1 Further details of the modeling approach are given in *Profit emergence under IFRS17: Gaining business insight through projection models*, Steven Morrison (August 2018).

Impact of choice of liability discount rate on expected profit emergence

In this case study, we have a portfolio of annuity policies. The assets backing the annuity outgo are modeled as a diversified portfolio of A-rated corporate bonds, constructed to provide a cash flow match to the annuity outgo. The assets backing the risk adjustment and the surplus assets are assumed to be invested in cash. In accordance with IFRS 17 standards, the liability discount rate includes an illiquidity premium. In this example, the liquidity premium[2] is evaluated as 50% * {spread on the corporate bond portfolio – 40 bp}.

We consider the scenario where there are no changes to assumptions and the yield curves (both risk-free and credit spreads) evolve as per the initial curve, and there are no defaults or transitions experienced on the bond portfolio. The projected P&L is shown in figure 2b, split in to the insurance service result and the net financial result. To illustrate the impact on expected profit emergence of including an illiquidity premium in the liability valuation, we compare against the two "boundary" cases: the case where the liability discount curve is the risk-free discount curve (that is, no liquidity premium, see figure 2a), and the case where the liability discount curve includes the full yield on the assets (see figure 2c). The latter is extreme but serves as a useful comparison point for our analysis. In this scenario, we project the P&L for 10 years and compare the results.

These charts illustrate how the choice of liability discount rate influences the profile of projected P&L. Opting for a more aggressive discount rate on day 1 (that is, higher illiquidity premium) will result in a higher CSM, which leads to higher projected insurance service results as this higher CSM is released. However, projected net financial results are lower, as liabilities unwind at a higher rate. In the extreme example where the liability discount rate is the same as the asset yield, the investment income on assets offsets almost exactly against the finance expense on liabilities and the reported net financial result is close to zero for the next five years (the only contribution being interest earned on the surplus cash and interest accreted on the CSM).

Over the lifetime of the business, the total P&L will be the same under all examples. It is the timing of recognition of the P&L—and the allocation between insurance service result and net financial result—that is influenced by the decision regarding the choice of discount rate.

Figure 2: Comparison of projected P&L for different liability discount rates

Figure 2a

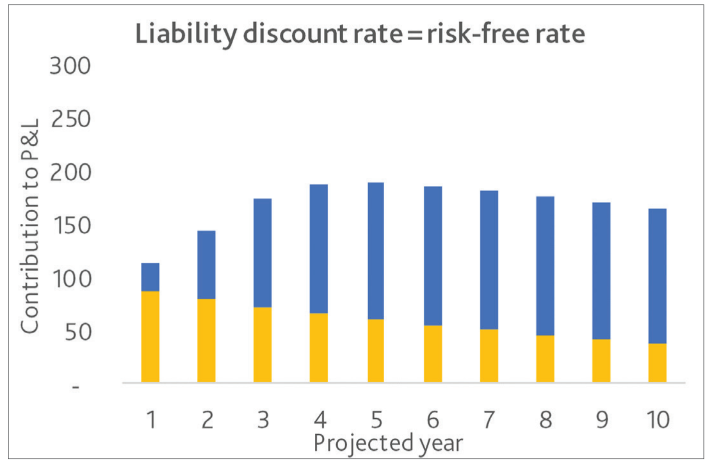


Figure 2b

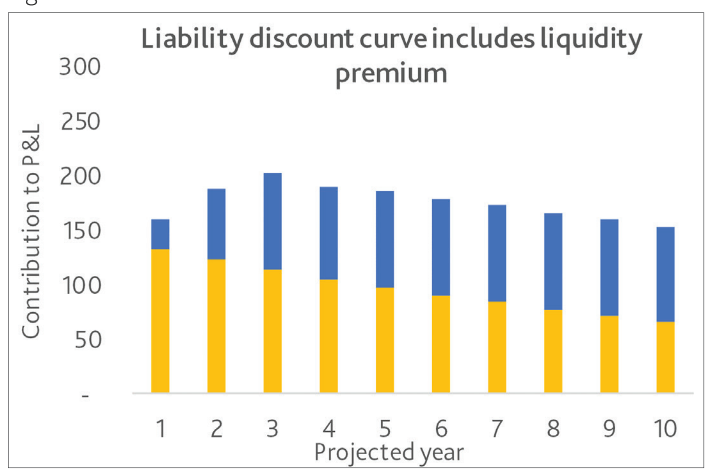
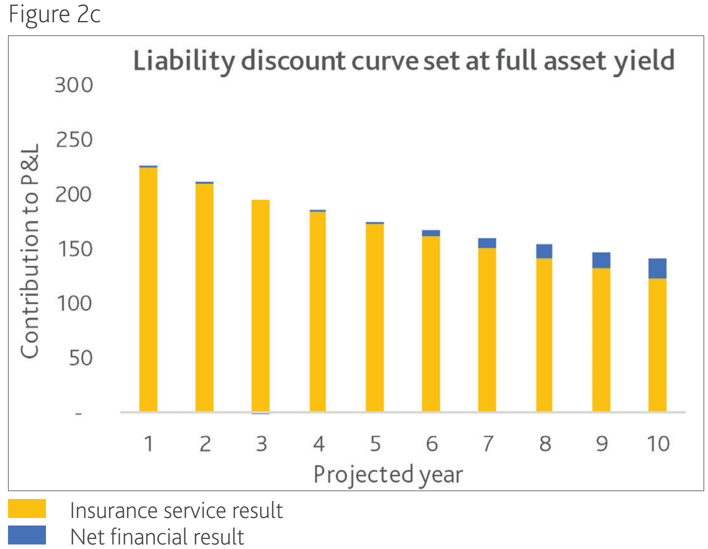


Figure 2c



2 This formula was originally developed by the CFO forum for MCEV reporting.

Impact of choice of liability discount rate on earnings volatility

Rather than look at a single scenario, the agile model provides the ability to investigate many scenarios. Generating scenarios using a stochastic model, we can build a picture of the distribution of items on the financial statements, or metrics derived from these scenarios. Figure 3 shows the results from a random sample of scenarios from the stochastic modeling.

Volatility of the net financial result decreases as more of the credit spread on assets is included in the liability discount rate, and the net financial result is more immune to spread movements. For example, in our extreme case where the illiquidity premium is set at the asset yield, the investment income and insurance finance expense almost exactly offset, since both are driven by the A-rated credit curve—and recall that the asset portfolio is cash flow matched to the liability cash flows. Note that even in this extreme case there is some volatility primarily due to rating migrations on the asset portfolio.

Figure 3: Comparison of the net financial result

Figure 3a

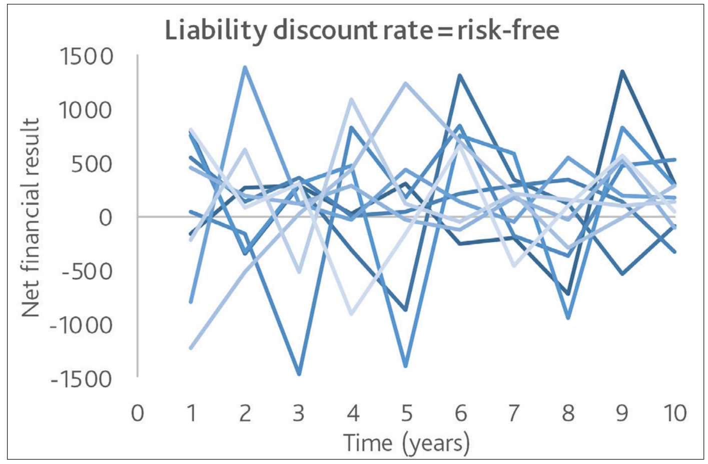


Figure 3b

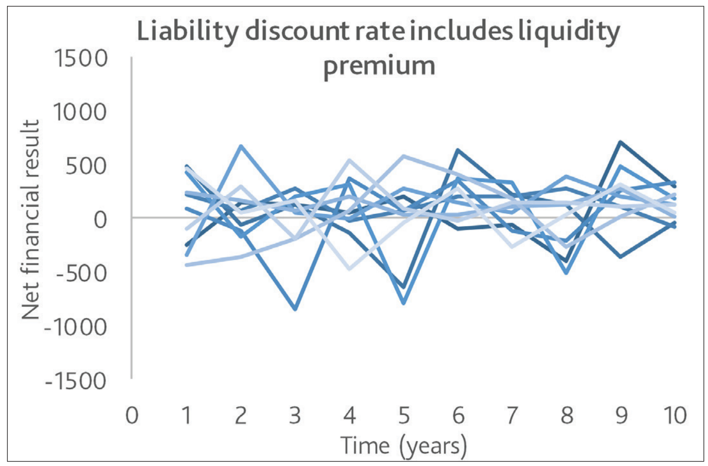
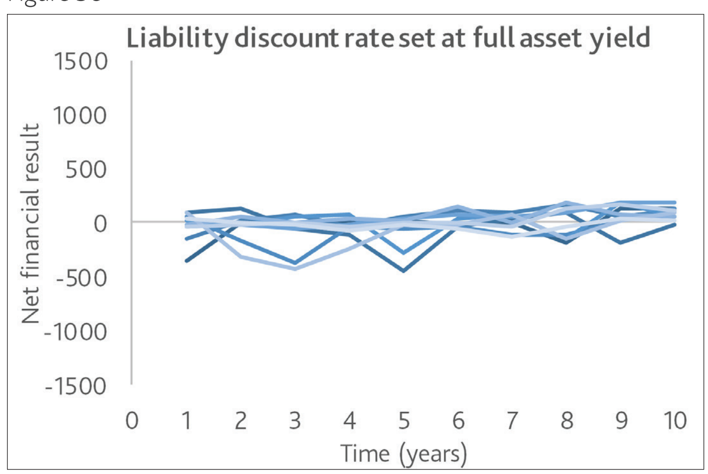


Figure 3c



Similarly, the stochastic model can be used to assess the volatility of the insurance service result, as shown in Figure 4. This shows the results from the same sample of scenarios from the stochastic modeling. As described earlier the liability discount rate affects the CSM, and therefore the probability of a contract group becoming onerous, and so affects the volatility of the insurance service result. The impact of introducing an illiquidity premium is an increase in the initial CSM, which means there is less chance of the CSM being wiped out and thus any mortality assumption change has a lower impact on the insurance service result.

Figure 4: Comparison of the insurance service result

Figure 4a

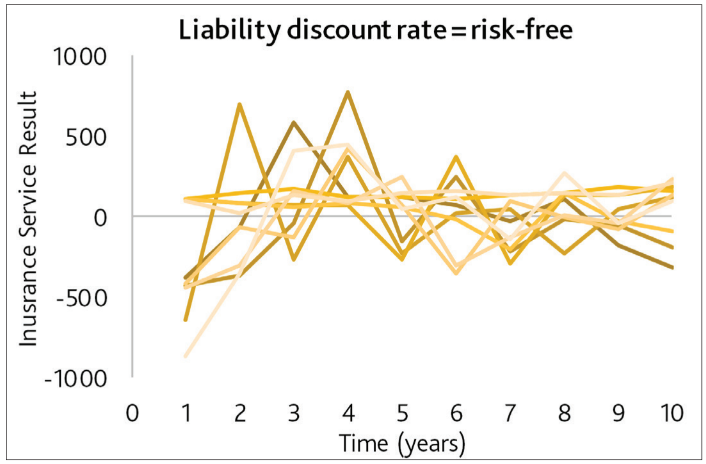


Figure 4b

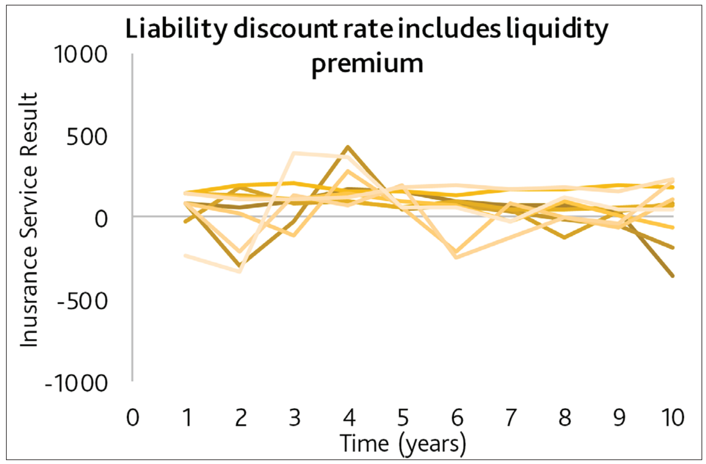
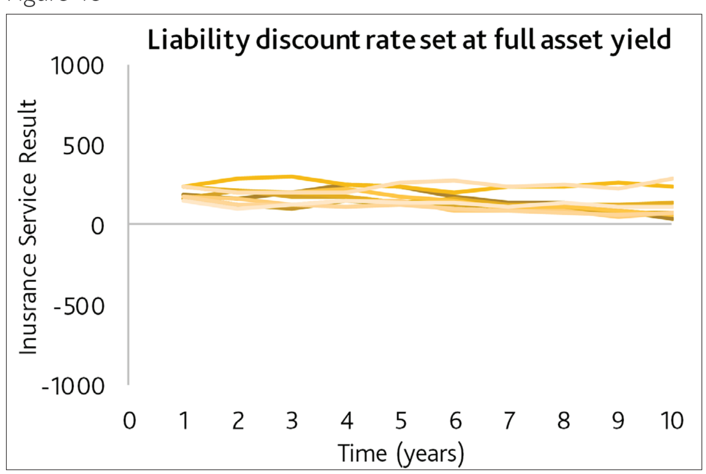


Figure 4c



Summary

The principles-based nature of IFRS 17 means that significant judgement will be involved in implementing the standard. The methodology used to define the liability discount rate is one of the key decisions that companies must make, and there have been several articles on this topic.[3] The current focus is on IFRS 17 and interpreting the principles but insurers must not forget about IFRS 9, which is also a complex standard. It is important to understand how the two standards interact, the resulting earnings volatility, and the sensitivity of volatility to methodology choices available under both standards (in particular the OCI option under IFRS 17 and option to classify as FVPL under IFRS 9). The use of projection models and stochastic modeling can be a useful tool in assessing the impact of these decisions.

This paper considered the case of a well-matched annuity portfolio where the insurer elected to report movements in both assets and liabilities at FVPL. By selecting the same accounting treatment on both sides of the balance sheet, this helps reduce P&L volatility, with the degree of volatility dependent on the size of the illiquidity premium included in the liability discount rate. Furthermore, the paper illustrates how the choice of liability discount rate influences the allocation of P&L between the insurance service result and the net financial result.

3 Refer to *Permitted approaches for constructing IFRS 17 Discount Rates*, Nick Jessop.
https://www.moodysanalytics.com/-/media/article/2018/permitted-approaches-for-constructing-ifrs17-discount-rates.pdf
The top-down approach is covered in more detail in *A cost of capital approach to estimating credit risk premia*, Alasdair Thompson and Nick Jessop.
https://www.moodysanalytics.com/-/media/article/2018/a-cost-of-capital-approach-to-estimating-credit-risk-premium.pdf

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MOODY'S ANALYTICS

Calibration Methods

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

A Cost of Capital Approach to Estimating Credit Risk Premia

Executive Summary

This note discusses the credit risk premium adjustment required for constructing discount rates specified by the IFRS 17 accounting rules. Calculating the credit risk premium is a key requirement in the 'top down' yield curve method. It may also be a useful input in computing (or benchmarking) the illiquidity premium for 'bottom up' discount rate construction.

We start by reviewing the two alternative approaches to constructing discount curves in the IFRS 17 reporting process. We then discuss the techniques which can be used to adjust a credit risky yield curve for both expected credit losses and market risk premiums for credit risk. Expected losses can be calculated by combining estimates for loss given default and real world probability of default. A Merton style model for estimating real world probability of default can then be combined with a credit risk premium to estimate the total credit adjustment (TCA). To best estimate the expected asset return which drives the credit risk premium we use a weighted average cost of capital (WACC) approach. To avoid difficulties in defining equity risk premia for specific issuers, the weighted cost of capital is defined at portfolio level and adjusted by market implied scalings, calculated from total market spreads, to derive individual credit risk premia for every bond. Results of this approach for a variety of portfolios and across economies are then presented.

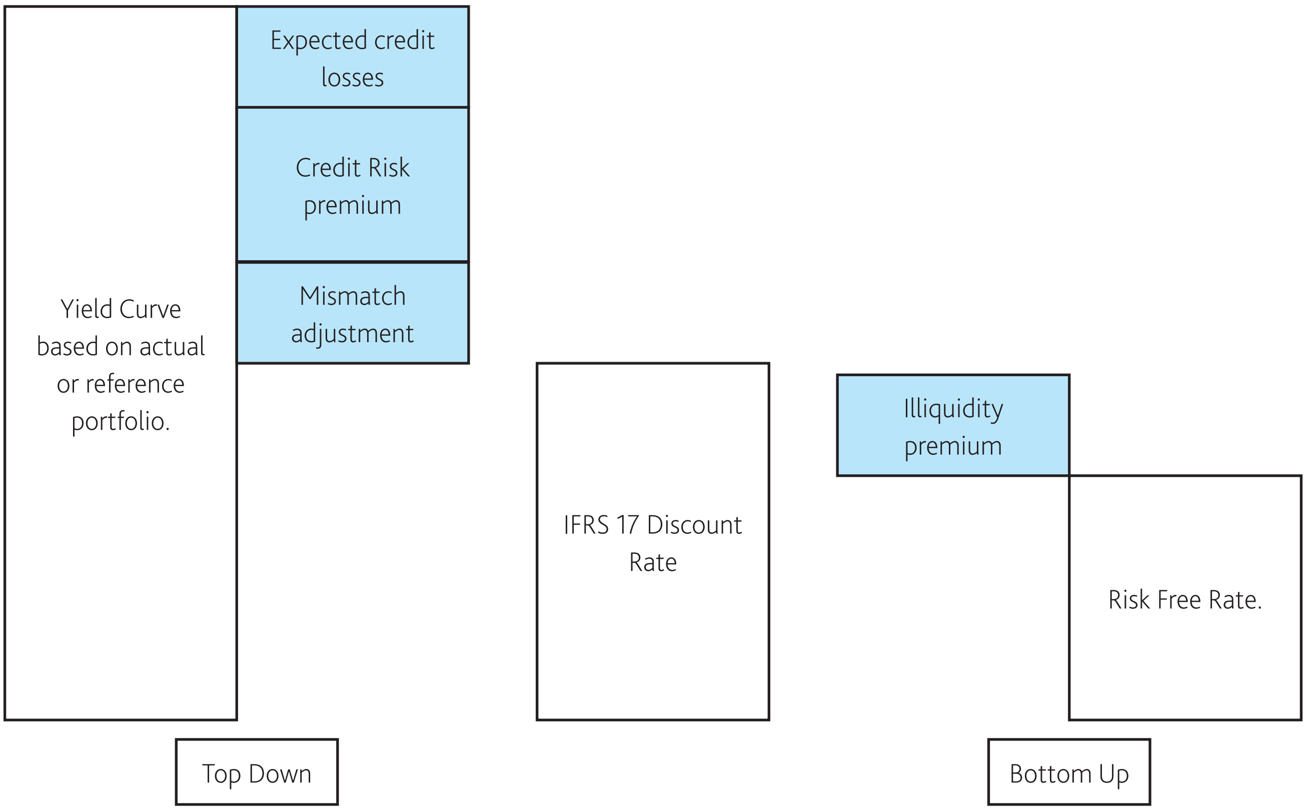
Finally, we conclude with a discussion of how these estimates can be used to construct discount curves for a top down approach within IFRS 17 rules and highlight key outstanding considerations.

CONTENTS

1. Introduction

The permitted approaches to fitting yield curves for IFRS 17 were outlined in a previous white paper (Jessop 2018). The rules specify two approaches, known as 'bottom up' and 'top down' which in theory should lead to equivalent results (a unique set of IFRS 17 discount rates). Our primary focus in this paper is in estimating the top down curves and specifically the adjustment for credit risk premium (which can be interpreted theoretically as the market premium associated with unexpected credit losses). The discount rates for liability valuation are not just critical in determining the present value of future cash flows reported in the balance sheet, but also in determining how profit and loss will be recognised under the heading of 'Insurance Financial Expenses' in the comprehensive income statement. The two yield curve approaches are outlined in Figure 3.

Figure 1 IFRS 17 yield curve construction approaches



Assuming the reference portfolio in the top down approach is defined in a way which minimises any mismatch adjustment (made to reflect differences in amount, timing and uncertainty between the reference asset portfolio and liabilities), then the most challenging technical parts of the construction process are likely to be the adjustments for the expected credit losses and the credit risk premium.

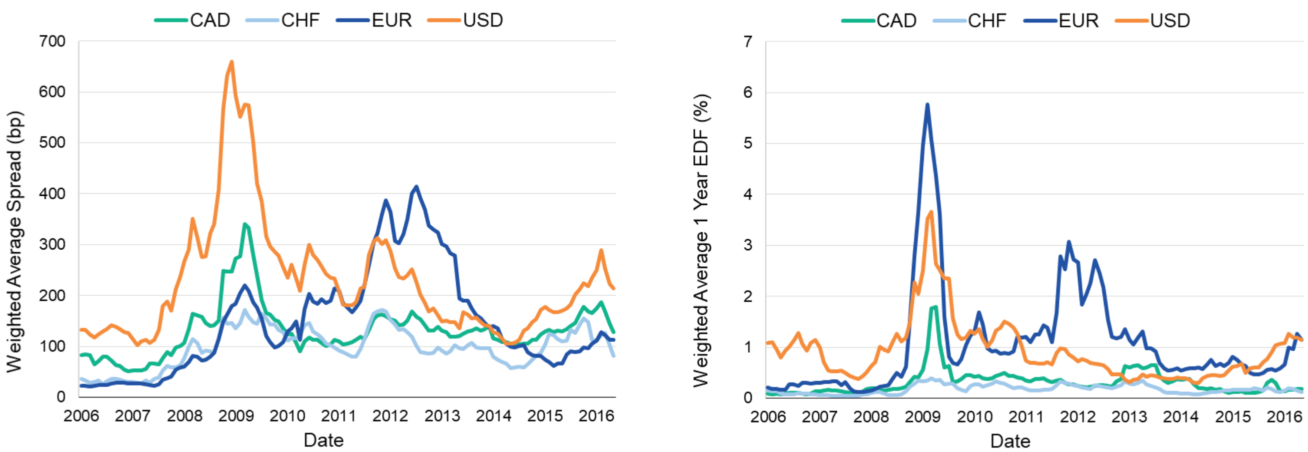
Different approaches for calculating the expected losses are possible (leveraging a broad range of probability of default and loss given default modelling techniques). For example, under Solvency II a 'through the cycle' (TTC) approach to estimating the credit losses is made which results in a very stable (effectively constant) estimate of the credit losses. This estimate is based on a combination of long term historical default and loss given default statistics and long term historical credit spread levels.

If this TTC estimate of loss was used on its own (or in combination with a constant credit risk premium adjustment in order to isolate the liquidity premium component of spread) this would lead to most of the spread market volatility being attributed to changes in liquidity premia.

However, in SII more 'point in time' volatility and matching adjustments are made by attributing only a proportion of the excess spread to the volatility and matching adjustments. This proportional adjustment is somewhat ad-hoc, but can be interpreted as a proxy for a pro-cyclical estimate of each component of the credit spread (embedding a view that market spreads, expected losses and credit risk are all positively correlated). This results in liability discount curves which partially but not completely mirror changes in market spreads for credit risky bonds. In turn this reduces but does not minimise completely the significance of ALM mismatches arising when liabilities are backed by duration (or cashflow) matched fixed income asset portfolios.

Figure 2 shows changes in market spreads (left) and PIT estimates of 1 year expected default frequency (right) over a ten year period for selected economies – in each case the averages are weighted by amount outstanding and are calculated for bonds with maturities from 4-5 years.

Figure 2



The modelling method outlined in this paper leverages a structural approach to estimating both components of the credit adjustment. This approach naturally introduces point in time characteristics to not only the expected losses component of credit spread but also the estimates of credit risk premium and illiquidity premia. The method leverages existing data and modelling techniques broadly used by Moody Analytics' clients for probability of default, loss given default and expected loss modelling.

In section 2 we begin by reviewing the Merton model of credit risk, which will form the basis for the structural approach taken in this paper. Having reviewed the basic model, we then detail the enhancement made by Moody's to create our Public Firm EDF™ model of real world expected default. The section concludes by considering how the model can be reconciled with approaches to expected loss calculation for IFRS 9.

Section 3 builds on the expected loss calculation to add a credit risk premium and derives a methodology to set this adjustment.

Section 4 then applies the model to a set of market portfolios of corporate debt to derive a decomposition of spreads into expected loss, credit risk premium and illiquidity premium components. Having applied the model, the sensitivity to several key underlying assumptions such as equity risk premium, leverage and the choice of risk free rate is examined.

Finally, section 5 concludes the paper by restating the fundamental problem to be addressed, the solution proposed in this paper and some considerations for further research in order to produce a robust method with could be implemented in practice.

2. Estimating Real World Probability of Default

2.1. A Brief Review of the Merton Model

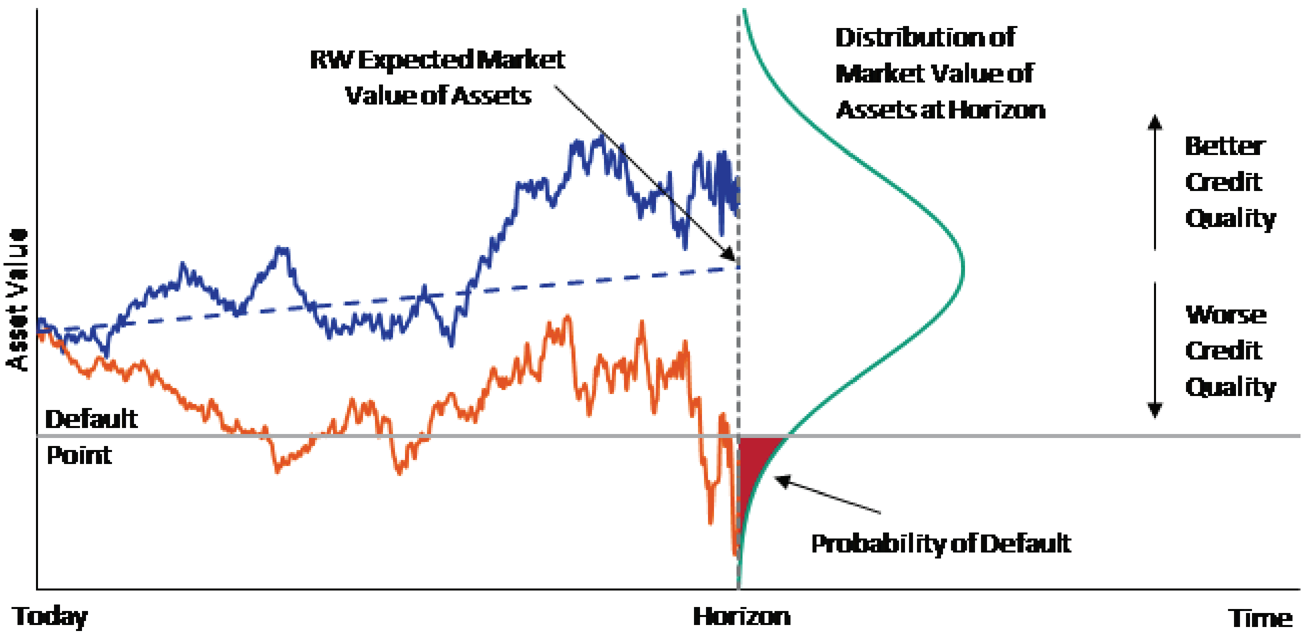
To estimate the real world probability of default, we will follow a structural model of credit risk as pioneered by Fischer Black, Robert Merton and Myron Scholes.

The Merton model starts from the realisation that equity in a firm can be considered as a call option on the firm's assets with a strike price equal to the face value of the debt. The capital structure of the firm is defined simply as a sum of debt (D) and equity (E).

$$Assets = Debt + Equity$$

The asset price is assumed to follow a lognormal, stochastic process and default occurs when the value of the firm's assets falls below the value of the debt. Specifically, in Merton's original formulation default occurs only if the asset price is below the debt at a specified, usually one year, horizon. Figure 3 below shows the model schematically, where the asset value varies stochastically and forms a distribution of market values at a horizon, the probability of default is given by the integral of this distribution below the default point.

Figure 3



Working in the risk neutral measure we can write the stochastic process for the asset price (A) as:

$$dA_t = r_f \, A \, dt + \sigma_A A \, dW^{\mathbb{Q}},$$

where r_f is the risk free rate, σ_A is the volatility of the asset price and $dW^{\mathbb{Q}}$ is a risk neutral Wiener process.

Then, recalling that the option pricing framework where equity is a call on the assets, where the payoff for the equity is $max(0, A - K)$ and K is the face value of the debt, by Black-Scholes the market value of the debt will be given by

$$D = A \, \mathrm{N}(-d_1) + Ke^{-r_f T} \, \mathrm{N}(d_2),$$

where

$$d_1 = \frac{\ln\left(\frac{A}{K}\right) + \left(r_f + \frac{\sigma_A^2}{2}\right) T}{\sigma_A \sqrt{T}},$$

and

$$d_2 = d_1 - \sigma_A \sqrt{T}.$$

We can also write the market value of the debt as the discounted face value to define a fair value spread

$$D = Ke^{-(r_f+S)T}.$$

Combining the two expressions for the market value of the debt, we can then write the fair value spread as

$$S = -\frac{1}{T}\ln\left(\frac{A}{K}e^{r_f T}N(-d_1) + N(d_2)\right).$$

The Merton model framework also allows us to derive the risk neutral probability of default

$$PD^{\mathbb{Q}} = N(-d_2).$$

Switching to the real world measure we can replace the risk free rate r_f with the real world expected asset return r_A to get a real world probability of default

$$PD^{\mathbb{P}} = N(-d_2^{\mathbb{P}}),$$

where

$$d_2^{\mathbb{P}} = \frac{\ln\left(\frac{A}{K}\right) + \left(r_A - \frac{\sigma_A^2}{2}\right)T}{\sigma_A\sqrt{T}}.$$

The Merton model is a simple, but widely used, starting point to understand credit risk building from a structural analysis of the firm. Since Merton's original paper, many extensions have been proposed to account for more complex capital structures, to allow for default at any point rather than a fixed horizon, stochastic interest rates, cash payments, and transaction and liquidation costs. In the next section we describe the extension used in the Moody's Public Firm EDF™ model.

2.2. Moody's EDF™ Model

Moody's Analytics' Public Firm EDF™ (Expected Default Frequency) model has been the industry-leading probability of default model since its introduction in the early 1990s. Since that time it has continually evolved to provide a sophisticated model of real world default frequencies. Moody's EDF model is based on the Vasicek-Kealhofer (VK) variant of the Merton model described above. This variant extends the Merton model in a number of key respects, in particular to consider a more complex capital structure for a firm, with a range of liability classes for short and long term debt; to incorporate a concept of preferred stock; and to allow for cash leakages in the form of coupons, dividends and interest payments.

The EDF model also replaces the naïve use of the total debt in the Merton model with a default point calculated at the sum of current liabilities plus half the long term liabilities. In addition, the latest version of the EDF model makes a cost of capital adjustment to the default point for financial firms, to reflect changes in interest rate environment and their effect on the depletion of working capital.

Both the Merton and VK models require an estimate of asset volatility to determine the distance-to-default. Unlike market capitalisation, neither equity, nor asset, volatility are directly observable in the market and the estimation of volatility is therefore an important element of the calibration of the model. Moody's EDF model uses a weighted average of empirically measured volatility over a historical window and a modelled volatility based on the size, location and business type of the firm.

Finally, the EDF model removes the assumption of normality for the relationship between distance-to-default (DD) and the probability of default. The distance-to-default gives an ordinal measure of the default risk. Interpreted as a number of standard deviations, the DD can be converted to a PD, using a normal cumulative distribution function

$$PD=N(-DD).$$

In practice, Moody's calibrate a more accurate empirical mapping

$$PD=M(-DD).$$

The calibration of the empirical mapping $M(\cdot)$ to a database of historical defaults is one of the primary inputs to the Moody's VK/EDF model and represents the key piece of IP within the model.

2.3. Consistency with IFRS 9: Moody's ImpairmentCalc

While the focus of this paper is the construction of discount curves for reporting liability valuations under IFRS17, some firms may be concerned with consistency with reporting impairments under IFRS9. The latest accounting standards for financial instruments require the recognition of expected credit losses based on a forward looking assessment of credit risk. Calculating these expected credit losses is also part of the requirement for adjusting top down IFRS17 discount curves and it is therefore reasonable to expect some consistency between the two estimates.

This paper uses a relatively simple methodology to calculate expected losses by combining unconditional EDFs and unconditional LGDs. However, for IFRS9 (and CECL) Moody's offers a more sophisticated approach via our ImpairmentCalc and ImpairmentStudio™ solutions. This solution also leverages CreditEdge for EDF estimates, RiskCalc™ for LGD and GCorr™ for correlations between a range of macroeconomic and credit factors. Expected losses are then calculated by taking the unconditional EDF and LGD values and conditioning these on a set of macroeconomic scenarios[1]. By first conditioning EDF and LGD estimates on a set of macro variables, which are correlated with credit shocks, and then taking a weighted average across these scenarios, this process produces a granular, forward-looking and probability weighted estimate of the expected credit loss which takes into account correlations between PD and LGD estimates[2].

In general, this more advanced methodology will produced expected credit losses which differ from the estimates presented in this paper. If full consistency with IFRS9 results is desired, ImpairmentCalc expected credit losses could be used in place of the unconditional estimates used here without much difficulty for either top-down credit risk adjustment or to estimate illiquidity premium for bottom-up yield curve construction.

3. Credit Risk Premium

3.1. Adjusting the Merton Model's Drift

To estimate the market compensation associated with credit risk we need to adjust the real world probability of default with a credit risk premium. Schematically, we move back from the real world measure to an asset risk neutral measure where the real world implied drift is replaced with the risk free rate. Removing the expected excess return shifts the probability distribution of market value of assets at the horizon and thereby increases the probability of default. An increased probability of default is associated with a higher spread and the difference between the real world EDF implied spread and the "asset risk neutral" EDF implied spread constitutes our credit risk premium spread.

Note that the move to the asset risk neutral measure performed here is different from the usual shift from a real world to a risk neutral frame, in that case the risk neutral measure is designed to exactly match market prices and risk premia can be directly inferred by fitting our model to market data, in contrast here the shift to the asset risk neutral measure does not account for liquidity risk, and so the model spread in this measure will be different from the observed market spread – the residual difference between market spreads and asset risk neutral model spreads will be attributed to an illiquidity premium (see section 4.2).

Figure 4 shows the three measures, real world, asset risk neutral and risk neutral schematically for the Merton model. As we move from the real world to the asset risk neutral measure the expected asset return decreases and the probability of default, and hence spread increases. The pure risk neutral measure, accounting for all risk premia, including illiquidity, has a still further lower expected

1 See Barnaby Black, Glenn Levine and Juan M. Licari, "Probability-Weighted Outcomes Under IFRS 9: A Macroeconomic Approach", Moody's Analytics Risk Perspectives, Volume VIII, June 2016

2 For additional details on PD-LGD correlation see Qiang Meng, Amnon Levy, Andrew Kaplin, Yashan Wang, and Zhenya Hu, "Implications of PD-LGD Correlation in a Portfolio Setting." Moody's Analytics Whitepaper, February 2010.

return and an even higher probability of default and spread. The three measures thus correspond to the expected credit loss spread, the expected loss plus the unexpected credit loss, and finally the observed market spread including both credit and illiquidity premia.

Mathematically, we can express the asset risk neutral spread as

$$RN\ Credit\ Spread = -\frac{1}{T}\ln(1 - CQPD \cdot LGD),$$

where $CQPD$ is the cumulative probability of default under the risk neutral $\mathbb{Q}$ measure. We can write the same spread in terms of the real world probability of default as

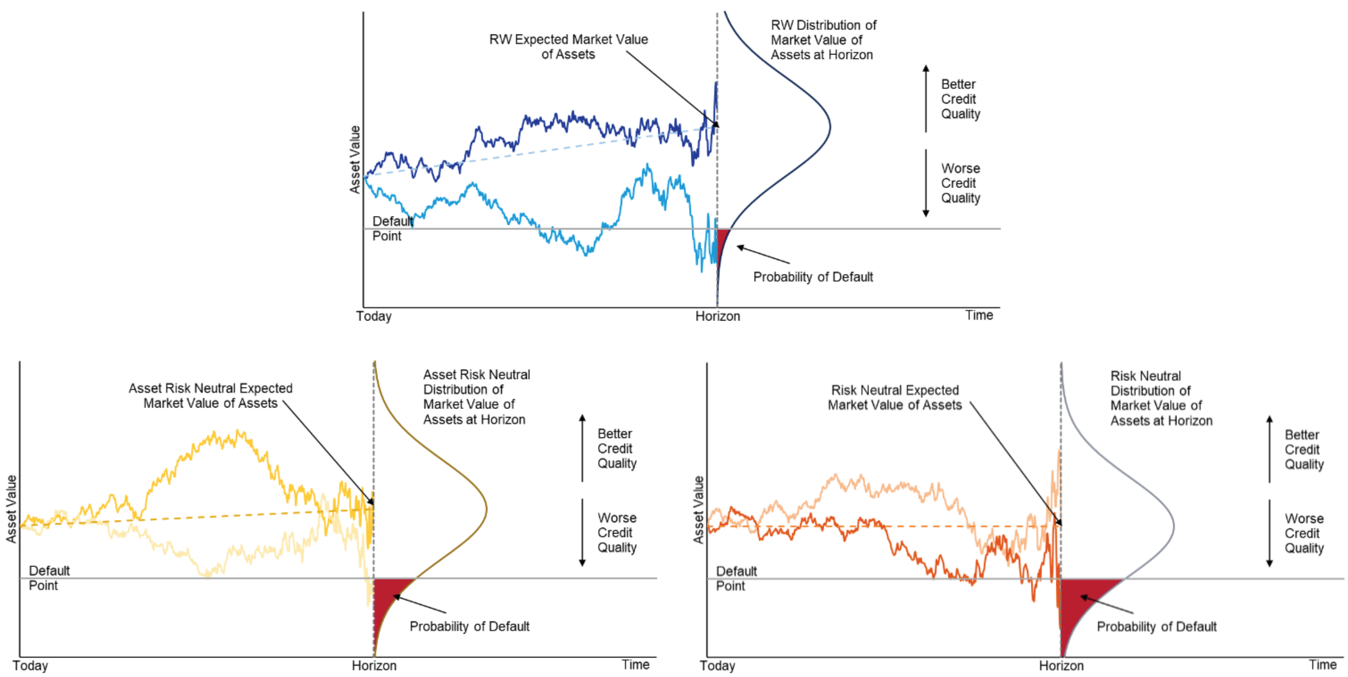
$$RN\ Credit\ Spread = -\frac{1}{T}\ln\left(1 - N\left(N^{-1}(CPD) + \beta\lambda\sqrt{T}\right) \cdot LGD\right),$$

where we have introduced the Market Price of Risk, λ, the firm's asset beta, β, and the risk premium, μ_A

$$\beta\lambda = \frac{\mu_A}{\sigma_A} = \frac{r_A - r_f}{\sigma_A}.$$

This asset risk neutral spread represents the model value for both the expected credit loss and the credit risk premium combined.

Figure 4



At this stage we could choose to go back to the initial EDF calculations and remove the drift term used to derive the real world default probabilities in order to access a risk neutral credit spread adjustment, however given the real world PDs have been derived using an empirical mapping which is calibrated to the real world distance-to-default values, it is not clear that this mapping would still be valid after the drift was removed. Instead, we take the real world EDF data as fixed inputs and make an independent estimate of the credit risk premium which can be layered upon the EDF without needing to delve into the details of that model. In the next section we describe our methodology for forming that estimate.

3.2. Weighted Average Cost of Capital

In order to estimate a suitable adjustment to the real world probability of default, we need to determine an appropriate credit risk premium. Churm and Paniigirtzoglou (2005) convert an empirically estimated asset risk premium into an equity risk premium by considering the asset risk premium as a leverage weighted average of the observed market spread and the equity risk premium. We follow a similar approach here, but working in reverse, to estimate an expected excess asset return.

Weighted average cost of capital is a standard method in corporate finance to calculate the cost of capital by combining the cost of debt, cost of equity and a simple measure of the firm's capital structure.

$$Cost\ of\ Capital = Leverage \cdot Cost\ of\ Debt + (1 - Leverage) \cdot Cost\ of\ Equity$$

For our purposes we need a measure of premium, or the excess return, and so we define our WACC estimate of the risk premium, $\mu_A^{WACC} = Cost\ of\ Capital - Risk\ Free\ Rate$. Using this definition the cost of debt becomes the corporate bond spread and the cost of equity the appropriate equity risk premium. It is common to also introduce an adjustment to the cost of debt to account for marginal tax relief on debt payments. Combining these elements our WACC risk premium is given by:

$$\mu_{A,i}^{WACC} = P_i \cdot OAS_i \cdot Tax + (1 - P_i) \cdot \left(r_{E,i} - r_f\right).$$

Where P_i is the leverage, $r_{E,i}$ is the equity expected return, OAS_i is the observed market option adjusted spread, r_f is the risk free rate, and Tax as an adjustment for tax relief on debt costs[3]. For high credit quality firms, in benign market conditions, the WACC tends to be dominated by the cost of equity capital, due to the fact that credit spreads are typically significantly lower than the equity risk premium. Note also, that in this model we assume the firm pays both a credit risk premia and a liquidity premium to holders of its debt (as both are included in market spread levels).

This individual WACC excess return, $\mu_{A,i}^{WACC}$, for bond i calculated using the specific firm leverage and spread and a constant equity risk premium, can be compared to the return implied by total market spreads, $\mu_{A,i}^{MI}$. By rearranging the relationship between spread, default frequency and expected return from the previous section, the market implied excess return can be written as:

$$\mu_{A,i}^{MI} = \frac{\sigma_{A_i}}{\sqrt{T}}\left(N^{-1}\left(\frac{1 - \exp(-OAS_i \cdot T_i)}{LGD_i}\right) - N^{-1}(CPD_i)\right).$$

Figure 4 shows both estimates of asset returns as a function of the asset volatility (left) and firm leverage (right), with $\mu_{A,i}^{WACC}$ shown in green and $\mu_{A,i}^{MI}$ shown in light blue. These data are generated for a set of USD investment grade bonds at End June 2018, and use an equity risk premium of 4.04%, equal to the equity risk premium for USD equity used in our standard Scenario Generator calibrations[4] and a tax adjustment of 0.8.

Figure 5 plots the raw data for the asset volatility of each firm in the sample against the leverage, naturally this shows a negative correlation as firms which are both highly levered and with a high asset volatility will have a high expected default frequency and are unlikely to be rated as investment grade.

3 A tax adjustment is not strictly required here, but is common practice in the cost of capital accounting literature.
4 "Real World Calibrations Developed Equities Constant Volatility at End Jun 2018", Moody's Analytics Modelling and Calibration Services, July 2018

Figure 5

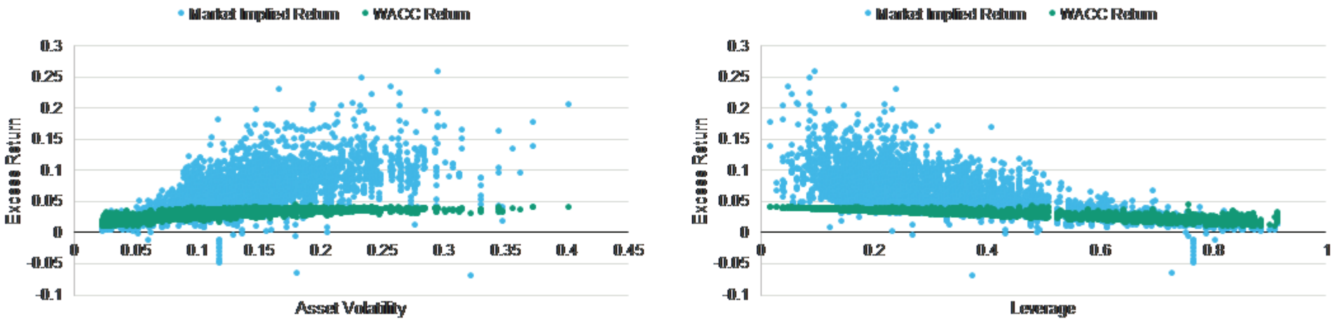
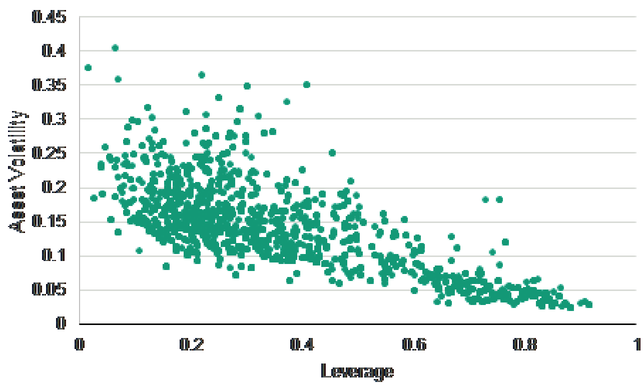


Figure 6



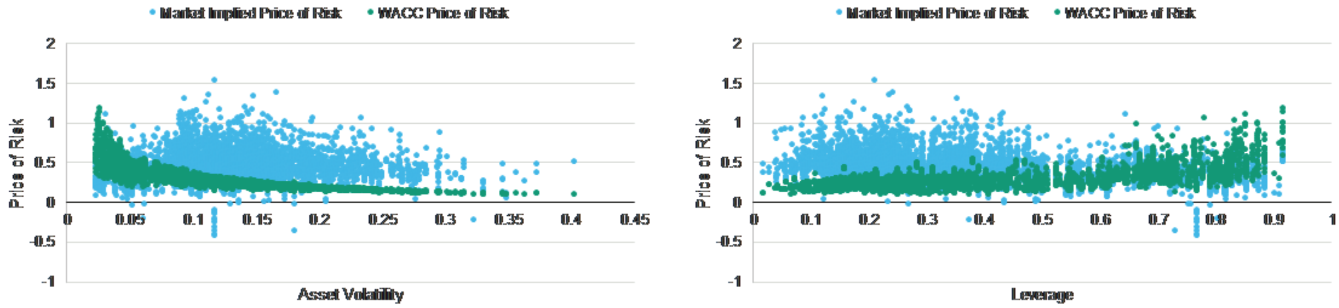
Both the market implied and WACC excess returns show a positive trend with increasing asset volatility and a negative relation with increasing leverage. The market implied returns account for the entire market observed spread, not just for credit risk, but also illiquidity (and any other premia) priced by the corporate debt market, and so are substantially higher than the WACC estimates in general, particularly for high asset volatility or low leverage. The WACC estimates of the excess return therefore add a credit risk premium which explains part, but not all, of the spread above the default compensation. Given our goal is to decompose the spread into three parts and distinguish credit and non-credit factors, this is promising.

The simple WACC estimate shown in Figure 4 uses a constant equity risk premium, making no allowance for firm specific factors like industry specific betas and costs of equity capital. The problems with using a single estimate of the equity risk premium for deriving the WACC can be seen more clearly if the risk premium is converted into a price of risk by dividing by the asset volatility:

$$\lambda^{WACC} = \frac{P \cdot OAS \cdot Tax + (1 - P) \cdot (\mu_E - r)}{\sigma_A}.$$

Figure 6 shows the excess returns implied by the market and calculated using the WACC formula, converted into price of risk and plotted versus asset volatility (left) and leverage (right). Clearly the market implied data show little systematic relationship between the variables, though there is lower variation in price of risk for higher leverage. In contrast, the constant equity risk premium WACC price of risk is inversely related to asset volatility and increases with leverage. These trends probably indicate systematic firm level dependencies for the equity risk premia, e.g. higher equity risk premia generally associated with higher asset volatilities and lower leverage. At a portfolio level it appears that a constant price of risk, rather than a constant equity risk premium better represents the data.

Figure 7



We discuss the equity risk premium in more detail in section 4.3.1, but note here that the simple WACC measure presented earlier clearly has too little variation (in both its specific and systematic behavior). We therefore investigate an alternative approach to estimating a WACC based credit risk premium which is better suited to portfolio analysis by leveraging broad market estimates.

The individual WACC estimate of the risk premium for each bond in our portfolio could be directly applied, such that the total credit spread for both expected default losses and credit risk premium is given by

$$WACC\ Implied\ Credit\ Spread_i = -\frac{1}{T_i}\ln\left(1 - N\left(N^{-1}(CPD_i) + \frac{\mu_{A,i}^{WACC}}{\sigma_{A_i}}\sqrt{T_i}\right)\cdot LGD_i\right),$$

where i indicates the specific bond in the portfolio.

However, for IFRS 17 the credit risk premium is only required at a portfolio level. What is more, the bond level estimates of credit risk premium are noisy, with potential errors introduced in the individual levels estimates of CEDF, LGD, μ_A^{WACC} and σ_A.

In order to define the credit risk premia, then, we define the WACC at the portfolio level, using the portfolio averages for spread and leverage. For a well-diversified portfolio we can more easily define an appropriate expected equity risk premium, based on our standard estimates for equity index excess returns and avoid the need to make detailed assertions about firm level expected equity returns. This portfolio level WACC is then scaled using market implied data to create a specific credit risk premium for each bond.

The final credit risk premium, combining the market implied data and portfolio WACC, is given by:

$$\mu_{A,i}^{CRP} = \mu_{A,i}^{MI}\cdot\frac{\lambda_{Port}^{WACC}}{\lambda_{Port}^{\mathrm{MI}}},$$

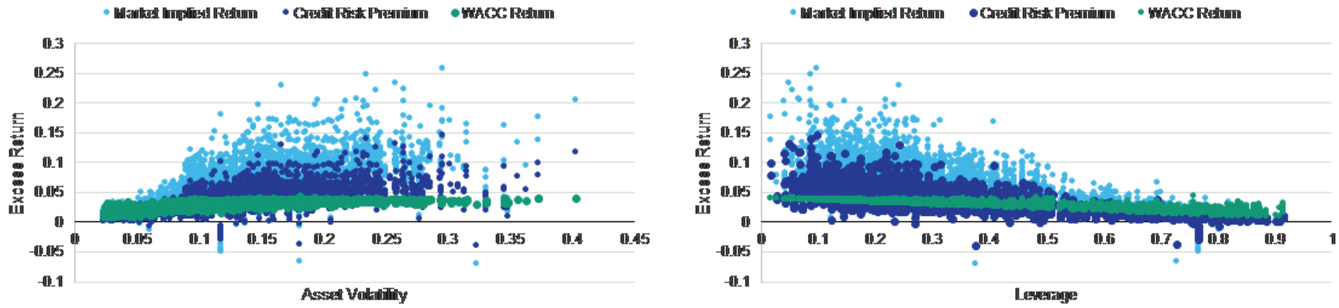
where λ_{Port}^{WACC} is the portfolio price of risk calculated using the portfolio average of leverage, spread, and equity risk premium and $\lambda_{\mathrm{Port}}^{\mathrm{MI}}$ is the portfolio price of risk implied by the market data.

To determine the market implied portfolio price of risk we minimise the average difference between the total market spread on each bond and the model implied spread using a constant portfolio price of risk (with $\beta = 1$):

$$\lambda_{Port}^{\mathrm{MI}} = \arg\min_{\lambda}\left(abs\left(\sum_i Total\ Spread_i + \frac{1}{T_i}\ln\left(1 - N\left(N^{-1}(CEDF_i) + \lambda\sqrt{T_i}\right)\cdot LGD_i\right)\right)\right).$$

Figure 7 shows $\mu_{A,i}^{MI}$, $\mu_{A,i}^{WACC}$ and $\mu_{A,i}^{CRP}$ as a function of asset volatility (left) and leverage (right). This estimate of the credit risk premium uses the WACC approach to produce an excess return lower than the market implied return, thereby allowing a decomposition between credit and liquidity factors, but also takes into account firm specific factors, without requiring complex **modelling** of equity returns on a firm by firm basis.

Figure 8



To understand the credit risk premium we can consider it equivalently as either a portfolio level proportional split in risk premium between credit and non-credit risk (principally illiquidity) factors, which is then applied uniformly to each bond or as a market implied scaling of the portfolio level WACC. In the first formulation we could write the credit risk premium as

$$\mu_{A,i}^{CRP} = \mu_{A,i}^{MI} \cdot \gamma,$$

where γ is the portfolio level ratio between market implied price of risk and WACC price of risk, which is constant for all bonds:

$$\gamma = \frac{\lambda_{Port}^{WACC}}{\lambda_{Port}^{\mathrm{MI}}}.$$

Alternatively, and equivalently, the second formulation would allow us to write the credit risk premium as:

$$\mu_{A,i}^{CRP} = \beta_i \cdot \lambda_{Port}^{WACC},$$

where the portfolio beta specifies the sensitivity of the bond to the portfolio price of risk, and is defined by the market implied returns:

$$\beta_i = \frac{\mu_{A,i}^{MI}}{\lambda_{Port}^{MI}}.$$

In either interpretation, applying the WACC at the level of portfolio price of risk substantially reduces the number of parameters to be estimated and the noise in the estimation process.

The total credit adjustment, or asset risk neutral spread, which is the sum of expected credit loss and the credit risk premium, but which excludes non-credit factors such as illiquidity, is then given by

$$Total\ Credit\ Adjustment_i = -\frac{1}{T_i}\ln\left(1 - N\left(N^{-1}(CPD_i) + \frac{\mu_{A,i}^{CRP}}{\sigma_{A_i}} \cdot \sqrt{T_i}\right) \cdot LGD_i\right).$$

4. Results and Discussions

4.1. Applying the Method to Market Portfolios

To analyse the results of the methodology proposed in this paper we apply it to five market portfolios of corporate bonds.

» Merrill Lynch US High Yield Master II Index

» Merrill Lynch US Corporate Master Index

» Merrill Lynch Sterling Corporate Securities Index

» Merrill Lynch EMU Corporate Index

» Custom Filtration of ZAR denominated Corporate bonds

For each Merrill Lynch index we take the list of constituent bonds and filter any for which there is missing data in CreditEdge. For South Africa, we take all the fixed or zero coupon ZAR denominated nominal corporate bonds within CreditEdge. For the SA portfolio most bonds within the database were not rated by Moody's and so this represents a broad market index across both investment grade and high yield.

4.1.1. US Investment Grade

The Merrill Lynch US Corporate Master Index contains 7760 publicly-issued, fixed-rate, non-convertible, investment grade bonds with at least one year to maturity and an outstanding par value of at least $250 million. Of these we found EDF, leverage and LGD data for 6735 within the CreditEdge database.

Figure 8 shows the result of applying these estimates of the credit risk premium to calculate the spread adjustment. The figure shows two sets of data one calculated using the first method proposed in Section 3.2, using an individual estimate of the WACC, and one using the second method, where the market implied return is scaled by the portfolio WACC. As predicted the individual WACC spread adjustment estimates contain substantially more variation, although the median relationship between credit risk premium and total market spread, illustrated by the dotted lines, is very similar for each approach.

Table 1 shows the average spreads across the portfolio for both methods and the decomposition into expected loss and credit risk premium spreads. For each method of determining the appropriate credit risk premium, using either the individual WACC or the market implied return scaled by the portfolio WACC, two methods are presented for taking the average, using either a mean or median across the portfolio. The mean across the portfolio can be skewed by outliers and the duration weighting of the portfolio, while the media is more robust in this regard. In general we focus on the relationship between market spread and the credit risk premium spread adjustment rather than the absolute value. The preferred metric of the mean portfolio WACC is highlighted in yellow.

The table shows that using the individual WACC method the credit risk premium accounts for 48% of the total market spread when taking the mean credit risk premium/mean market spread, while with the portfolio WACC method the credit risk premium accounts for 32% of the spread on the same basis. In comparison the equivalent median data show that the premium explains 35% of the fit using the individual WACC directly and 31% using the market implied return scaled by the portfolio WACC. Note that using the portfolio WACC to scale the market implied return the mean and median results, for this portfolio, are almost identical, while using the individual WACC directly produces a more skewed distribution.

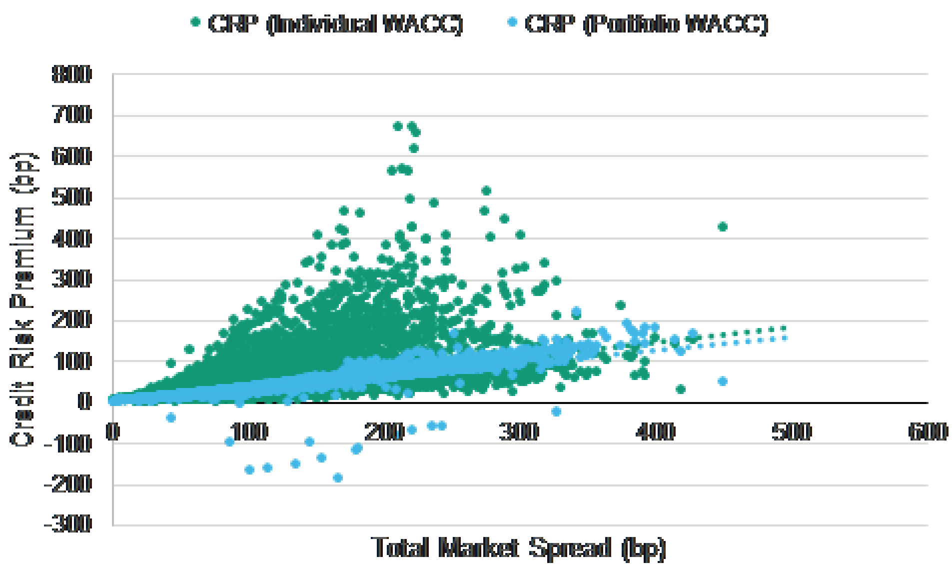
The table also shows the results of performing least squares fits, for mean results, and least absolute deviation fits, for median results. The least absolute deviation, median, fits are the gradient of the dotted line in Figure 8. The gradients of these fits, as expected, are almost identical to taking the simple ratio of the credit risk premium spread to the market spread.

Table 1

US Investment Grade Spreads

	Mean Results		Median Results	
	Individual WACC	Portfolio WACC	Individual WACC	Portfolio WACC
Market Spread	129.3	129.3	123.3	123.3
Expected Loss Spread	21.2	21.2	13.9	13.9
Credit risk premium Spread	61.5	41.4	43.7	38.5
Credit risk premium Spread/Market Spread	0.48	0.32	0.35	0.31
Gradient Fit	0.49	0.33	0.37	0.32

Figure 9



Note that in Figure 8 there are a number of bonds with a negative market implied excess return, and hence a negative credit risk premium spread adjustment when using the market implied return. These are bonds for which the CreditEdge EDF implies a larger expected loss spread than the total observed market spread. In all of these cases the issuer is a state owned enterprise (either from China or Abu Dhabi) where the market spread likely takes into account the expectation of additional, implicit guarantees for which the EDF model does not account. The use of median fits above means that these small number of outliers can be left in the sample without substantially effecting the results and we do not need to manually filter the data.

Given the breadth of the US portfolio considered here, the final results, using the market implied scaling of the portfolio WACC, can be broken down by sector and rating, as shown in Table 2 and Table 3. These tables show an increasing total spread and credit adjustment as ratings lower and a higher spread and credit adjustment for bonds issued by non-financial entities. The proportion assigned to each category, expected loss, credit risk premium and illiquidity premium is similar in each case, as expected given the tight relationship illustrated in Figure 8.

Table 2

US Average Spreads by Sector

	Spread	Expected Loss	Credit risk premium	Illiquidity Premium
Financial	98.1	20.2	30.6	45.3
Non-Financial	138.9	21.5	44.7	69.5

Table 3

US Average Spreads by Rating

	Spread	Expected Loss	Credit risk premium	Illiquidity Premium
AAA	85.3	16.2	25.8	41.5
AA	91.7	19.8	28.6	41.5
A	106.6	22.0	32.9	49.4
BBB	148.5	20.9	48.5	75.7

4.1.2. EU Investment Grade

Results for EU investment grade corporate bonds use the Merrill Lynch EMU Corporate Index. This index contained 2789 publicly issued, EUR denominated investment grade bonds at the time of access, of which we had EDF, leverage and LGD data for 1879 within CreditEdge. All bonds have at least one year to maturity and a minimum outstanding of €250m. Results are calculated using spreads over appropriate country specific treasuries and use an equity risk premium of 4.46% as in our standard Scenario Generator calibrations and a tax adjustment of 80%.

Table 4 below shows mean and median market, expected loss and credit risk premium spreads calculated using either the individual WACC credit risk premium or the market implied return scaled by a portfolio WACC. The table shows that using mean estimates across the portfolio the individual WACC credit risk premium explained around 80% of the market spread, while the portfolio WACC scaled market implied return explained just over 50%. Using median estimates the individual WACC explained slightly over 60% of the spread and the portfolio WACC explained around 50%.

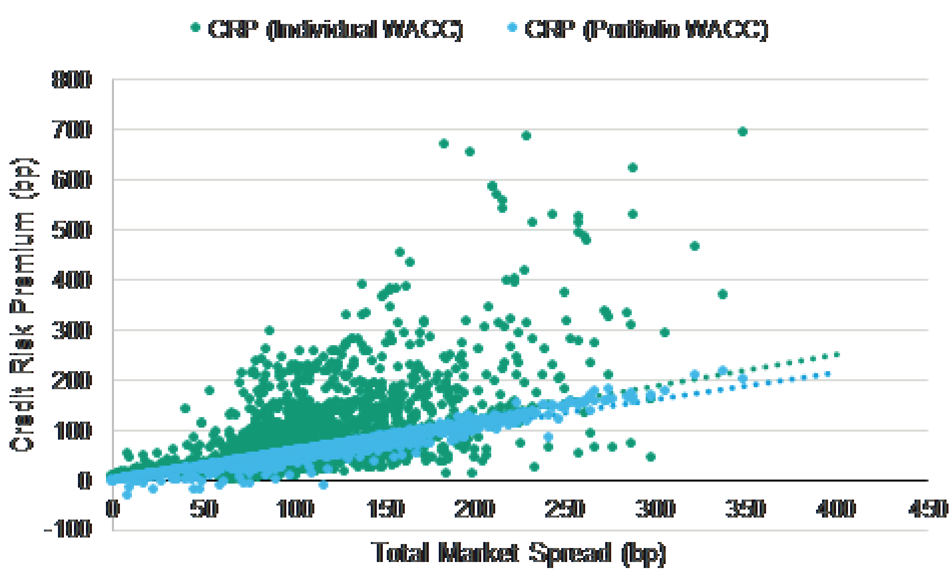
Figure 9 shows the variation in estimates for each bond in the portfolio. As in the US case, above, the individual WACC shows far more variation and a more skewed distribution. The dotted lines in the figure illustrate the results of the least absolute deviation, median, fit to the data.

Table 4

EU Investment Grade Spreads

	Mean Results		Median Results	
	Individual WACC	Portfolio WACC	Individual WACC	Portfolio WACC
Market Spread	109.4	109.4	99.3	99.3
Expected Loss Spread	23.2	23.2	17.6	17.6
Credit Risk Premium Spread	86.8	56.7	60.8	50.9
Credit Risk Premium Spread/Market Spread	0.79	0.52	0.61	0.51
Gradient Fit	0.84	0.53	0.63	0.54

Figure 10



4.1.3. UK Investment Grade

Results for UK investment grade corporate bonds use the Merrill Lynch Sterling Corporate Index. This index contained 777 publicly issued, GBP denominated investment grade bonds at the time of access, of which we had EDF, leverage and LGD data for 496 within CreditEdge. All bonds have at least one year to maturity and a minimum outstanding of £100m. Results are calculated using spreads over treasuries and use an equity risk premium of 3.40% as in our standard Scenario Generator calibrations and a tax adjustment of 80%.

Table 5 below shows mean and median market, expected loss and credit risk premium spreads calculated using either the individual WACC credit risk premium or the market implied return scaled by a portfolio WACC. The table shows that using mean estimates across the portfolio the individual WACC credit risk premium explained around 60% of the market spread, while the portfolio WACC scaled market implied return explained just under 40%. Using median estimates the individual WACC explained 45-50% of the spread and the portfolio WACC explained 36-38%.

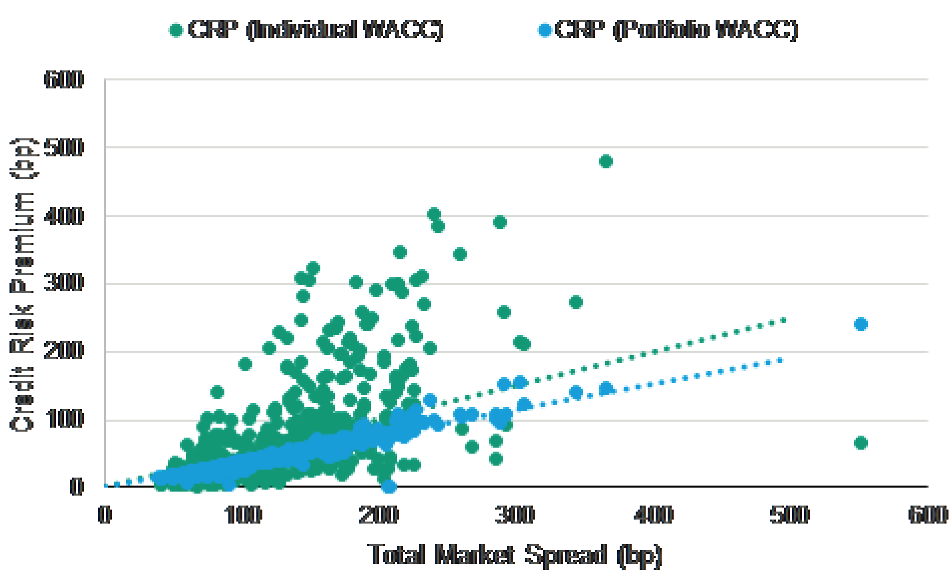
Figure 10 shows the variation in estimates for each bond in the portfolio. As in the US and EU cases, above, the individual WACC shows far more variation and a more skewed distribution. The dotted lines in the figure illustrate the results of the least absolute deviation, median, fit to the data.

Table 5

UK Investment Grade Spreads

	Mean Results		Median Results	
	Individual WACC	Portfolio WACC	Individual WACC	Portfolio WACC
Market Spread	134.7	134.7	132.8	132.8
Expected Loss Spread	25.8	25.8	21.1	21.1
Credit Risk Premium Spread	79.5	50.7	59.1	48.3
Credit Risk Premium Spread/Market Spread	0.59	0.38	0.45	0.36
Gradient Fit	0.62	0.38	0.50	0.38

Figure 11



4.1.4. SA Corporate Bonds

For South African corporate debt available data within CreditEdge was substantially more limited than for the other portfolios considered in this paper. Overall we were able to find necessary EDF, LGD, Leverage and volatility data for 62 ZAR denominated bonds. Many of these were not rated and the vast majority were from financial organisations, see Figure 11. For SA bonds, LGD data were sourced from Moody's RiskCalc rather than CreditEdge as this database adjusts for country as well as sector and produced more plausible estimates. Results are calculated using spreads over swap rates and use an equity risk premium of 2.89% as in our standard Scenario Generator calibrations and a tax adjustment of 80%.

Figure 12

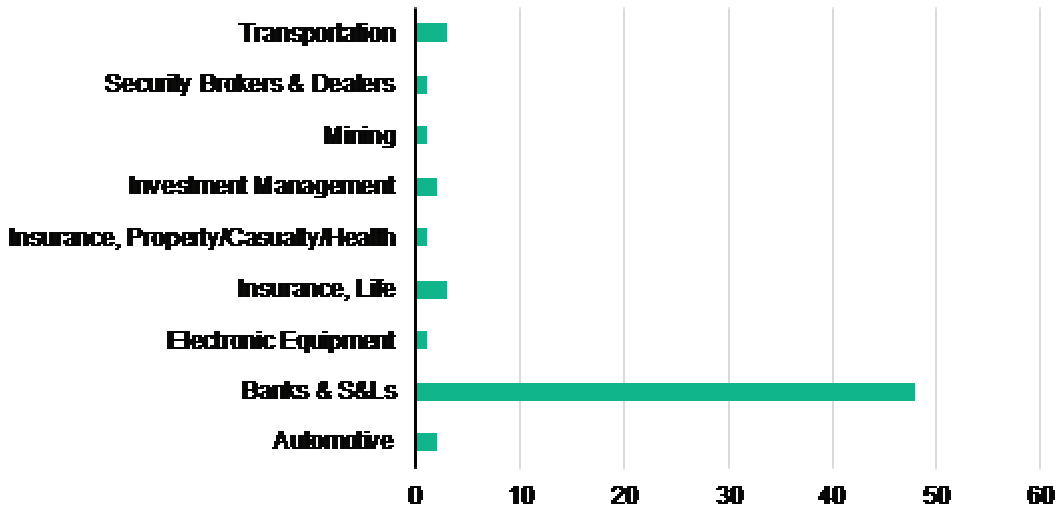


Table 6 below shows mean and median market, expected loss and credit risk premium spreads calculated using either the individual WACC credit risk premium or the market implied return scaled by a portfolio WACC. The table shows that using mean estimates across the portfolio the individual WACC credit risk premium explained around 140% of the market spread, while the portfolio WACC scaled market implied return explained just under 70%. Using median estimates the individual WACC explained around 120% of the spread and the portfolio WACC explained 61-68%. These results are noticeably higher than for the EU, US and UK portfolios considered above, and in particular the individual WACC approach seems to predict a credit risk premium substantially in excess of the total market spread. The portfolio WACC scaled by the market implied return predicts a more reasonable credit risk premium, but still predicts no illiquidity premium over the risk free instruments.

These results may be explained by the lower quality of data, and the far smaller sample size of the portfolio, the skew towards banks and the likelihood of residual credit and illiquidity risk within the swap curve.

Figure 12 shows the variation in estimates for each bond in the portfolio. As in previous cases, above, the individual WACC shows far more variation and a more skewed distribution. The dotted lines in the figure illustrate the results of the least absolute deviation, median, fit to the data.

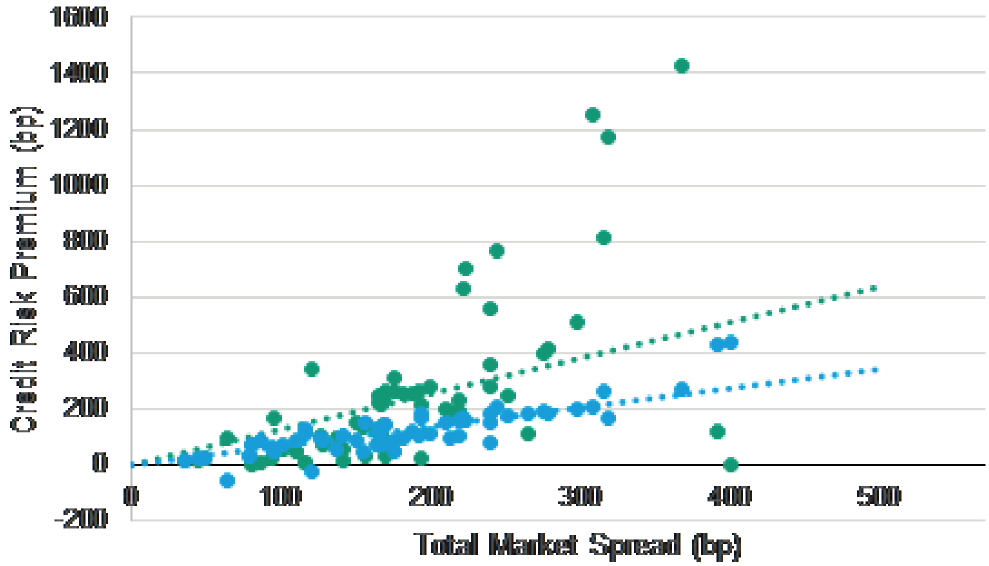
Table 6

SA Corporate Bond Spreads

	Mean Results		Median Results	
	Individual WACC	Portfolio WACC	Individual WACC	Portfolio WACC
Market Spread	183.0	183.0	169.3	169.3
Expected Loss Spread	71.4	71.4	71.3	71.3

Credit Risk Premium Spread	254.0	120.9	191.1	102.6
Credit Risk Premium Spread/Market Spread	1.39	0.66	1.13	0.61
Gradient Fit	1.54	0.70	1.28	0.68

Figure 13



4.1.5. US High Yield Bonds

For high yield US bonds we use the Merrill Lynch High Yield Master II Index. This index tracks dollar denominated publicly issued corporate bonds with a below investment grade rating, at least one year to maturity, fixed coupons and a minimum outstanding value of $250m. At the time of access we recovered 1872 ISINs for constituent bonds, of which we could find leverage, EDF and LGD data for 1394.

Unlike the portfolios listed above, Moody's do not produce an estimate of equity risk premium specifically for a portfolio of US firms issuing high yield debt. In order to derive an appropriate cost of capital, there are a number of options.

First the equity risk premium could be assumed to be equal to that used for the US investment grade portfolio.

Second, the investment grade ERP could be adjusted to account for the difference in average leverage between the two portfolios, by assuming the same unlevered ERP:

$$\mu_E^{HY} = \mu_E^{IG} \cdot \frac{1 - Leverage^{IG}}{1 - Leverage^{HY}}.$$

Third, a constant equity market price of risk could be assumed, and the ERP could be rescaled to account for the difference in average equity volatility. For the Merton model the equity and asset volatilities are related by

$$\sigma_E = N(d_1) \cdot \frac{A}{E} \cdot \sigma_A.$$

where A is the asset value and E is the equity. Assuming a constant equity market price of risk implies that

$$\mu_E^{HY} = \frac{\mu_E^{IG}}{\sigma_E^{IG}} \cdot \sigma_E^{HY}.$$

Ignoring the correction for changes in the value of $N(d_1)$[5], the adjusted high yield equity risk premium is then

$$\mu_E^{HY} = \mu_E^{IG} \cdot \frac{\sigma_A^{HY}}{\sigma_A^{IG}} \cdot \frac{1 - Leverage^{IG}}{1 - Leverage^{HY}}.$$

Fourth, an equity excess return could be inferred by assuming the asset market price of risk to be constant.

$$\lambda_{HY\ Port}^{WACC} = \lambda_{IG\ Port}^{WACC} \cdot \frac{\sigma_A^{HY}}{\sigma_A^{IG}}.$$

Reversing the formula for the cost of capital backs out an implied equity risk premium:

$$\mu_E^{HY} = \frac{(\lambda_{HY\ Port}^{WACC} - Spread^{HY} \cdot Leverage^{HY} \cdot Tax)}{1 - Leverage^{HY}}.$$

Table 7 compares a number of statistics for the US investment grade and high yield portfolios considered in this paper. This shows a slightly higher average leverage and a significant difference in average volatility. The market implied returns show a higher cost of capital for firms with a lower credit rating, but a very similar market price of risk when accounting for the difference in estimated asset volatility. This suggests it might also be prudent for us to adjust the estimate of the WACC to account for this difference in volatility.

Table 7

Comparison of US Investment Grade and High Yield Portfolios

	Investment Grade	High Yield
Average Asset Volatility	12.7%	19.1%
Average Leverage	38.0%	43.5%
Average Spread (bp)	129.3	367.1
Market Implied Portfolio Return (λ_Port^MI)	5.12%	7.39%
Market Implied Portfolio Price of Risk (Λ_Port^MI)	0.404	0.387

Table 8 shows the impact of the four methods described above in terms of the implied equity risk premium, the WACC, the proportion of the market implied excess return ascribed to credit risk, the average credit risk premium spread and the proportion of the total market spread assigned to the credit risk premium. As expected, if the asset market price of risk is assumed to be constant between the investment grade and high yield portfolios then the proportion of the total spread explained by the credit risk premium is approximately constant, at 32% for both portfolios.

If the equity market price of risk is held constant, the higher average spreads for the high yield portfolio lead to a higher credit risk premium and a larger proportion of the market spread at 40%. Making no adjustment to the equity risk premium for differences in volatility, leads to a notably lower cost of capital and a smaller proportion of the market spread explained by the credit risk premium, 23%-25%.

Table 8

US High Yield Bond Equity Return Comparison

	Equity Risk Premium	Portfolio WACC	Portfolio WACC MPR	Portfolio WACC/ Market Implied Return
Investment Grade ERP	4.04%	3.56%	0.186	48.2%
Relevered ERP	4.44%	3.78%	0.198	51.2%

5 From Section 2.1 note that $d_2 = d_1 - \sigma_A\sqrt{T}$ and $CPD = N(-d_2)$. Putting these together, $N(d_1) = N\left(N^{-1}(1 - CPD) + \sigma_A\sqrt{T}\right)$. Using the average durations of the investment grade (7.18 years) and high yield (5.07 years) portfolios with the average asset volatilities and CPD (3.6% vs 9.3%) gives a ratio of $N(d_1^{HY})/N(d_1^{IG}) = \mathbf{0.98}$

Constant Equity MPR	6.69%	5.06%	0.265	68.5%
Constant Asset MPR	5.48%	4.37%	0.229	59.2%

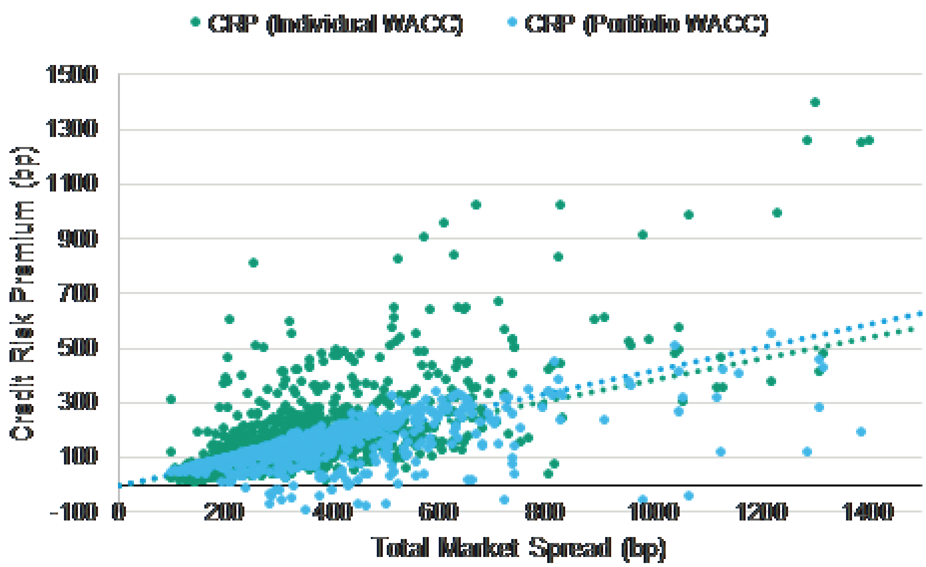
Using the constant equity market price of risk to define a high yield equity risk premium, produces the spread results detailed in Table 9. For the high yield data there is a significant difference between the mean and median results as the individual estimates, shown in Figure 13, exhibit higher variance and skew. For our preferred mean average using the portfolio WACC, the credit risk premium account for one third of the average spread.

Table 9

US High Yield Corporate Bond Spreads

	Mean Results		Median Results	
	Individual WACC	Portfolio WACC	Individual WACC	Portfolio WACC
Market Spread	352.2	352.2	298.4	298.4
Expected Loss Spread	133.6	133.6	50.2	50.2
Credit Risk Premium Spread	171.8	115.8	111.0	117.1
Credit Risk Premium Spread/Market Spread	0.49	0.33	0.37	0.39
Gradient Fit	0.61	0.28	0.39	0.42

Figure 14



4.2. Deriving an Illiquidity Premium

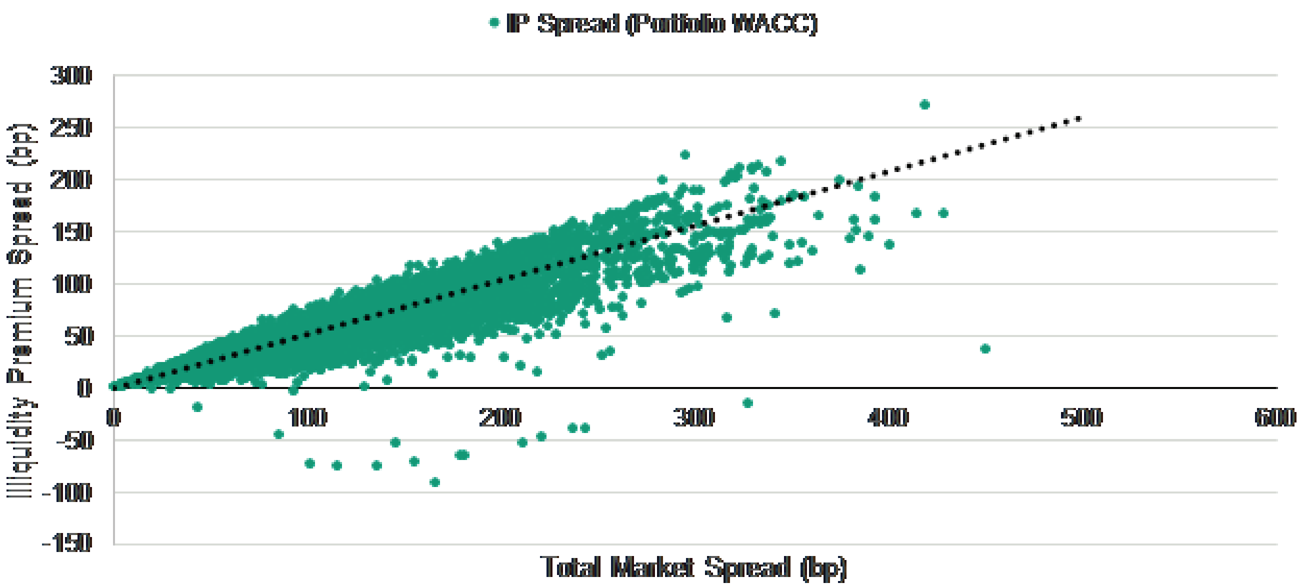
Under IFRS 17's top-down approach to discount rate construction the total yield for the reference portfolio must be adjusted to remove the effect of credit risk, both expected losses and a credit risk premium. Assuming the reference portfolio is well matched to the associated liabilities, the credit-adjusted yield curve is taken as the appropriate discount curve. In principle there is no need to identify any spread over the risk free rate as an illiquidity premium. Using the bottom-up approach, however, there is a need to specifically account for liquidity and the methodology described in this paper could be used in order to estimate the associated spread.

If the total observed market spread is assumed to comprise of only credit risk and illiquidity risk, then the illiquidity premium can be defined as the residual after adjusting the total yield for the default spread and the credit risk premium:

$$\textit{illiquidity premium} = \textit{marked observed spread - EL - UL.}$$

Based upon the results presented in section 4.1 the analysis suggests that the illiquidity premium accounts for around 30%-50% of the total spread, depending on the specific choice of methodology for the credit risk premium, the choice of risk free basis and the economy under consideration. Figure 14 shows the relationship between the illiquidity premia, defined as the residual after credit adjustment, and the total market spread for the US investment grade portfolio. The dotted line indicates the least absolute deviation linear fit to the data.

Figure 15



For a practical implementation of the bottom up approach there are a number of considerations that need to be taken by a firm.

Firstly, should a uniform adjustment be made to the risk free rate to account for illiquidity, or is there a need to estimate a term structure? Given that the method described here is able to estimate total yields and credit adjustments for each individual bond, a term structure for the illiquidity premium could be estimated by directly fitting to the individual IP estimates, or by applying a scaling to the portfolio spread over the appropriate risk free rate.

Secondly, is the adjustment applied as a point-in-time calculation using a snapshot of market spreads at a given reporting date? or should the results be smoothed using historical data to determine either the credit risk premium or the total spread? In the next section we investigate the sensitivity of the results to a number of modelling choices and parameters.

4.3. Sensitivity to Model Assumptions

The results of sections 4.1 and 4.2 show that the WACC model of credit risk premium is able to generate intuitive results and offers a plausible route to estimating the credit risk adjustment for IFRS17 discount rate construction.

However, while the model aims to use market observable and implied data where possible, and utilise real world EDF and LGD data in which we have confidence, there remain a number of key data inputs which can impact the results. In the sections below we example the sensitivity of the model to two of these, equity risk premium, and the choice of risk free basis.

4.3.1. Equity Risk Premium

Perhaps the most important unobservable input to the model is the equity risk premium. Equity risk premia are a matter of considerable contestation in the financial literature and estimates can vary significantly. Brotherson et al. (2013) report that best practice, and by far the most common method, to calculate the equity risk premium for a specific firm is to use the CAPM. Within their survey there were a range of sources cited for the source of the market risk premium associated with the CAPM: historical data, forward-looking dividend discount model (DDM), Bloomberg and expert judgement among them. These varied sources returned a range of market equity risk premia between 4% and 9%, with a mean around 6.5%.

Within Moody's Analytics we calculate forward looking equity risk premia for country specific market indices for use within the calibrations of our Scenario Generator. Our methodology uses the Dimson, Marsh and Staunton historical analysis to set a global arithmetic risk premia (in excess of cash) of 4%. To calculate risk premia across equity markets we then set a target covariance matrix Ω from target correlations and volatilities and calculate a vector of β coefficients as

$$\beta = \frac{1}{\sigma_p^2}\Omega w,$$

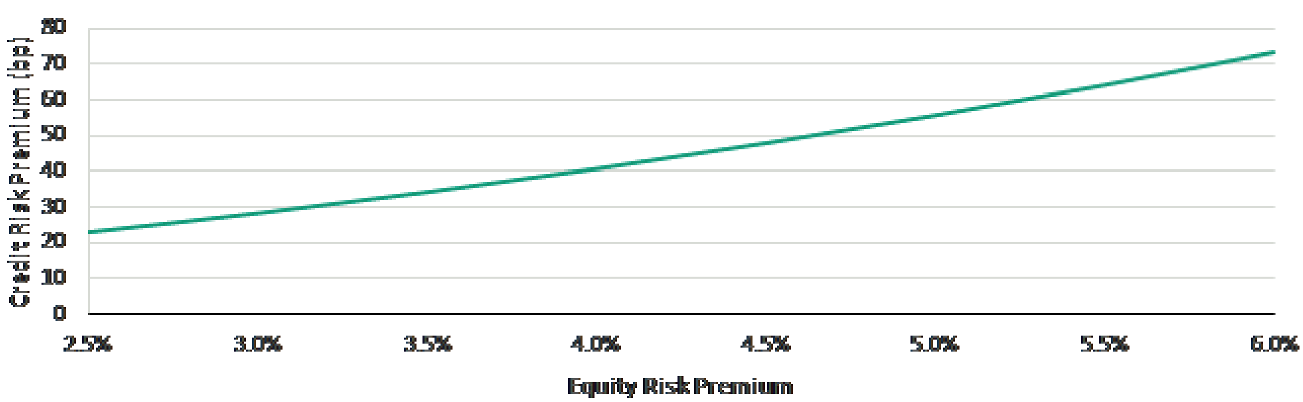
where σ_p^2 is the global portfolio variance and w are a set of weighs based on the observed relative market capitalisations. The arithmetic risk premium of a specific country is then

$$\mu_{E,i} = \beta \mu_E.$$

The asset betas for specific firms could be produced using Moody's GCorr™ or, alternatively, equity betas could be constructed using data from Bloomberg or Barra (consistent with many responses to Brotherson).

In any case, the choice of cost of equity capital (equity risk premium) can make a noticeable impact on the credit risk premium, as shown in Figure 15 below, which holds everything else constant and varies the overall market equity risk premium, measuring the impact on the credit risk premium. In this case, for a broad portfolio of USD denominated investment grade bonds, there is a non-linear sensitivity where, at 4% equity risk premium a 1% change in risk premium produce a 14bp change in credit risk premium spread.

Figure 16



Whilst Moody's estimates of equity index risk premia are periodically updated, the global arithmetic equity risk premium remains relatively constant over time. As such, the economy specific values, particularly for large markets like the US, will vary only to a limited degree. The largest contribution to any change in credit risk premium will therefore come through changes in the expected losses, weighted by the leverage, and changes in volatility. The estimate for the credit risk premium may in consequence vary more slowly than total market spreads and the derived illiquidity premia may be more volatile than preferred.

The correlation between estimates of the total credit adjustment or liquidity premia and spreads on assets in this structural modelling approach depends on the correlations assumed between spreads and the default probabilities and the correlations between spreads and the equity risk premia. It is worth noting that if we were to assume a positive historical correlation between spreads and the equity risk premia this would produce less volatile estimates of the illiquidity premia and more volatile estimates of the credit risk premia. This assumption is therefore a critical one in determining how effectively the illiquidity premia estimate dampens ALM volatility under the IFRS 17 framework.

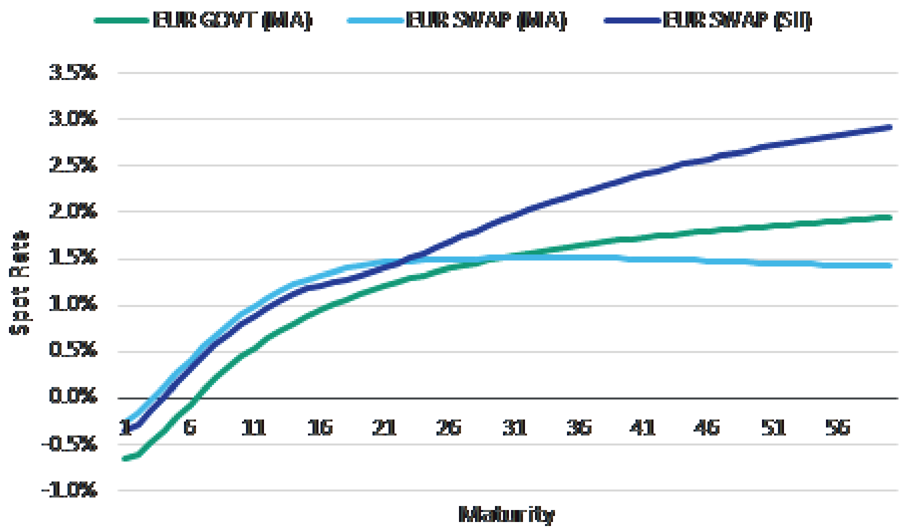
4.3.2. Risk Free Rate

Although in principle a top-down approach to discount rate construction under IFRS 17 does not require us to define the risk free rate, our proposed approach in this paper, which scales a weighted average cost of capital by market implied returns, does implicitly depend on the choice of risk free basis to define the overall market spreads. These spreads impact both the weighted cost of capital itself via the cost of debt, and the market implied returns. The choice of appropriate basis to define these spreads is therefore important.

The text of the IFRS 17 standard states that the risk free rate should reflect the yield curve in the appropriate currency for instruments with no or negligible credit risk. The question then arises as to whether either swap or treasury instruments exhibit no or negligible credit risk. Both could themselves be adjusted to account for residual credit risk, for example using interbank-OIS spread data, or CDS spreads respectively. The standard further states that the liquid risk-free yield curve should then be adjusted to reflect the *difference* in liquidity between the instruments underlying the observed market rates for the risk free curve and the liquidity of the insurance contracts. Either swap contracts or government bonds could in practice contain some illiquidity premia over a fully liquid risk free rate and care should be taken not to double count this premium.

For some economies the choice of risk free basis will not have a significant effect, for example, in the US results produced in this paper swap/treasury spreads are low. In other economies there can be a substantial swap/government spread and results will vary depending on whether swaps or treasuries are used to define the credit spread, see Table 10 below. Figure 16 shows three spot rate curves for EUR at end June 2018 and illustrates the significant spread between swaps and treasuries. In the case of the Eurozone there is the additional complication that there is a single swap rate which crosses many countries each issuing their own government debt a different rates. The MA EUR government curve shown in the figure below is based on a combination of French and German bonds. In addition, where firms are valuing liabilities under the Solvency II regime, the discount curve published by EIOPA defines a last liquid point at 20 years for EUR, and extrapolates much more quickly from there to an unconditional forward rate than the market data, this can be seen from the difference between the MA and SII data in Figure 16.

Figure 17



For investment grade debt, during periods of market calm, the WACC is dominated by the cost of equity, which is typically significantly higher than the cost of debt, and so while the credit risk premium will vary depending on the choice of basis, the absolute value of the average credit risk premium spread is not overly sensitive to the choice, see Table 10 for comparisons. However, during periods of market stress, e.g. during the financial crisis, the difference could be more material. Further, even in periods with low average cost of debt, where the overall WACC does depend more strongly on the choice of basis, the illiquidity premium estimate will vary more substantially, as does the proportional relationship between total spread and credit risk premium. Table 10 shows that for EUR data at End June 2018 there was nearly a 50bp difference between the median spread over swap rates and the median spread over treasuries. The credit risk premium only varied by 7bp, but the illiquidity premium is 40bp lower using the residual over swap rates. For the UK there is a swap spread, and illiquidity premia swap spread of around 10bp and for the US the difference between bases is even lower.

Table 10

Risk Free Basis Comparison

	SWAP			Treasury		
	Spread	Credit risk premium	Illiquidity Premium	Spread	Credit risk premium	Illiquidity Premium
EUR	52.4	44.0	-12.6	99.3	50.9	28.3
GBP	124.6	49.3	44.9	132.8	48.3	55.5
USD	123.3	38.5	63.2	119.2	37.3	61.3

5. Conclusion

Calculation of credit and liquidity adjustments is a complex challenge. Estimates of illiquidity premia can vary substantially depending on the choice of model and underlying assumptions (Hibbert 2009). Under IFRS 17, the methodology to set discount rates will be a key challenge. For many insurers the focus will be to ensuring that well matched balance sheets are stable and that P&L results are informative of real changes in underlying economic conditions and not simply accounting mismatches (Jessop 2018). Insurers therefore need to be aware of the dangers of artificially introducing instability to their results as a consequence of modelling choices whilst still capturing genuine changes in market conditions.

This paper lays out one potential method to calculate the necessary total credit adjustment, accounting for both expected loses and the credit risk premium, by leveraging Moody's experience with credit loss calculations and combining that knowledge and modelling with established cost of capital techniques used in corporate finance. The expected loss adjustment considered in this analysis could easily be extended to reconcile with the more sophisticated impairment methods used by firms for IFRS 9 and CECL.

We propose a credit risk premium which starts from an estimate of the weighted cost of capital at the level of the portfolio and scales this for each firm using market implied returns. Combining this credit risk premium with an estimate of the asset volatility allows us to estimate a spread adjustment and derive an illiquidity premium as the residual of the spread over the risk free rate after adjusting for credit risk. We analysed this method for four economies considering both investment grade and high yield corporate debt and considered the sensitivity of the results to several of the key model inputs.

This paper hopes to show that using a structural model of credit risk could be a useful method to derive discount curves for IFRS 17 under either the top-down or bottom-up approaches. In practice, some further work may be required to before firms commit to adopting such an approach. For example we would expect firms to want to:

- Compare the estimated illiquidity premia with alternative benchmarks such as the EIOPA Solvency II Volatility Adjustment
- To understand the stability over time of results and the sensitivity to changes in market data and assumptions about the time varying behavior of equity risk premium.
- To potentially enhance the method to reconcile expected losses with IFRS 9 impairment calculations
- To develop robust methods to apply where data (particularly ratings, or market price) is scarce
- To extend the analysis to further asset classes, such as government debt, infrastructure and structured loans.
- Understand the liquidity characteristics of liability contacts and resolve how to transfer an illiquidity premia derived for a portfolio of assets to a set of insurance contracts.

While a number of significant open questions need to be addressed when implementing IFRS 17, we believe the methodology presented here is promising, not least because it has the potential to be applied to address most of these considerations.

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Moody's ANALYTICS

Calibration Methods

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

Illiquidity and Credit Premia for IFRS 17 at End December 2018

Executive Summary

This note sets out our calibrations of corporate credit yield curves for selected economies at End Dec 2018 alongside our estimates of the split between credit risk premia and illiquidity premia for the same data. Market yields of corporate bonds are adjusted by removing both an expected credit loss and a unexpected credit loss using a Merton-style structural model based on Moody's Expected Default Frequency (EDF™) model combined with a cost-of-capital approach to set credit risk premia.

Yield curves are fitted to market yields with and without credit adjustment using a cubic-spline Nelson-Siegel method. The residual difference between the credit risk adjusted corporate bond yields and the equivalent currency government bond yields defines an implicit relative illiquidity premium for those assets.

These illiquidity premia and credit risk premia, split per rating and by financial and non-financial status could form the basis for a firm to define an appropriate entity-specific liability discount curve for the purposes of IFRS 17 reporting.

CONTENTS

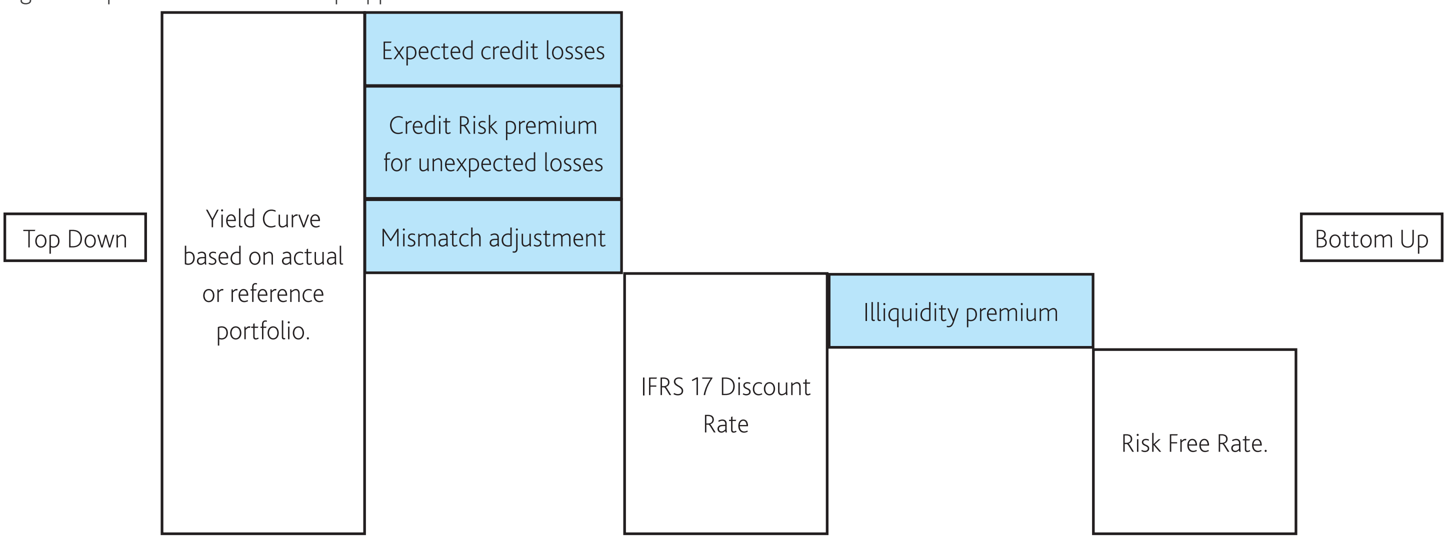
Introduction

IFRS 17 allows for two different approaches to yield curve construction and discounting, a "top-down" approach and a "bottom-up" one, as shown schematically in Figure 1. The top down approach requires an insurer to build a curve based on their actual asset portfolio or a reference portfolio and then adjust the yield on this portfolio by deducting an allowance for credit risk. The insurer also needs to adjust the yield to account for any mismatch between asset and liability cash flows. Credit risk within this approach can further be decomposed into a compensation for expected losses (real world default risk) and a specific credit risk premium, which reflects the uncertainty around expected losses.

The bottom up approach requires an insurer to choose financial instruments to reflect the (liquid) risk free rate and then to fit a curve to those data and then determine an appropriate liability specific illiquidity premium to be applied above the risk free curve.

Whilst in principle both approaches should give the same results, section B84 of the IFRS 17 standard acknowledges that the top down and bottom up calculations may give different answers in practice and do not need to exactly reconcile.

Figure 1 Top-Down and Bottom-Up Approaches to IFRS 17 Discount Curve Construction



There are related, but distinct, challenges to both top-down and bottom-up approaches. Top-down the primary questions relate to estimating the credit risk premium and the selection of an appropriate reference portfolio. Bottom-up the standard states that the illiquidity premium applied must reflect the liquidity characteristics of the insurance product being valued, determining the appropriate liquidity characteristics and mapping these to asset data where the illiquidity premium can be estimated is a key task for this approach. The liquid risk-free rate also needs to be defined for a bottom-up approach, we discuss this point in more detail on page page 49.

Methodology overview

Within this report we follow the top-down structural method defined in our previous white paper Thompson and Jessop (2018) to calculate the credit risk premium and to decompose market spreads into three components: 1) expected losses from defaults 2) Unexpected losses (credit risk premium) and 3) illiquidity premium. The derived illiquidity premia are then presented in a form where they could be applied bottom-up.

Our method uses a Merton-style structural model of credit risk to calculate fair value spreads based on a combination of real world probabilities of default, estimated at an individual firm level, sectoral estimates of loss given default and a weighted cost-of-capital adjustment for credit risk premium. This method leverages Moody's Analytics CreditEdge™ expected default frequency (EDF™) model of real world probability of default. CreditEdge EDFs are an industry recognized standard for point-in-time probability of default, please refer to Nazeran and Dwyer (2015) for more detail of the EDF model.

The forward looking nature of the EDF estimates is well aligned to recent developments in the IFRS standards, in particular the IFRS 9 impairment methodologies which were introduced as a response to 'too little too late' during the financial crisis (Zhang, 2018). EDFs are procyclical estimates of credit risk, and will also drive a proportionately procyclical estimate of the credit risk premia using our method. This means that all three components of spread changes (expected losses, credit risk premium and illiquidity premia) are all expected to be positively correlated with market spread changes when using the method outlined. Understanding and being able to provide robust justification for this aspect of the IFRS 17 yield curve calibrations is likely to be a critical component of a successful and acceptable implementation of the standards.

Methodology Considerations

Credit risk adjustment

In brief, the structural model of credit risk employed in our method calculates a firm's credit risk by treating the traded equity of the firm as a call option on the firm's assets, with a strike price given by the default point, where the firm's assets cannot cover its liabilities. By modelling the value of the firm's assets with a stochastic process, a geometric Brownian motion, the real-world probability of default can be calculated at a given horizon, dependent on the leverage or the firm, the expected return on the firm's assets and the asset volatility. The final real world probability of default is calculated using an empirical mapping based on a database of historical defaults.

Mathematically, the compensation for expected credit losses is given by combining the real world probability of default with the recovery rate, or loss given default:

$$Expected\ Credit\ Loss\ Spread_i = -\frac{1}{T_i}\ln(1 - CPD_i \cdot LGD_i),$$

where CPD_i is the duration matched cumulative probability of default for a given bond i and LGD_i is the loss given default for that issuer's industrial sector, a parameter also derived from CreditEdge.

The unexpected loss is then calculated by adjusting the real world probability of default to account for a credit risk premium. This credit risk premium is calculated based on a cost-of-capital approach, assuming that the expected return on a firm's assets is related to the leverage weighted cost of capital for that firm. We say the cost of capital is given by

$$Cost\ of\ Capital = Leverage \cdot Cost\ of\ Debt + (1 - Leverage) \cdot Cost\ of\ Equity,$$

where the cost of debt is derived from the corporate bond spread and the cost of equity is the equity risk premium.

The cost of capital is estimated at a portfolio level, where we can more easily determine an average equity risk premium, and then scaled using a portfolio beta to get the credit risk premium for a given issuer. The portfolio betas are estimated using the market implied returns for the overall portfolio and each individual issuer.

$$\frac{Credit\ Risk\ Premium_i}{Issuer\ Market\ Implied\ Return_i} = \frac{Portfolio\ Weighted\ Cost\ of\ Capital \cdot}{Portfolio\ Market\ Implied\ Return}$$

The total credit adjustment is then the sum of the expected credit loss spread and the unexpected credit loss due to the credit risk premium.

By defining the observed market spread as the sum of expected loss, unexpected loss and illiquidity premium, the implied illiquidity premium can then be backed out as the residual of the market spread minus the total credit adjustment

$$Illiquidity\ Premium_i = Market\ Spread_i - Total\ Credit\ Adjustment_i.$$

Rating and Sector Breakdown

Within each economy we break down the estimate of the credit risk premium and the implied illiquidity premium for each bond rating for which there is sufficient data and across ratings between financial and non-financial issuers. As the leverage and volatility characteristics of firms vary significantly between sectors our cost-of-capital adjustment should also vary between these categories. To do this we follow the method described in Thompson and Jessop (2018) to adjust the equity risk premium assuming a constant asset price of risk. The market implied returns indicate that this is a more reasonable quantity to hold constant as leverage and volatility change than the equity risk premium itself and the results quoted in this report are more intuitive when this adjustment is performed.

Reference Portfolio Construction

As a principles based approach, IFRS 17 allows firms freedom to choose reference portfolios aligned to their own business lines and products. In theory insurers could choose to set a distinct reference portfolio for each line of business or separate product type, reflecting the difference in liquidity characteristics between each liability. Alternatively insurers may wish to use a single reference portfolio and scale top-down curves or illiquidity premia derived from it as appropriate to each liability.

The composition of the reference portfolio will be crucial and there does not yet appear to be consensus in the industry on how this should be constructed, or on whether the portfolio should represent the actual assets used to back the relevant liabilities.

Some insurers (particularly the UK bulk annuity players) will be looking to derive a discount rate curve which, at least partially, reflects an illiquid asset portfolio. Much of the analysis on illiquidity premia, including within this report, relates to corporate bonds. Extending this to illiquid assets such as infrastructure debt or real estate loans increases the challenge. Moody's Analytics are looking at ways to leverage the credit expertise and data which exists within the company to assist with this task. This is likely to be a more significant issue where an insurer has chosen to use their actual assets as the reference portfolio.

The choice of reference portfolio is not only a concern for a top-down approach to discount curve construction, however, even for bottom-up insurers need to understand the liquidity characteristics of liability contacts and resolve how to transfer an illiquidity premia derived for a portfolio of assets to a set of insurance contracts. An obvious starting point for many insurers may be the old QIS5 "bucketing" approach, where for example annuities were allocated 100% of the premium, with-profits 75% and unit-linked 50%. A more sophisticated approach may be to examine the underlying liability cashflows and quantify their predictability, thereby determining how much of the illiquidity premium on the backing assets could realistically be earned by holding assets to maturity. In either case, the choice of backing assets is still key: it is no use to know that the liabilities should apply 75% of the premium on the assets without knowing to which assets this refers.

Extrapolation and Interpolation

Within the standard for IFRS 17 the method for interpolating and extrapolating market data is not specified, though the standard does require that all appropriate and relevant market data are included. That, however, cannot be our only guiding principle.

When performing our standard Scenario Generator calibrations there are a number of core principles we value in constructing appropriate yield curves:

1. Accuracy: liquid markets should be accurately priced
2. Continuity: the forward curve should be continuous.
3. Smoothness: the forward curve should be smooth, i.e. the first derivative should be continuous.
4. Neutrality where data is missing: avoid extrapolating or interpolating spurious features or views (such as oscillations, humps, or bumps).

As in the IFRS 17 standard we first need to ensure that relevant market data are accurately priced, but to that we also add considerations that the calibrated curves should be continuous, smooth and without spurious variation.

Moody's Analytics standard calibrations use a cubic spline Nelson-Siegel (CSNS) algorithm to interpolate and extrapolate market data. This method proceeds by selecting a set of knot points, optimising forward rates at these knot points to satisfy an objective function and finally matching gradients at the last knot point to extrapolate to a specified ultimate forward rate (UFR) using a Nelson-Siegel form.

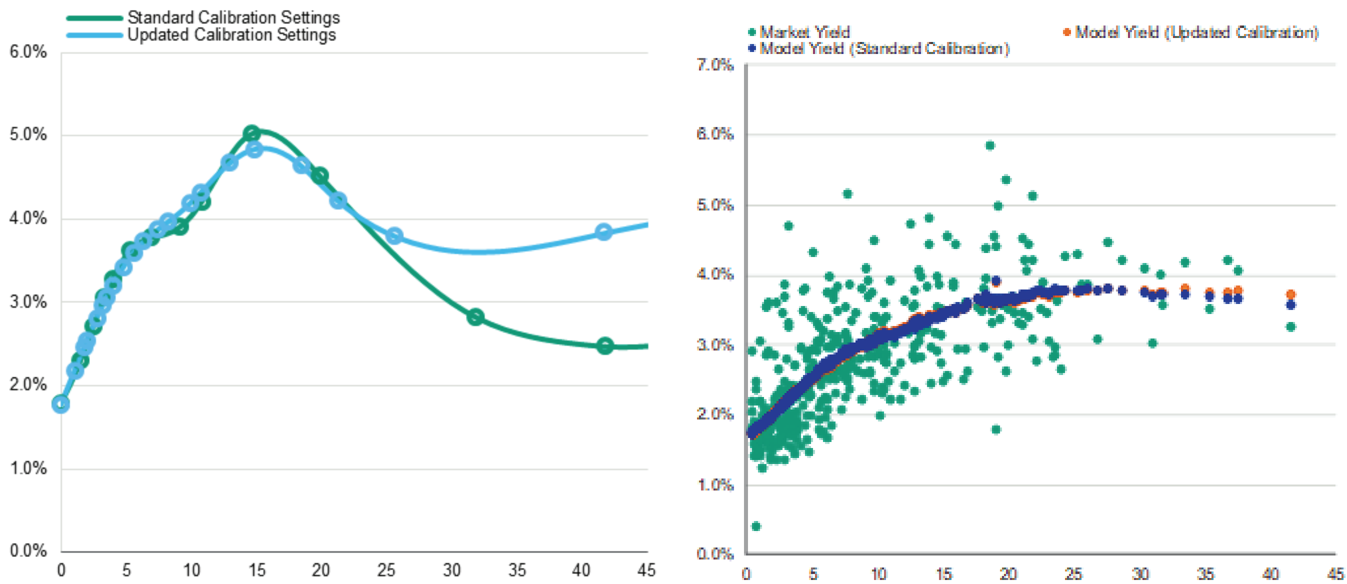
In order to follow our third and fourth core principles several penalty terms are added to the objective function, which control the final gradient of the forward rate curve and the smoothness of the first and second gradients. As standard the number of knot points scales with the square root of the number of fitting data, but caps at 12.

When fitting to corporate bond data, instead of swap rates or government bonds, the calibration is more challenging: due to differences in credit risk corporate bonds display far more variation in yields to maturity then the equivalent risk free instruments.

In order to achieve smoother and more neutral fitted curves, the calibrations in this report relax the constraint on the number of knot points but also increase the second derivative smoothing penalty compared to our standard calibrations. Figure 2 shows a comparison of the two calibration parameter sets for GBP investment grade corporate bonds at end December 2018. Where market data is relatively sparser, generally at longer maturities, calibrated yield curves can be sensitive to individual points and if knot points are spaced too widely can produce unintuitive forward rate curves. Note that whilst the forward rates are noticeably different between calibrations, the model yields are very similar.

Figure 2 Alternative Calibrations for GBP Corporate Bonds at End Dec 2018

(Left) Forward Rates, Knot Points Marked with Circles. (Right) Bond Yields



The IFRS 17 standard does not prescribe the extrapolation method, nor any choice of last liquid points (LLP) or UFR. Some firms may wish to use the Smith-Wilson method. This method is not well suited to fitting to large sets of data with substantial variation, i.e. to raw corporate bonds as used in this report, however, firms could first smooth corporate bond yields with a cubic spline, and then fit the final curve and extrapolation using Smith-Wilson. Other firms may wish to simply extrapolate using constant forward rates without setting an explicit UFR target; this avoids the need to set an assumption for unconditional illiquidity premia, but may result in less stable long term curves. In this report we use Nelson-Siegel extrapolated to our standard swap UFR for all calibrations but report only the first 30 years.

Risk-Free Basis

For any IFRS 17 discount rate methodology which follows the bottom-up approach, the choice of risk-free basis is essential. Within our top-down approach to calculating credit risk premia, however, the choice of risk-free rate can also impact the final results. The total credit risk adjustment is weakly dependent on the choice of risk-free rate through a change in spread component of the cost-of-capital. By changing the underlying basis the spread level, and hence the credit risk premium, or unexpected loss adjustment, will vary.

For some economies there is a significant difference between the swap and government curves. Figure 3 shows the difference between Moody's standard SG calibration for Germany at end December 2018, alongside the official EIOPA SII curve at the same date. In periods of market stress this can become even more pronounced; Figure 4 shows the one year LIBOR spread for Germany, UK and US from 1997 to 2017.

In principle, the "risk-free" curve may need adjustment itself. Either swap contracts or government bonds could in practice contain some illiquidity premia over a fully liquid risk-free rate. Both LIBOR and treasury rates could be adjusted to account for residual credit risk, for example using interbank-OIS spread data, or CDS spreads. Directly using OIS swap data might provide the most robust estimate of a truly risk-free yield curve.

Figure 3 Government and Swap Spot Rates for Germany at End Dec 2018

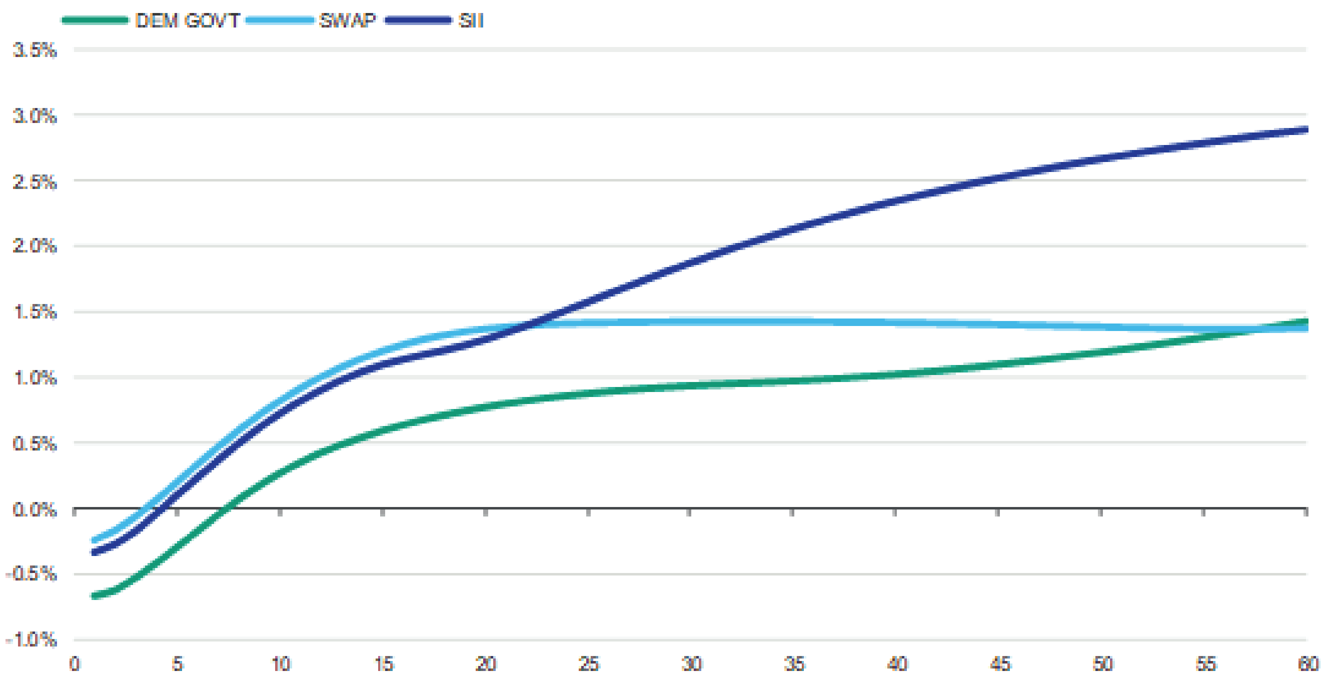
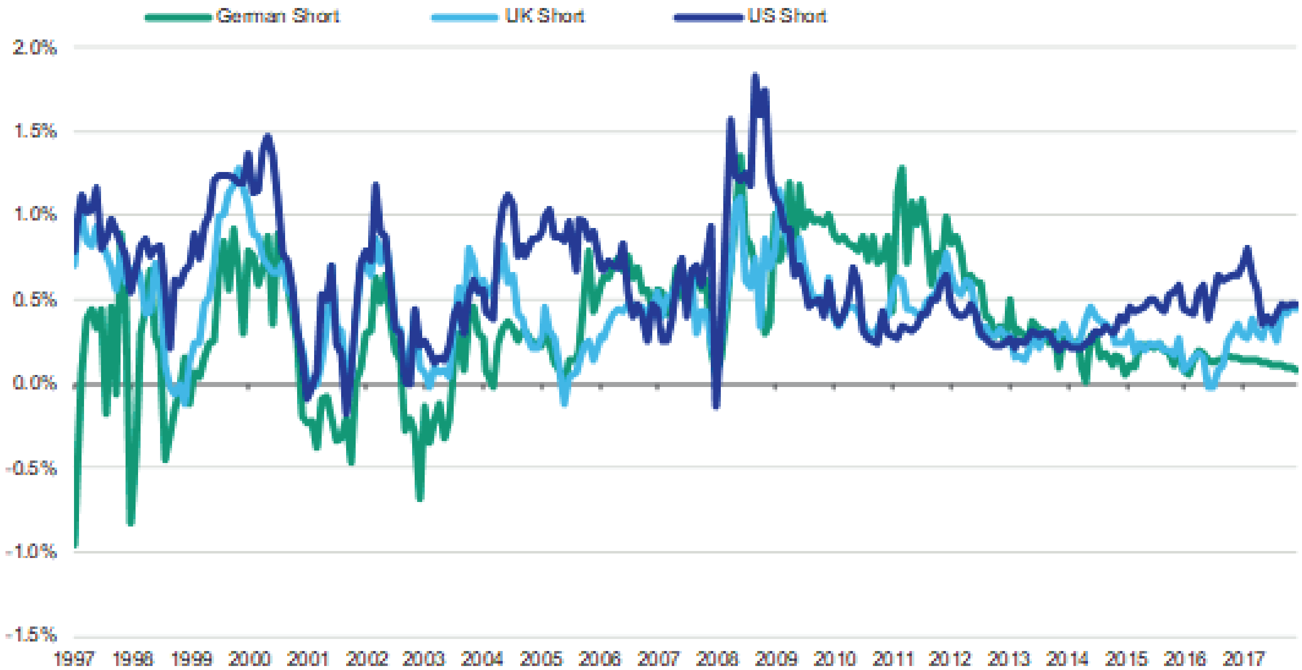


Figure 4 One Year Swap Spread For Selected Economies



Within this report we have used unadjusted government rates as the reference liquid risk-free rates against which to define the implied illiquidity premia. Whilst insurers wishing to align their IFRS 17 balance sheet with Solvency II may wish to start from swap rates, doing so would require understanding the current swap spreads and performing appropriate adjustments to understand the decomposition of that spread otherwise unintuitive results for the corporate bond decomposition could be produced.

Results

EUR

Top-down credit risk adjusted yield curves are shown in Figure 5 and Figure 6 firstly for a composite portfolio of 1585 investment grade corporate bonds and secondly split by rating. In Figure 5 the fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for German government bonds is also shown. Figure 6 shows the fitted yield curve for portfolios of AA, A and BBB rated corporate bonds using both the raw market yields (solid lines) and after removing credit risk (dotted lines), the latter represent the top down curves for those portfolios. Average characteristics of the bonds, by rating, are presented in Table 1.

Implied illiquidity premia per rating class can be derived by calculating the spread of the top-down curves over the government curve: these are presented in Figure 7. Average illiquidity premia per rating and maturity bucket are presented in Table 2. Figure 8 shows a regression of the excess spread, defined as the market spread at end Dec18 minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 3. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread (referred to as the fundamental spread).

Finally data are split into financial and non-financial categories. Figure 9 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 10 displays the implied illiquidity premia for each category. Table 4 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia.

Financial bonds have a significantly higher probability of default and expected loss than non-financial bonds (an average of 37 bp for financials to 17 bp for non-financial corporate bonds), this is consistent with the EIOPA VA and MA calculations where financial bonds generally have higher fundamental spreads. Driving this change, Figure 12 shows that financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium. Table 1 also shows that financial issuers have a higher average credit rating, and the analysis per rating shows that a higher rating leads to lower illiquidity premia.

Data in all figures and tables are quoted as percentages except where stated otherwise.

Table 1 EUR Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	1585	1.08 %	4.80	25%
AAA	7	0.88 %	7.77	0
AA	163	0.57 %	4.45	57%
A	581	0.89 %	5.05	31%
BBB	834	1.31 %	4.67	15%

TOP-DOWN YIELD CURVES

Figure 5 Credit Risk Adjusted Yield Curves
EUR End Dec 2018 – All Investment Grade Bonds

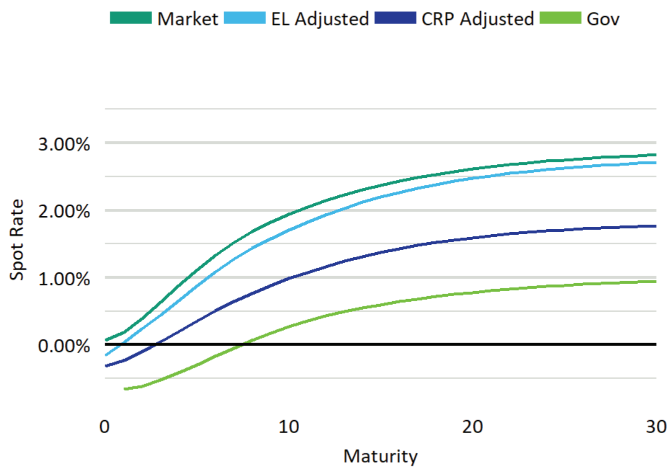
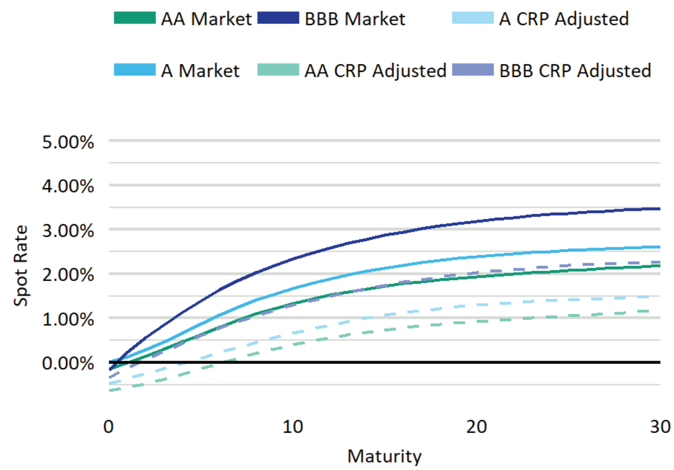


Figure 6 Credit Risk Adjusted Yield Curves
EUR End Dec 2018



ILLIQUIDITY PREMIA

Figure 7 Implied Illiquidity Premia
EUR End Dec 2018

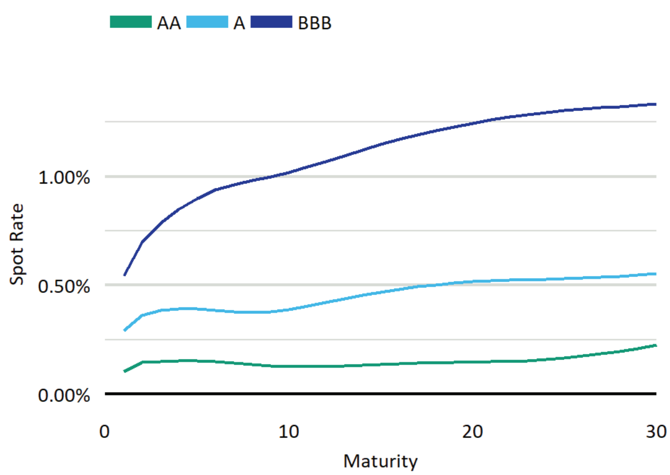


Figure 8 Illiquidity Premia vs Excess Spread
EUR End Dec 2018

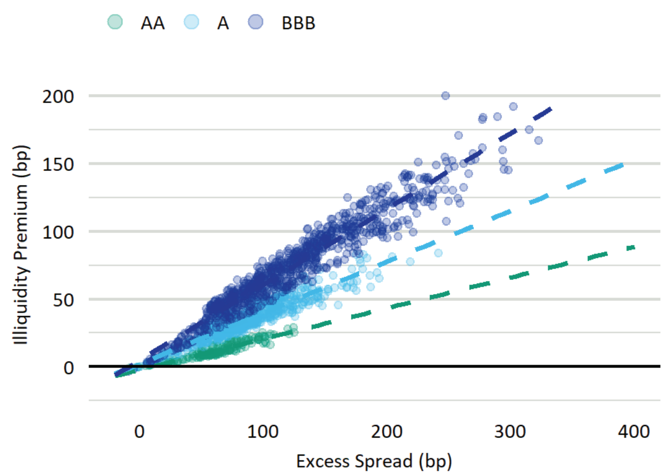


Table 2 Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
AAA	3	15	42	53
AA	10	10	15	19
A	26	31	40	52
BBB	55	66	93	117
All Bonds	41	46	67	81

Table 3 Illiquidity Premia Proxy Coefficients[1]

MATURITY -> /RATING	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
AAA	4.3	0.56
AA	24.1	0.20
A	22.1	0.38
BBB	22.4	0.60
All Bonds	22.4	0.51

SECTORAL ANALYSIS

Figure 9 Financial and Non-Financial Yield Curves
EUR End Dec 2018

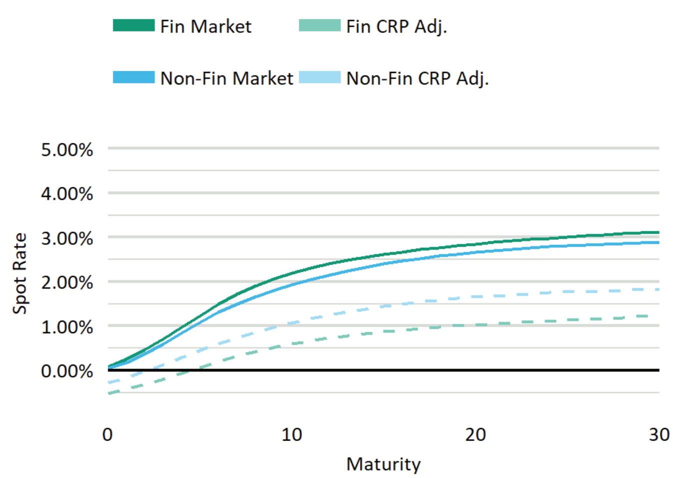


Figure 10 Financial and Non-Financial Implied Illiquidity Premia
EUR End Dec 2018

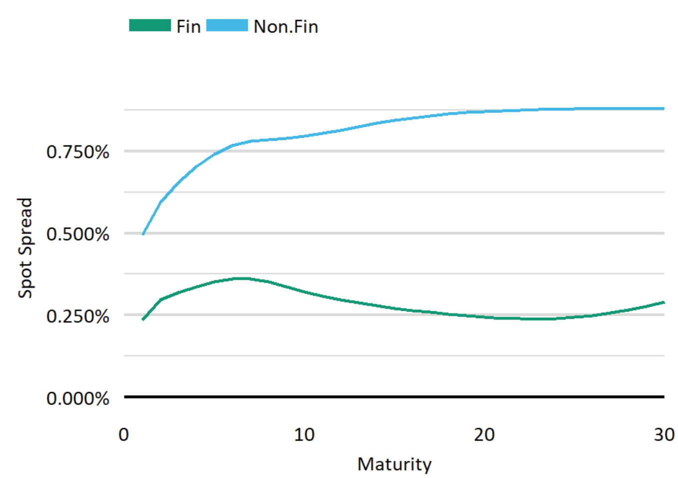


Figure 11 Financial and Non-Financial Illiquidity Premia vs Excess Spread
EUR End Dec 2018

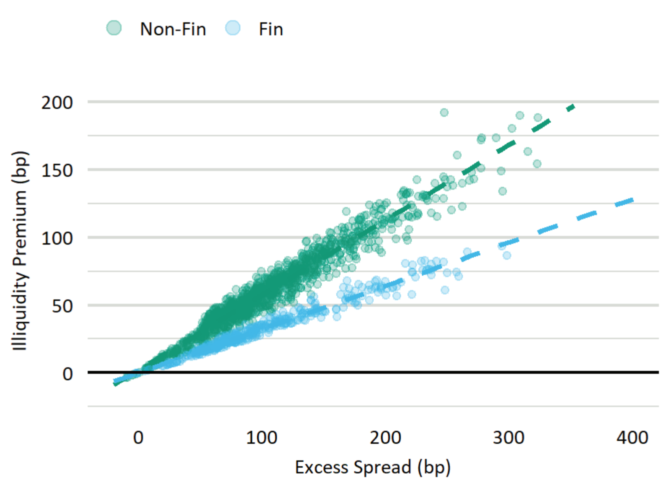
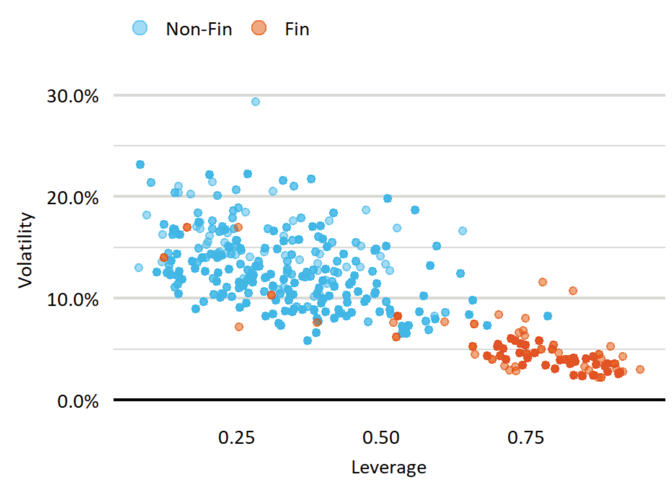


Figure 12 Financial and Non-Financial Leverage
EUR End Dec 2018



1 Coefficients should be interpreted as the intercept and slope, e.g. for EUR all bonds: *IP = 0.51 * (Spread - 22.4 bp)*

Table 4 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	44	51	74	87
Financial	27	31	40	42
All Bonds	41	46	67	81

GBP

Top-down credit risk adjusted yield curves are shown in Figure 13 and Figure 14, firstly for a composite portfolio of 413 investment grade corporate bonds and secondly split by rating. In Figure 13 the fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for UK government bonds is also shown. Figure 14 shows the fitted yield curve for portfolios of AA, A and BBB rated corporate bonds using both the raw market yields (solid lines) and after removing credit risk (dotted lines), the latter represent the top down curves for those portfolios. Average characteristics of the bonds, by rating, are presented in Table 5.

Implied illiquidity premia per rating class can be derived by calculating the spread of the top-down curves over the government curve: these are presented in Figure 15. Figure 16 shows a regression of the excess spread, defined as the market spread minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 7. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread. Average illiquidity premia per rating and maturity bucket are presented in Table 6.

Finally data are split into financial and non-financial categories. Figure 17 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 18 displays the implied illiquidity premia for each category. Table 8 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia.

Financial bonds have a significantly higher probability of default and expected loss than non-financial bonds (an average of 36 bp to 18 bp), this is consistent with the EIOPA VA and MA calculations where financial bonds generally have higher fundamental spreads. Driving this change, Figure 20 shows that financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium. Table 5 also shows that financial issuers have a higher average credit rating, and the analysis per rating shows that a higher rating leads to lower illiquidity premia.

Table 5 GBP Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	413	2.67%	6.47	31%
AAA	1	1.70%	4.96	0
AA	66	1.97%	5.34	62%
A	135	2.42%	6.38	37%
BBB	211	3.04%	6.91	18%

TOP-DOWN YIELD CURVES

Figure 13 Credit Risk Adjusted Yield Curves
GBP End Dec 2018 – All Investment Grade Bonds

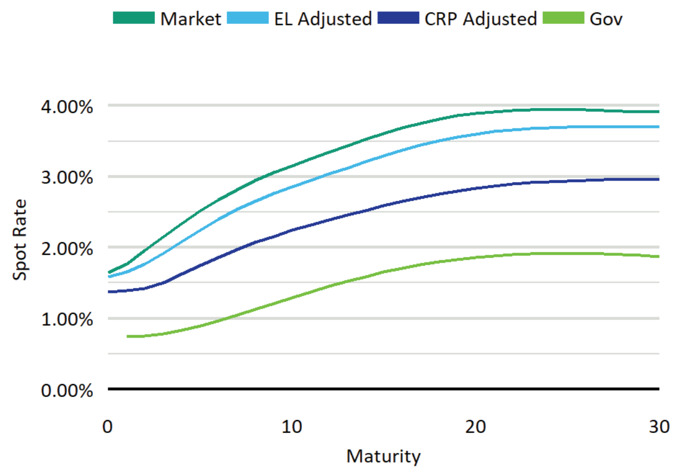
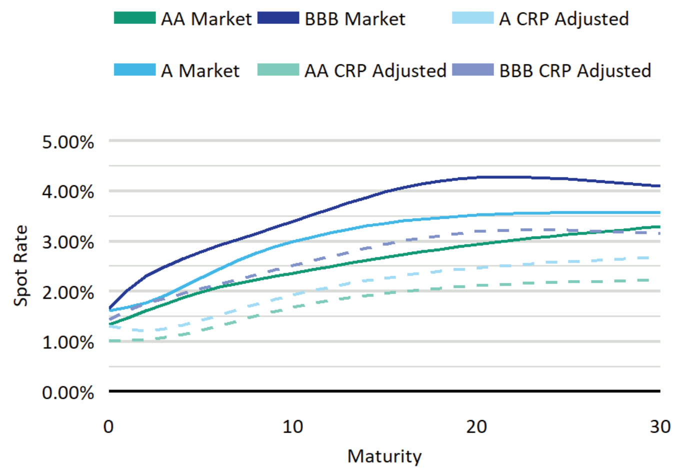


Figure 14 Credit Risk Adjusted Yield Curves
GBP End Dec 18



ILLIQUIDITY PREMIA

Figure 15 Implied Illiquidity Premia
GBP End Dec 2018

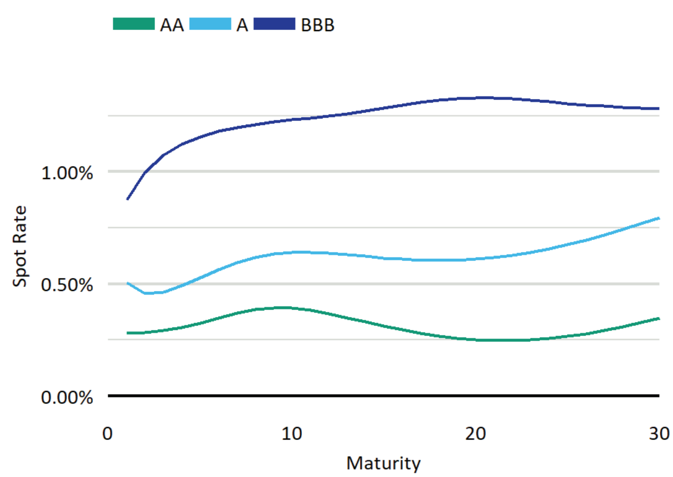


Figure 16 Illiquidity Premia vs Excess Spread
GBP End Dec 2018

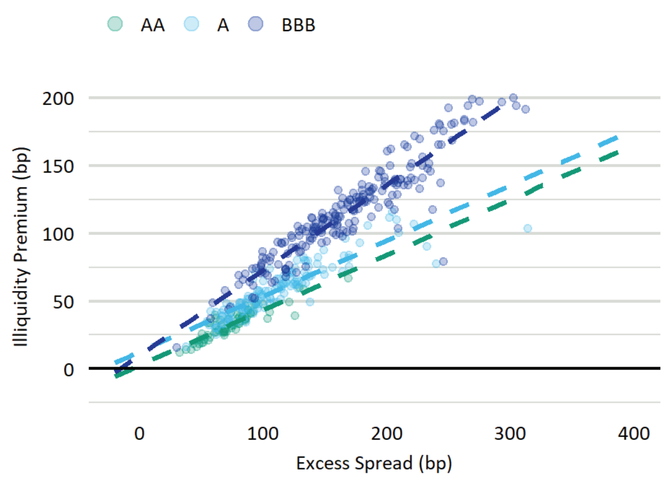


Table 6 Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
AAA	NaN	NaN	60	NaN
AA	30	31	40	39
A	46	51	65	67
BBB	98	112	123	133
All Bonds	65	75	96	100

Table 7 Illiquidity Premia Proxy Coefficients

MATURITY -> /RATING	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
AAA	3.7	0.81
AA	22.9	0.44
A	25.7	0.51
BBB	22.2	0.69
All Bonds	23.4	0.62

SECTORAL ANALYSIS

Figure 17 Financial and Non-Financial Yield Curves
GBP End Dec 2018

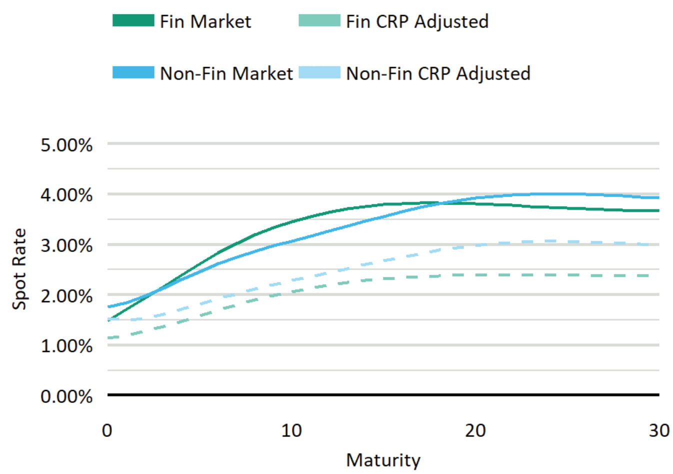


Figure 18 Financial and Non-Financial Implied Illiquidity Premia
GBP End Dec 2018

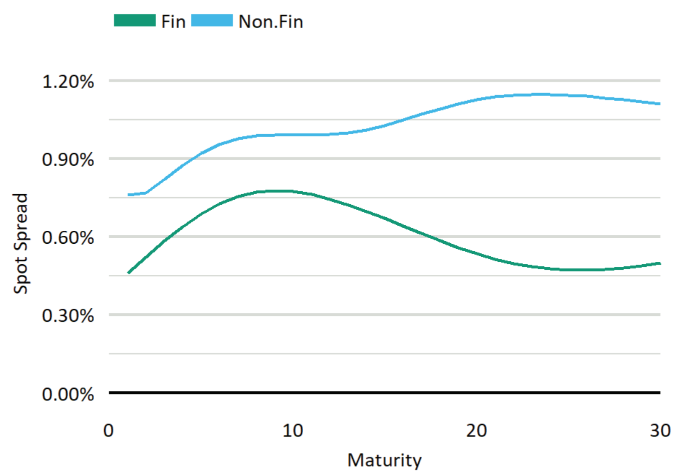


Figure 19 Financial and Non-Financial Illiquidity Premia vs Excess Spread
GBP End Dec 2018

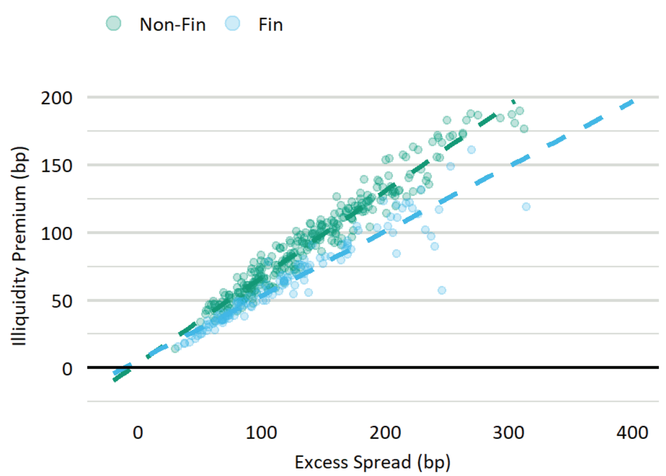


Figure 20 Financial and Non-Financial Leverage
GBP End Dec 2018

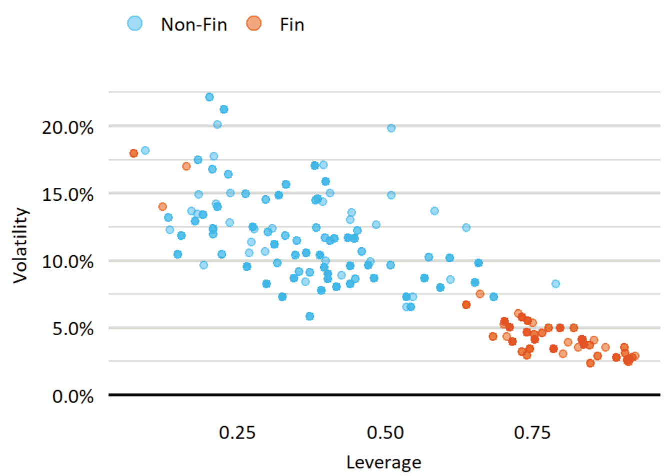


Table 8 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	75	83	101	107
Financial	50	62	82	68
All Bonds	65	75	96	100

USD

Top-down credit risk adjusted yield curves are shown in Figure 21 and Figure 22, firstly for a composite portfolio of 7453 investment grade corporate bonds and secondly split by rating. In Figure 21 the fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for US government bonds is also shown. Figure 22 shows the fitted yield curve for portfolios of AAA, AA, A and BBB rated corporate bonds using both the raw market yields (solid lines) and after removing credit risk (dotted lines), the latter represent the top down curves for those portfolios. Average characteristics of the bonds, by rating, are presented in Table 9.

Implied illiquidity premia per rating class can be derived by calculating the spread of the top-down curves over the government curve: these are presented in Figure 23. Figure 24 shows a regression of the excess spread, defined as the market spread minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 11. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread. Average illiquidity premia per rating and maturity bucket are presented in Table 10.

Finally data are split into financial and non-financial categories. Figure 25 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 26 displays the implied illiquidity premia for each category. Table 12 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia.

Financial bonds have a significantly higher probability of default and expected loss than non-financial bonds (an average of 38 bp to 20 bp), this is consistent with the EIOPA VA and MA calculations where financial bonds generally have higher fundamental spreads. Driving this change, Figure 28 shows that financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium.

Table 9 USD Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	7453	4.14%	6.42	0.25
AAA	135	3.32%	5.56	0.21
AA	738	3.58%	5.87	0.33
A	2768	3.85%	6.61	0.30
BBB	3812	4.50%	6.43	0.20

TOP-DOWN YIELD CURVES

Figure 21 Credit Risk Adjusted Yield Curves
USD End Dec 2018 – All Investment Grade Bonds

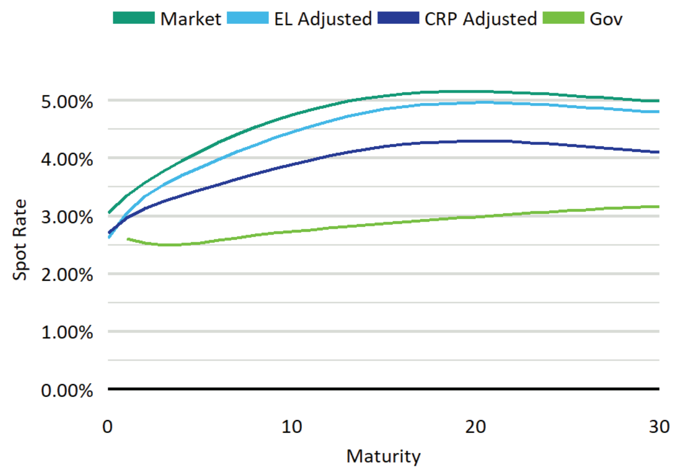
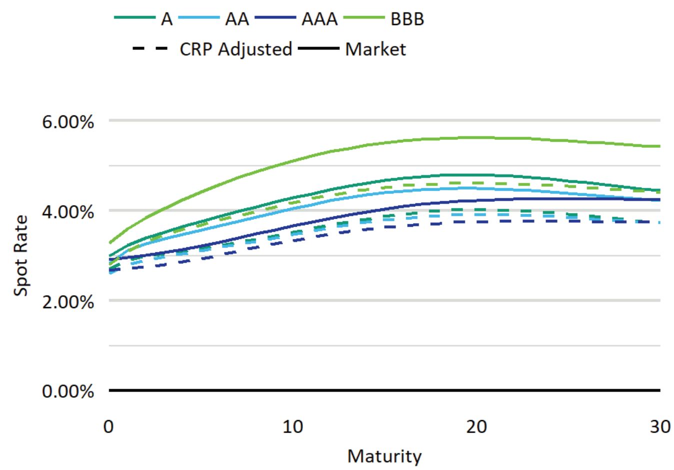


Figure 22 Credit Risk Adjusted Yield Curves
USD End Dec 18



ILLIQUIDITY PREMIA

Figure 23 Implied Illiquidity Premia
USD End Dec 2018

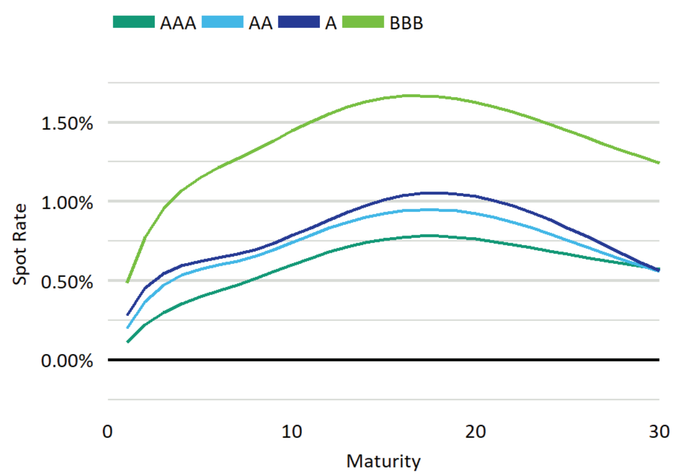


Figure 24 Illiquidity Premia vs Excess Spread
USD End Dec 2018

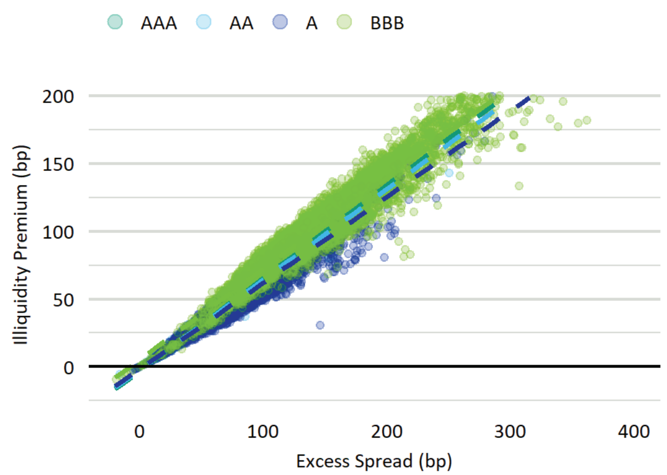


Table 10 Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
AAA	21	24	47	68
AA	32	46	54	79
A	41	52	60	86
BBB	7	96	115	145
All Bonds	54	75	91	115

Table 11 Illiquidity Premia Proxy Coefficients

MATURITY -> /RATING	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
AAA	10.9	0.65
AA	14.7	0.64
A	21.1	0.61
BBB	29.3	0.65
All Bonds	24.5	0.63

SECTORAL ANALYSIS

Figure 25 Financial and Non-Financial Yield Curves
USD End Dec 2018

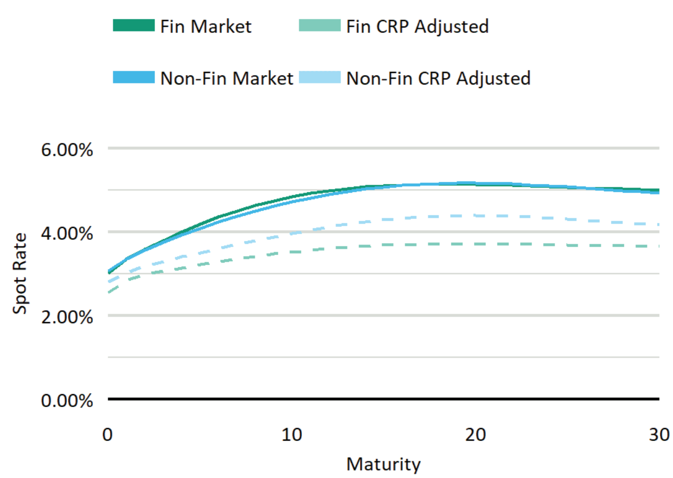


Figure 26 Financial and Non-Financial Implied Illiquidity Premia
USD End Dec 2018

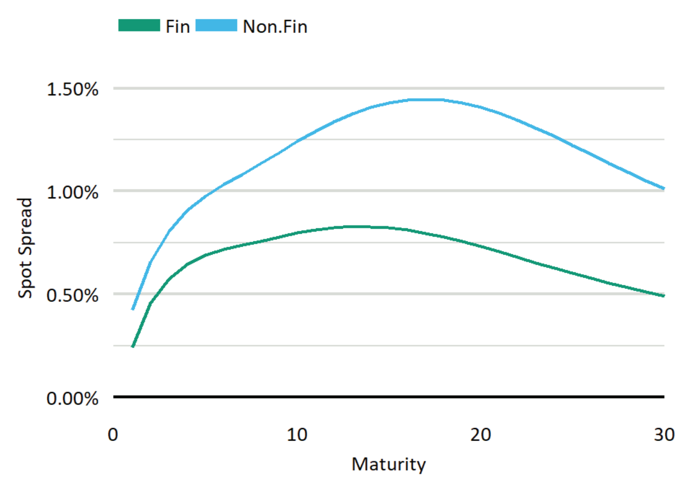


Figure 27 Financial and Non-Financial Illiquidity Premia vs Excess Spread
USD End Dec 2018

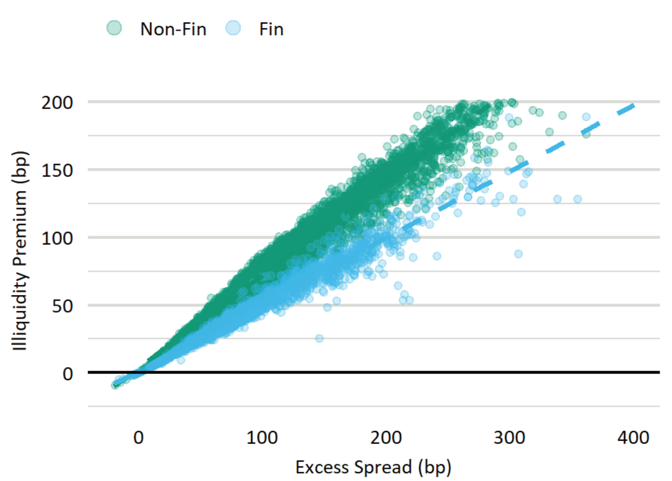


Figure 28 Financial and Non-Financial Leverage
USD End Dec 2018

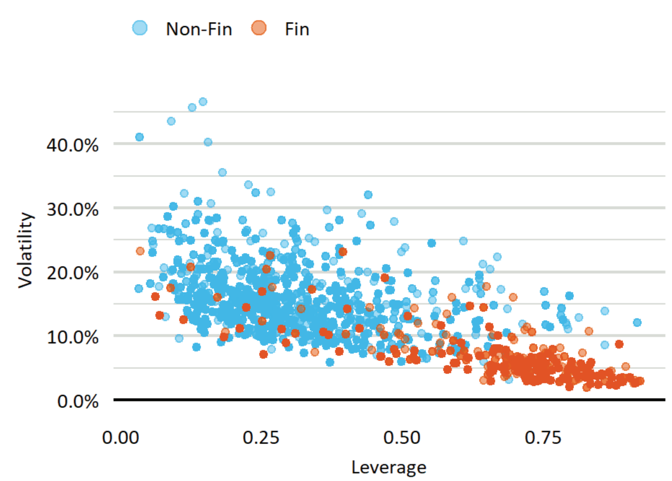


Table 12 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	61	81	98	123
Financial	38	54	65	69
All Bonds	54	75	91	115

CAD

Top-down credit risk adjusted yield curves are shown in Figure 29 and Figure 30, firstly for a composite portfolio of 356 investment grade corporate bonds and secondly split by rating. In Figure 29 the fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for CA government bonds is also shown. Figure 30 shows the fitted yield curve for portfolios of AAA, AA, A and BBB rated corporate bonds using both the raw market yields (solid lines) and after removing credit risk (dotted lines), the latter represent the top down curves for those portfolios. Average characteristics of the bonds, by rating, are presented in Table 13.

Implied illiquidity premia per rating class can be derived by calculating the spread of the top-down curves over the government curve: these are presented in Figure 31. Figure 32 shows a regression of the excess spread, defined as the market spread minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 15. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread. Average illiquidity premia per rating and maturity bucket are presented in Table 14.

Finally data are split into financial and non-financial categories. Figure 33 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 34 displays the implied illiquidity premia for each category. Table 16 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia.

Financial bonds have a significantly higher probability of default and expected loss than non-financial bonds (an average of 24 bp to 12 bp), this is consistent with the EIOPA VA and MA calculations where financial bonds generally have higher fundamental spreads. Driving this change, Figure 36 shows that financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium. Table 13 also shows that financial issuers have a higher average credit rating, and the analysis per rating shows that a higher rating leads to lower illiquidity premia.

Table 13 CAD Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	356	3.40%	5.13	26%
AAA	3	2.33%	1.04	33%
AA	69	2.69%	2.33	83%
A	98	3.26%	5.22	19%
BBB	186	3.76%	6.19	9%

TOP-DOWN YIELD CURVES

Figure 29 Credit Risk Adjusted Yield Curves
CAD End Dec 2018 – All Investment Grade Bonds

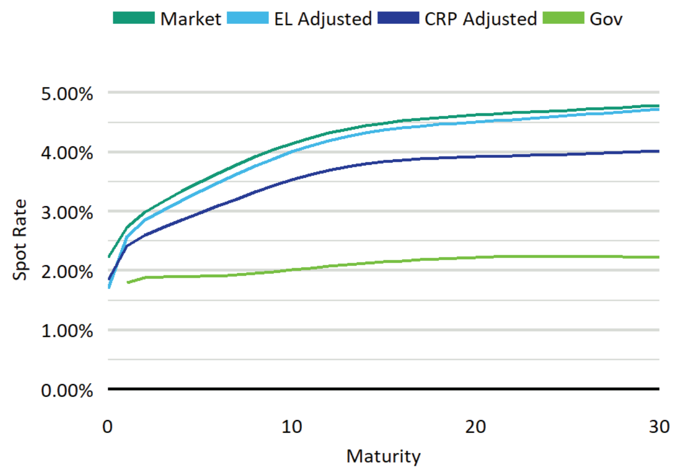
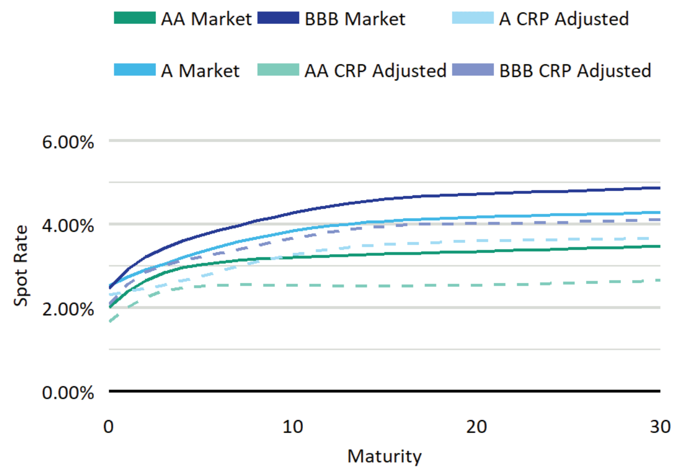


Figure 30 Credit Risk Adjusted Yield Curves
CAD End Dec 18



ILLIQUIDITY PREMIA

Figure 31 Implied Illiquidity Premia
CAD End Dec 2018

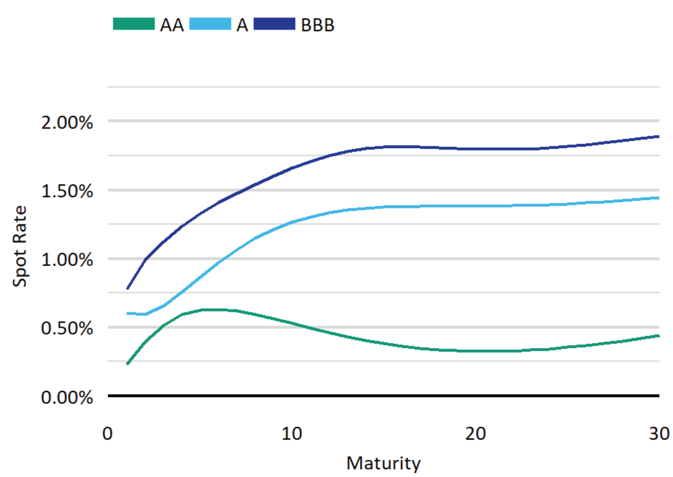


Figure 32 Illiquidity Premia vs Excess Spread
CAD End Dec 2018

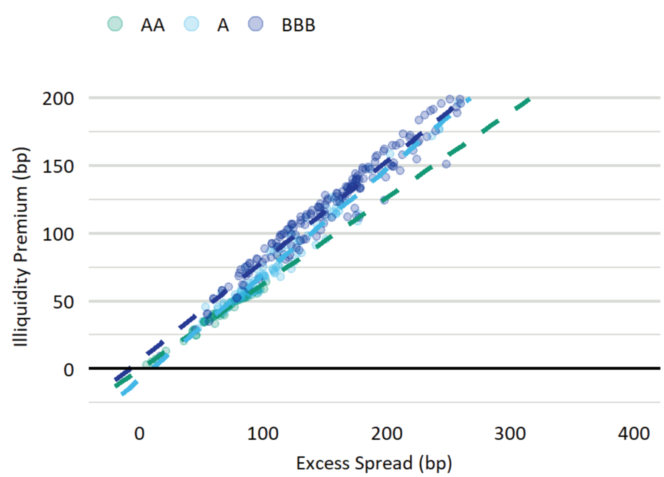


Table 14 Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
AAA	31	NaN	NaN	NaN
AA	43	52	59	NaN
A	61	72	101	133
BBB	93	126	137	177
All Bonds	69	91	120	164

Table 15 Illiquidity Premia Proxy Coefficients

MATURITY -> /RATING	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
AAA	20.3	0.66
AA	21.3	0.46
A	15.5	0.72
BBB	13.4	0.78
All Bonds	15.6	0.74

SECTORAL ANALYSIS

Figure 33 Financial and Non-Financial Yield Curves CAD End Dec 2018

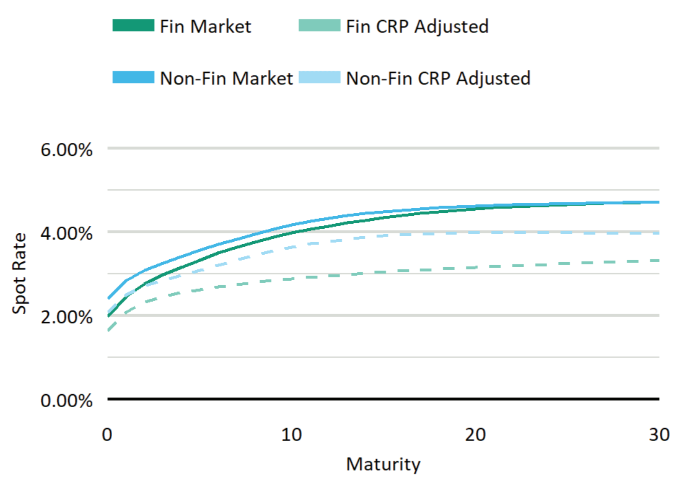


Figure 34 Financial and Non-Financial Implied Illiquidity Premia CAD End Dec 2018

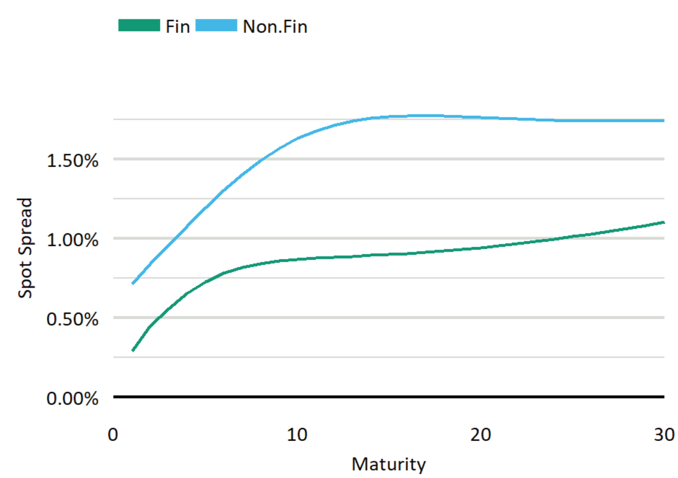


Figure 35 Financial and Non-Financial Illiquidity Premia vs Excess Spread CAD End Dec 2018

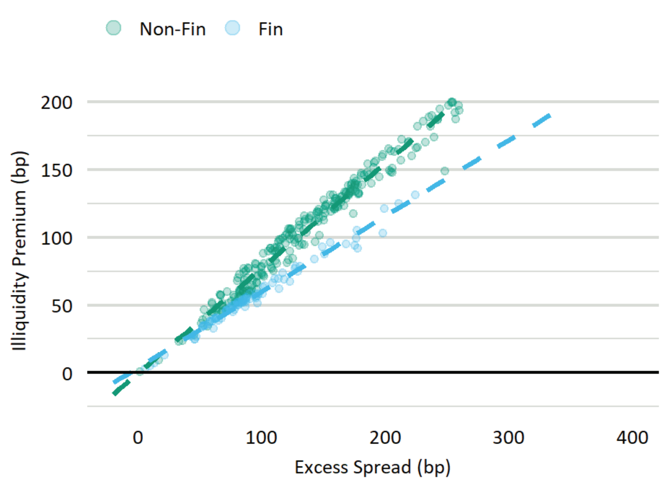


Figure 36 Financial and Non-Financial Leverage CAD End Dec 2018

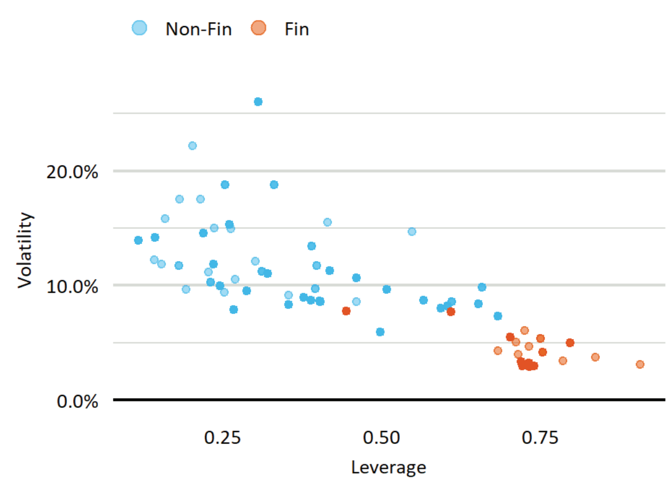


Table 16 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	80	104	131	169
Financial	46	59	80	96
All Bonds	69	91	120	164

CNY

For CNY corporate bonds there is a lack of coverage from agencies like Moody's Investor Services, as such we cannot use agency data in order to perform the split between rating categories. Implied ratings can be derived from EDF data, however, even using a PD rating mapping appropriate to APAC data, as in Robinson and Hibbert (2019) there is no clear relationship between market yields and rating class. As such we do not present a breakdown by rating for CNY data.

Top-down credit risk adjusted yield curves are shown in Figure 37 for a composite portfolio of 584 corporate bonds. The fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for CN government bonds is also shown.

Implied illiquidity premia can be derived by calculating the spread of the top-down curves over the government curve: this is presented in Figure 38. Figure 39 shows a regression of the excess spread, defined as the market spread minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 19. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread. Average illiquidity premia per maturity bucket are presented in Table 18.

Finally data are split into financial and non-financial categories. Figure 40 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 41 displays the implied illiquidity premia for each category. Table 20 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia.

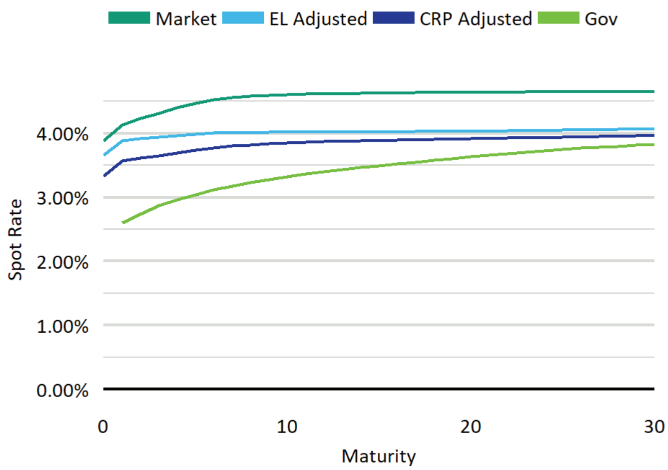
Financial bonds have a significantly higher probability of default and expected loss than non-financial bonds (an average of 29 bp to 15 bp), this is consistent with the EIOPA VA and MA calculations where financial bonds generally have higher fundamental spreads. Driving this change, Figure 43 shows that financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium.

Table 17 CNY Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	584	4.15%	2.10	85%

TOP-DOWN YIELD CURVES

Figure 37 Credit Risk Adjusted Yield Curves
CNY End Dec 2018



ILLIQUIDITY PREMIA

Figure 38 Implied Illiquidity Premia
CNY End Dec 2018

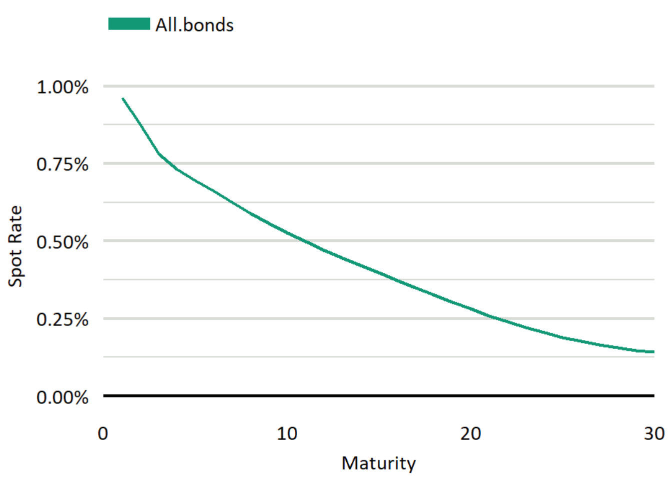


Figure 39 Illiquidity Premia vs Excess Spread
CNY End Dec 2018

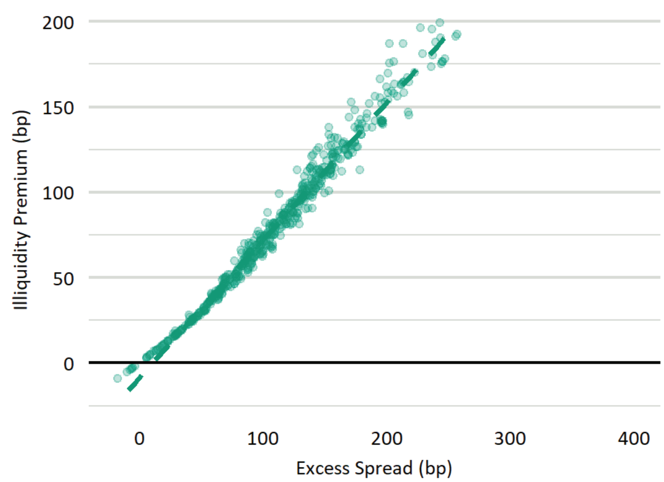


Table 18 Illiquidity Premia

MATURITY	1-3	3-5	5-10	10+
All Bonds	74	74	32	30

Table 19 Illiquidity Premia Proxy Coefficients

MATURITY	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
All Bonds	27.0	0.75

SECTORAL ANALYSIS

Figure 40 Financial and Non-Financial Yield Curves
CNY End Dec 2018

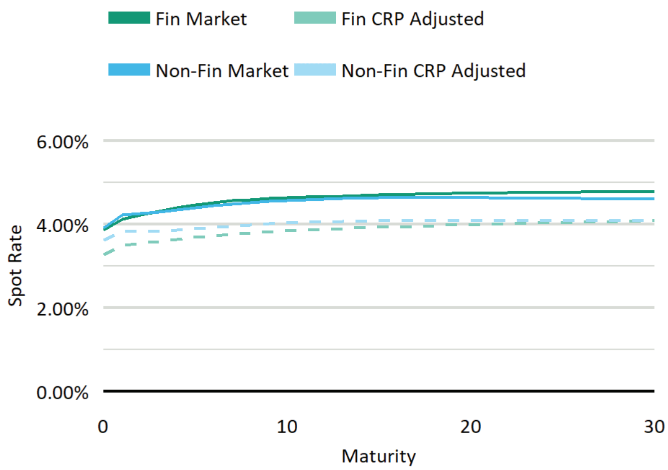


Figure 41 Financial and Non-Financial Implied Illiquidity Premia
CNY End Dec 2018

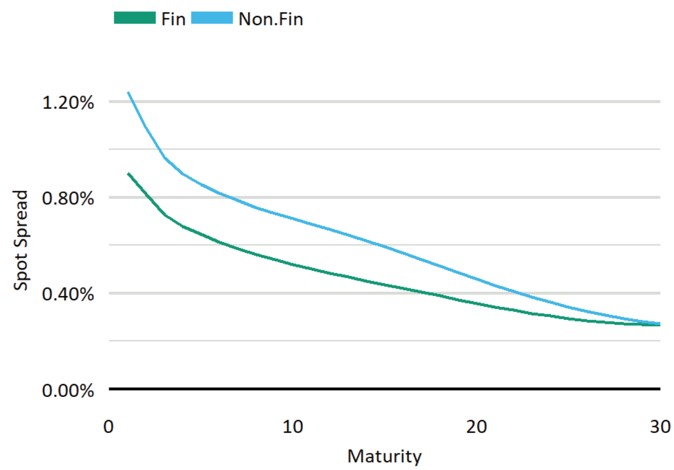


Figure 42 Financial and Non-Financial Illiquidity Premia vs Excess Spread
CNY End Dec 2018

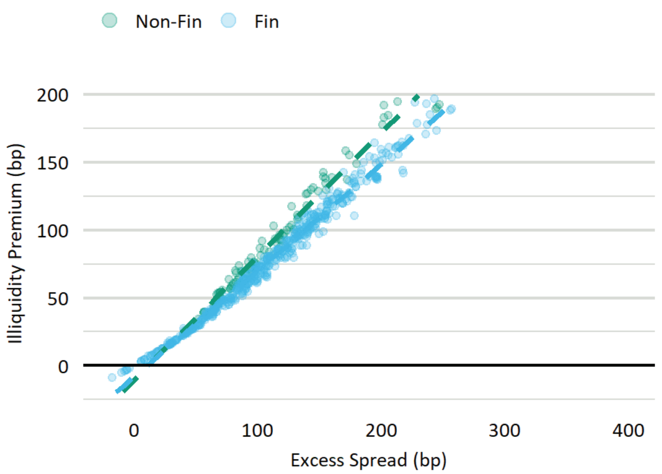


Figure 43 Financial and Non-Financial Leverage
CNY End Dec 2018

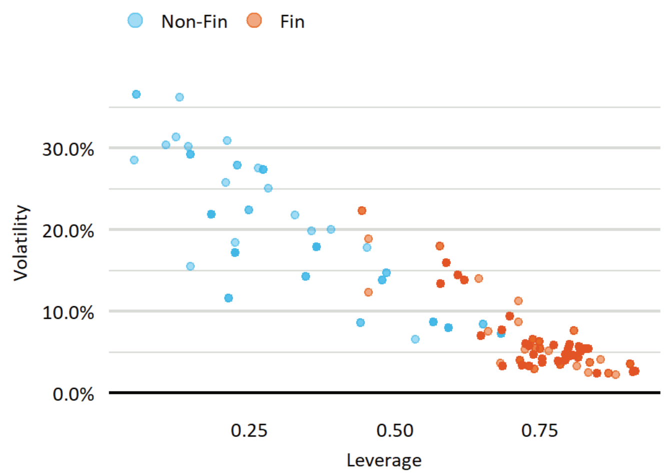


Table 20 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	89	122	61	48
Financial	71	58	29	25
All Bonds	74	74	32	30

HKD

Top-down credit risk adjusted yield curves are shown in Figure 44 for a composite portfolio of 395 corporate bonds. The fit to the raw yields is shown alongside the fitted yield curves produced after adjusting the yield to maturity on each bond for the expected credit loss and after removing the credit risk premium. The CRP adjusted curve represents the top-down curve for that portfolio. For reference Moody's Analytics standard calibration for HK government bonds is also shown.

Implied illiquidity premia can be derived by calculating the spread of the top-down curves over the government curve: this is presented in Figure 45. Figure 46 shows a regression of the excess spread, defined as the market spread minus the expected credit loss, versus the implied illiquidity premia for each bond, this regression allows us to derive an average relationship between spreads and illiquidity premia, these proxy coefficients are listed in Table 23. These numbers could be compared to SII where EIOPA define the VA as 65% of the credit-adjusted spread. Average illiquidity premia per maturity bucket are presented in Table 22.

Finally data are split into financial and non-financial categories. Figure 47 shows the unadjusted (solid) and credit adjusted (dotted) top-down yield curves for each category. Figure 48 displays the implied illiquidity premia for each category. Table 24 presents the average implied illiquidity premia per category and maturity bucket. Although the unadjusted market yields are similar for both financial and non-financial corporate bonds, there is a significant difference in the implied illiquidity premia. Unlike other economies in this report HKD financial bonds have a higher illiquidity premia than non-financial bonds.

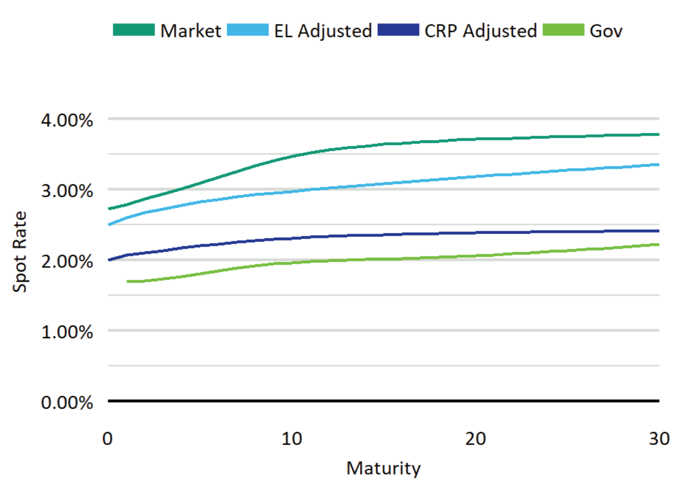
Financial bonds have a slightly lower probability of default and expected loss than non-financial bonds (an average of 27 bp to 35 bp), this is in contrast to other economies examined here. Despite this difference, Figure 50 shows that as across other economies, financial issuers have higher leverage and lower asset volatility than non-financial issuers, these factors affect both the EDF and the credit risk premium. Implied illiquidity premia, in particular for non-financial bonds, show a downward trend with maturity. This is likely driven by the limited availability of government bond data and the early point at which extrapolation begins: HK government bond data in Moody's Analytics standard calibrations ends around 10 years, while corporate bond data extends to 30 years. The low, or negative, implied illiquidity premia are perhaps an indication that the risk-free curve extrapolates towards the UFR too quickly.

Table 21 HKD Bond Characteristics

RATING	NUMBER OF BONDS	AVERAGE YIELD TO MATURITY	AVERAGE DURATION	FINANCIAL PROPORTION
All bonds	395	3.07%	4.34	55%

TOP-DOWN YIELD CURVES

Figure 44 Credit Risk Adjusted Yield Curves
HKD End Dec 2018



ILLIQUIDITY PREMIA

Figure 45 Implied Illiquidity Premia
HKD End Dec 2018

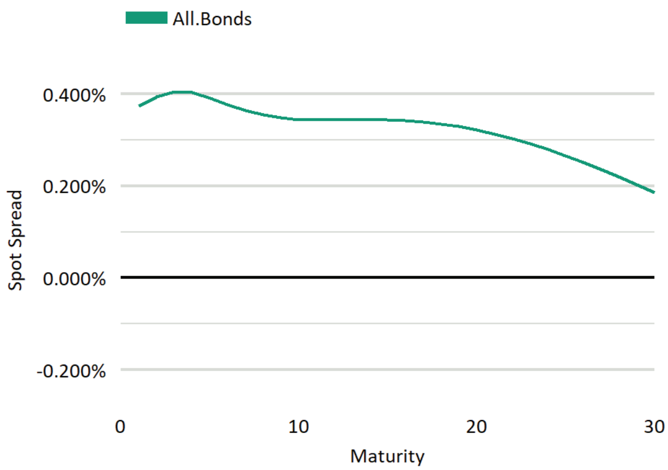


Figure 46 Illiquidity Premia vs Excess Spread
HKD End Dec 2018

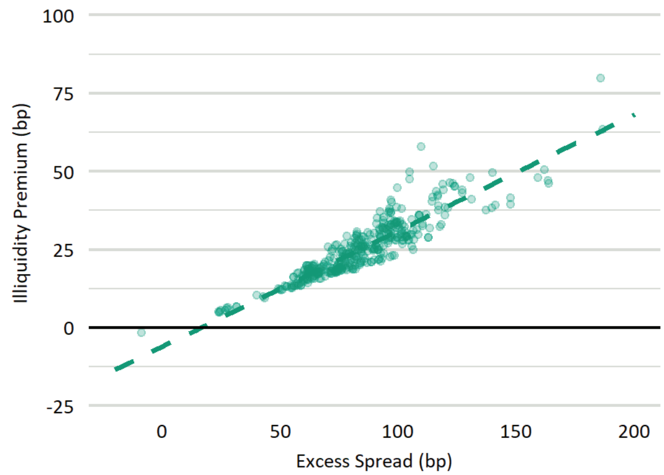


Table 22 Illiquidity Premia in Basis Points per Annum

MATURITY	1-3	3-5	5-10	10+
All Bonds	27	27	24	26

Table 23 Illiquidity Premia Proxy Coefficients

MATURITY	AVERAGE EXPECTED LOSS SPREAD (BP)	IP PROPORTION
All Bonds	29.7	0.31

SECTORAL ANALYSIS

Figure 47 Financial and Non-Financial Yield Curves
HKD End Dec 2018

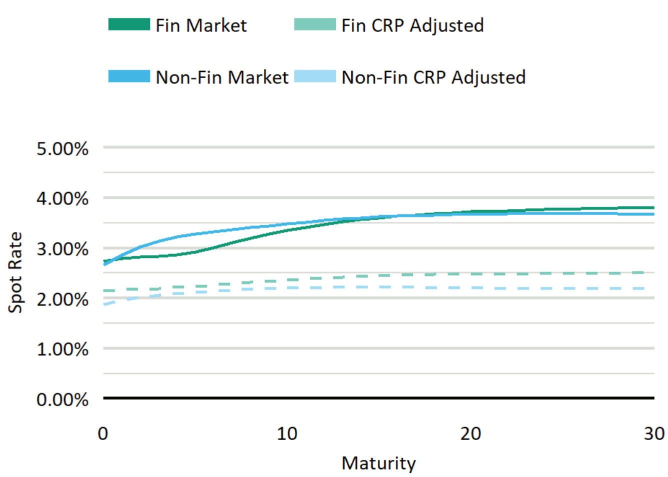


Figure 48 Financial and Non-Financial Implied Illiquidity Premia
HKD End Dec 2018

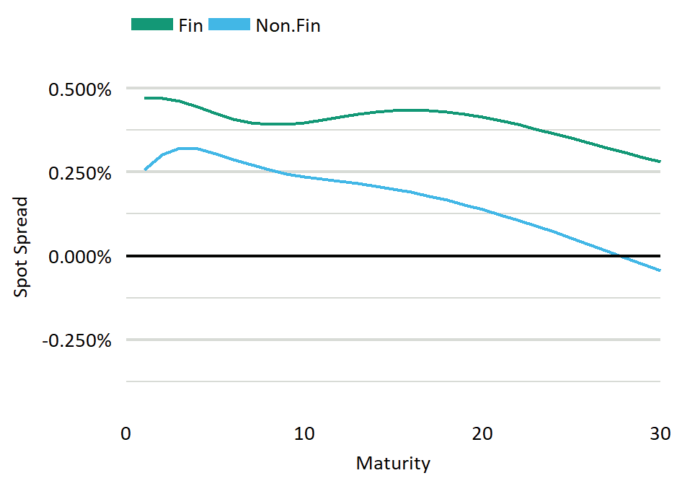


Figure 49 Financial and Non-Financial Illiquidity Premia vs Excess Spread HKD End Dec 2018

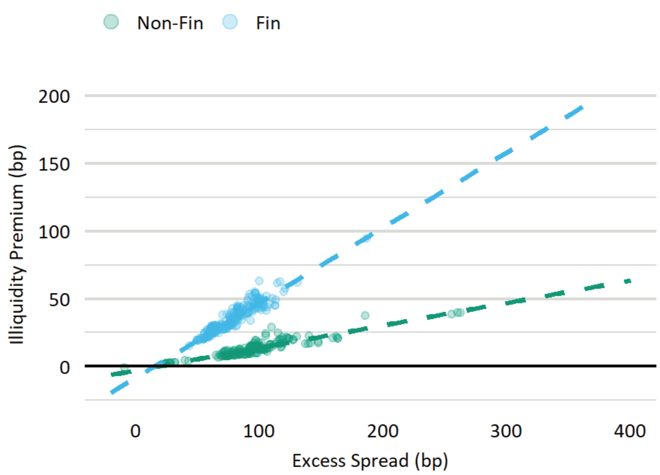


Figure 50 Financial and Non-Financial Leverage HKD End Dec 2018

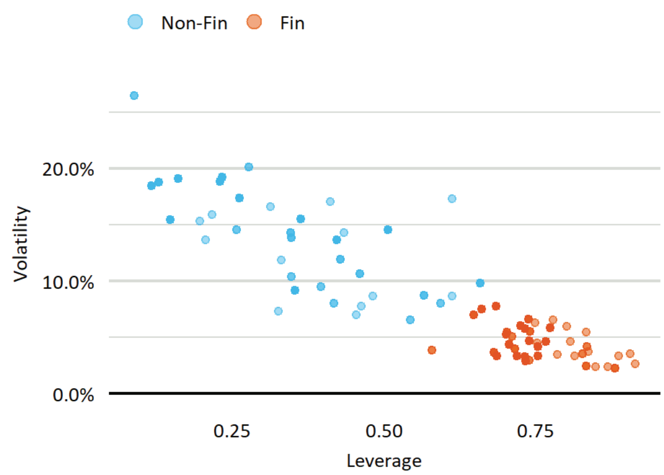


Table 24 Financial and Non-Financial Illiquidity Premia in Basis Points per Annum

MATURITY -> /RATING	1-3	3-5	5-10	10+
Non-Financial	15	17	11	11
Financial	38	33	31	32
All Bonds	27	27	24	26

Conclusion

The results presented in this report are an attempt to provide a market data driven, structural approach to determining appropriate components for either a top-down or bottom-up approach to constructing discount curves for use under IFRS 17. The modelling leverages Moody's Analytics substantial experience in expected credit loss modelling alongside standard accounting techniques to determine a cost-of-capital adjustment for credit risk premia.

The IFRS 17 standard states that discount curves, whether produced bottom-up or top-down, should relate to the liquidity characteristics of a firm's own liabilities. As such, we do not believe that it likely that a standard discount curve can be defined which is appropriate to all insurers. Instead, we aim to provide standard components which can be utilised to derive an appropriate discount rate for any business. In order to determine the appropriate liability discount rate, a mapping will have to be performed between specific insurance contracts and market traded assets. As we have shown in this report, the choice of portfolio can have a significant impact on the final discount rate; the implied illiquidity premia for different ratings of corporate bonds are substantially different. This is an essential consideration for both top-down and bottom-up approaches.

The method used in this report provides a straightforward application to break down estimates of illiquidity premia by rating and sector. We have focussed on corporate bonds, but the methodology could be extended to other asset classes if probability of default, recovery rate and cost-of-capital assumptions are available. The specific illiquidity premia for each asset class can then be combined appropriately for any reference portfolio to derive a final discount rate.

Appendix: Additional Data Tables

Table 25 Settings

Economy	Equity Risk Premium	Rating Source	Targeted Ratings	Base Risk Free Rate
CAD	3.40%	Moody's SRA	AA, A, BBB	CAD Treasury
CNY	4.61%	EDF-Implied	AA, A, BBB, BB	CNY Treasury
EUR	4.43%	Moody's SRA	AA, A, BBB	DEM Treasury
GBP	3.41%	Moody's SRA	AA, A, BBB	GBP Treasury
HKD	4.94%	Moody's SRA	AA, A, BBB	HKD Treasury
USD	4.04%	Moody's SRA	AAA, AA, A, BBB	USD Treasury

Table 26 Estimated ERP by Rating

Economy	AAA	AA	A	BBB	BB
CAD	N/A	2.49%	3.68%	3.57%	N/A
CNY	N/A	3.54%	3.59%	3.32%	5.18%
EUR	N/A	4.31%	4.36%	4.51%	N/A
GBP	N/A	3.59%	3.44%	3.41%	N/A
HKD	N/A	3.79%	5.52%	4.72%	N/A
USD	4.01%	3.57%	3.81%	4.30%	N/A

Table 27 Estimated ERP by Sector

Economy	Financial	Non-Financial
CAD	1.67%	3.74%
CNY	3.66%	6.67%
EUR	1.60%	4.73%
GBP	0.91%	3.87%
HKD	2.91%	5.93%
USD	2.17%	4.35%

References

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IFRS 17 Series

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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.

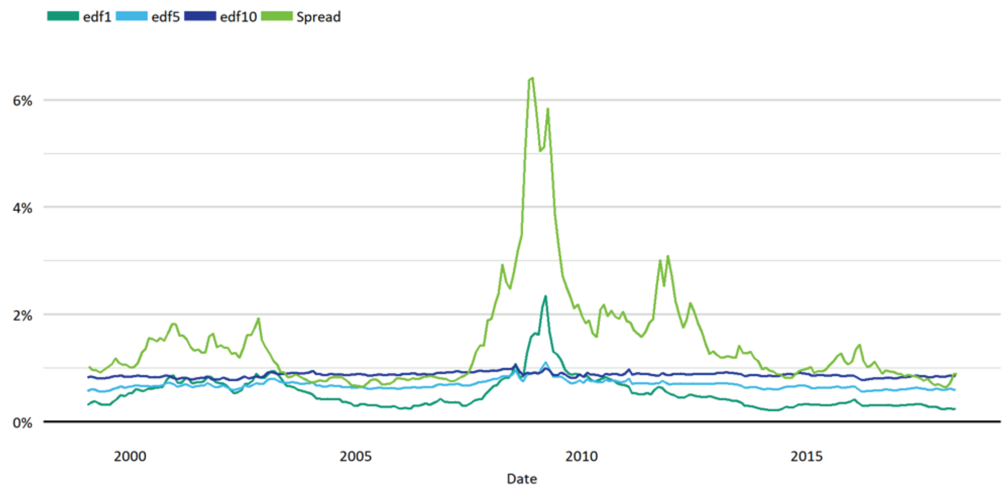
Note that within our calibrations, the global equity risk premium is always 4%. Individual economy equity risk premia will change over time, but the movements will not be large. We include the sensitivity to the choice of equity risk premia here for completeness.

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%

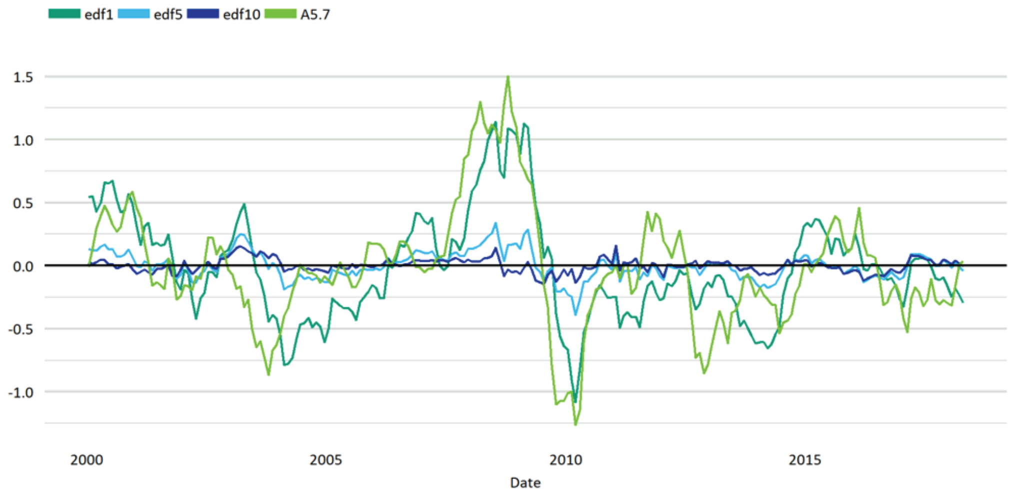
Changes in EDF are not strongly correlated with changes in spread over short time periods, but generally a stronger correlation is observable when considered over longer time periods: for example, correlation between log changes in EDF and log changes in spreads over 1, 3, 6, or 12 months are listed 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

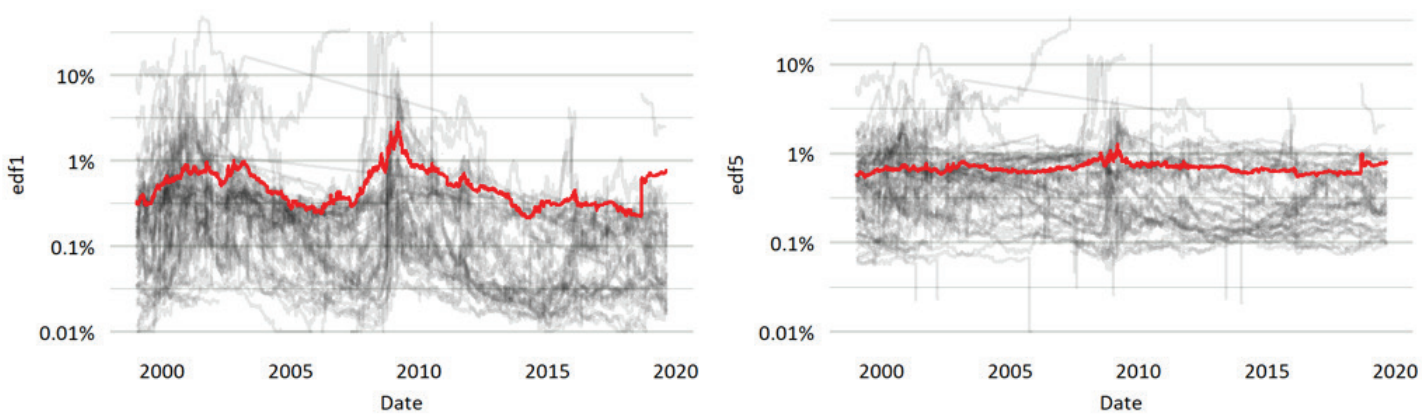
	EUR	GBP	USD
1 Month Change	38%	20%	46%
3 Month Change	48%	29%	55%
6 Month Change	56%	34%	65%
12 Month Change	59%	37%	73%

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)



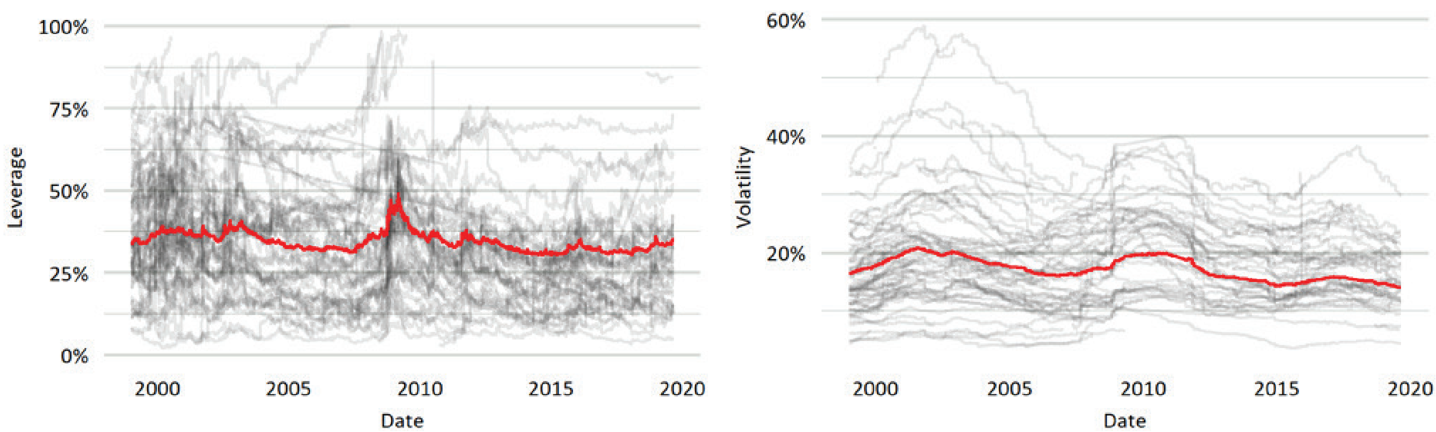
These figures show that 1-year EDF varies substantially over time, across several orders of magnitude for individual issuers and over one order of magnitude at an aggregated, average level. At both an individual issuer level and on average variation is much lower for 5-year EDF.[5]

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



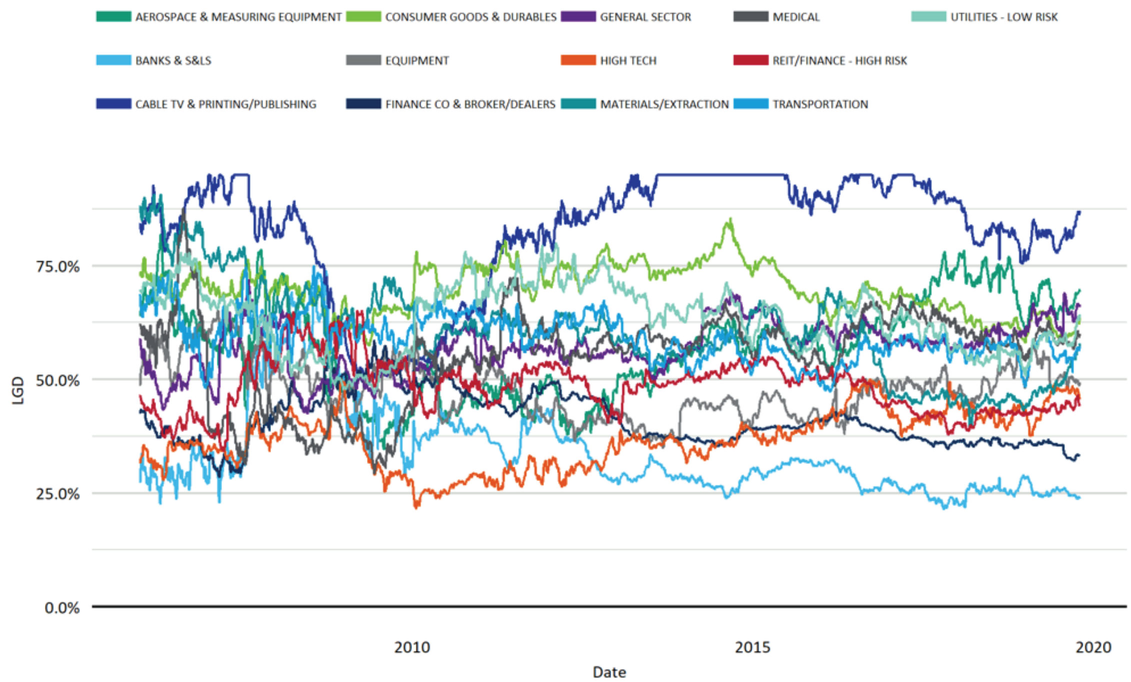
Recovery Rate

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

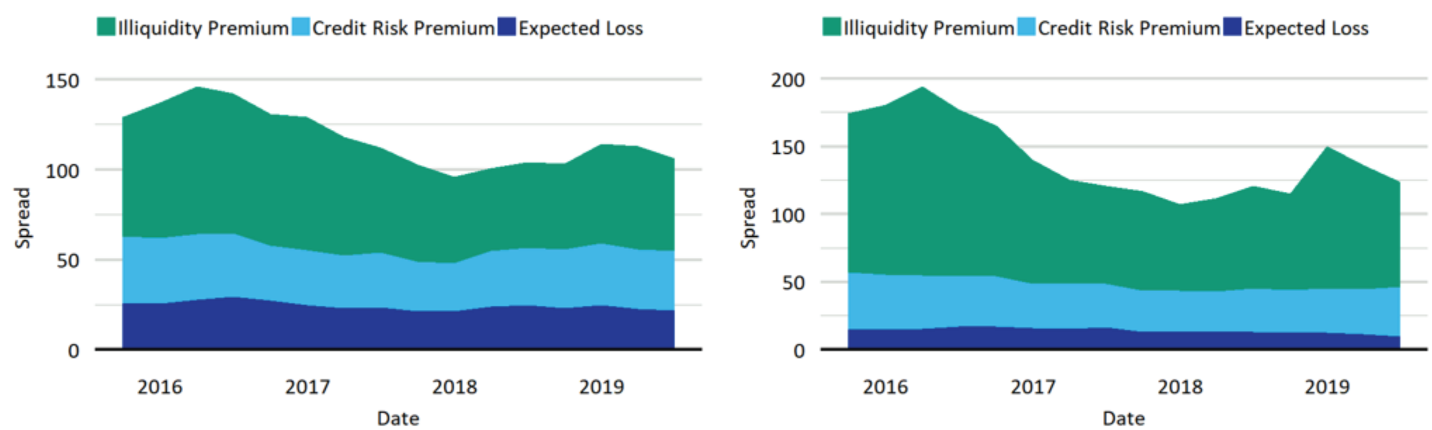


Backtesting the Model

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.

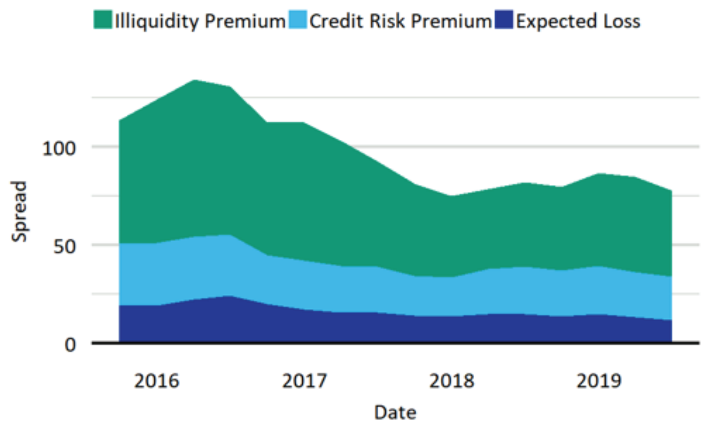
First, we consider the behavior of the model under recent market conditions, absent of any particular market-wide credit event. Figure 6 shows the evolution over the last four years (16 quarters) of the spread decomposition for an AUD (left) and CAD (right) denominated portfolio of investment-grade corporate 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.

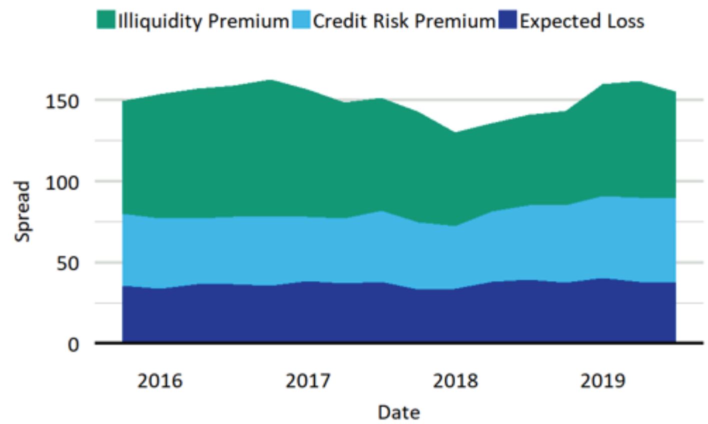
Figure 6 Components of average (median) spread across an investment-grade portfolio for AUD (left) and CAD (right)



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





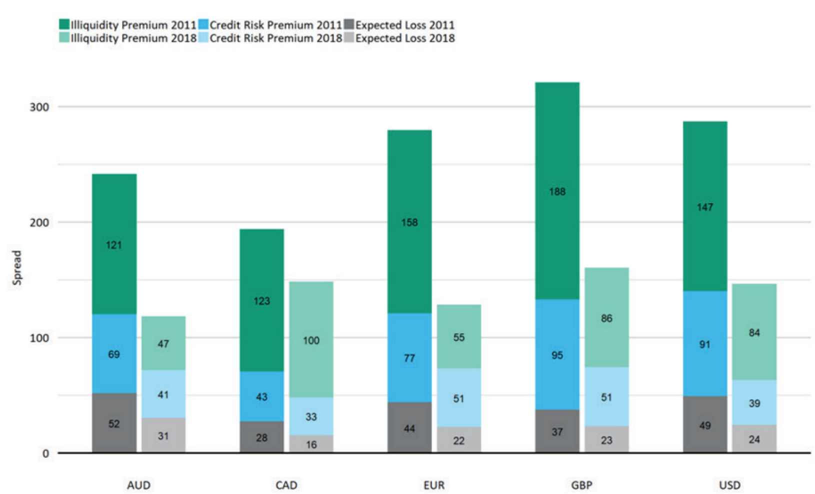
Under stable market conditions, the model produces stable estimates of credit risk and slowly varying illiquidity premia. Under stressed market conditions, the behavior could be significantly different, and the credit risk premium should be significantly larger. In Figure 8 we compare the decomposition 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:

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

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.

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Author

Steven Morrison
Senior Director-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

Implementing IFRS 17 Discount Curves: Theoretical and Practical Challenges

Introduction

IFRS 17 requires liability cash flows to be discounted at rates that reflect the characteristics of the cash flows including their liquidity. As a principles-based standard, IFRS 17 does not specify liability discount rates and entities must develop their own assumptions. Such assumptions are important as they could have significant implications for the IFRS 17 balance sheet, future profits, and volatility.[1] This has reignited the classical actuarial debate of how to estimate the illiquidity premium, a topic which has occupied actuaries since the introduction of market-consistent reporting in the early 2000s. Recently, significant thought and effort have gone into the specification of IFRS 17 discount rates allowing for liquidity.[2]

The challenge of incorporating the illiquidity premium extends beyond estimating its size. For example, the insurer might apply the illiquidity premium to products where stochastic models are used for valuation. This presents its own set of challenges, both theoretical and practical, to which insurers are now turning their attention. In this paper, we compare two potential approaches.

Valuation of contracts with participation features under IFRS 17

IFRS 17 does not prescribe the methodology for valuation of contracts with participation features, in particular contracts with embedded guarantees. However, a standard approach adopted in other contexts (such as calculation of Best Estimate Liabilities under Solvency II) is to use stochastic modeling techniques with scenarios generated using a risk-neutral Economic Scenario Generator (ESG).

Discount rates are used in two separate parts of this calculation:

- To discount liability cash flows.
- To calculate returns on underlying items. In a risk-neutral ESG, the expected returns on all assets are equal to the assumed "risk-free" interest-rate.

Now, it seems consistent with the principles of the standard that (stochastic) liability cash flows are discounted using a rate that reflects the liquidity characteristics of those cash flows. What is less clear is whether expected returns on the underlying items should be equal (on average) to the liability discount rate, or some other rate?

1 *Profit Emergence Under IFRS 9 and IFRS 17*: The impact of choice of liability discount rate, Gavin Conn & Steven Morrison https://www.moodysanalytics.com/-/media/article/2019/profit-emergence-under-ifrs9-ifrs17-the-impact-of-choice-of-liabillity-discount-rate.pdf

2 *A cost of capital approach to estimating credit risk premia*, Alasdair Thompson & Nick Jessop https://www.moodysanalytics.com/-/media/article/2018/a-cost-of-capital-approach-to-estimating-credit-risk-premium.pdf

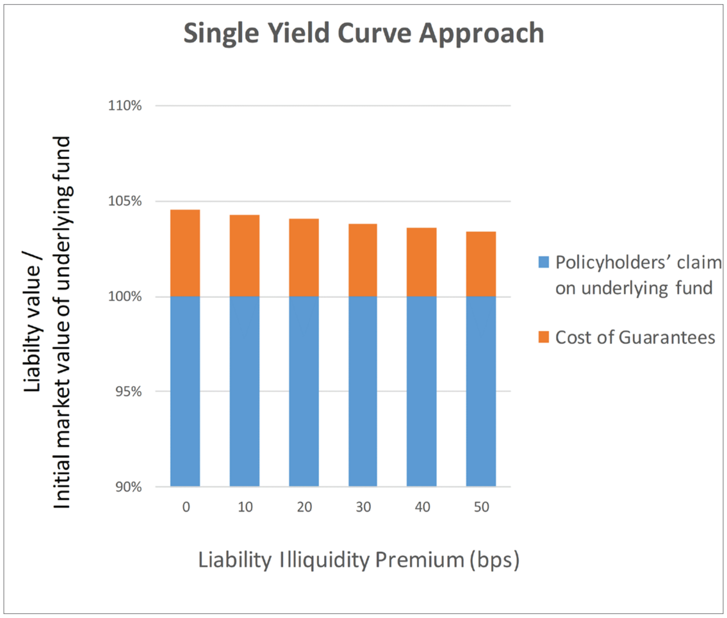
The Single Yield Curve approach

There is a precedent for this question. The Solvency II Volatility Adjustment (VA) is an adjustment to risk-free interest rates that can be interpreted as allowing for the illiquidity of liabilities in the calculation of the Best Estimate Liabilities (BEL). In our experience, insurers using stochastic modeling techniques to calculate the Solvency II BEL have typically incorporated the VA both in the rate used to discount liability cash flows *and* in the rate used to calculate average returns on assets.[3] We call this approach the Single Yield Curve approach since a single yield curve is used both for calculating returns on assets and for discounting.

To illustrate, suppose that we have a contract where the policyholder receives the value of an underlying fund in 10 years' time, subject to a minimum guarantee equal to the initial market value of the assets in the fund. We assume no charges for simplicity.

Figure 1 shows how the value of this liability, as a proportion of the initial market value of the underlying fund, varies depending on the assumed illiquidity premium on the liabilities.[4] The value is broken down into two components: (1) the value of the policyholders' claim on the underlying fund; (2) the value of any guarantee shortfalls (the Cost of Guarantees).

Figure 1: Example liability valuations under the Single Yield Curve approach



We note that the Cost of Guarantees decreases with increasing illiquidity premium, partly because the cash flows are being discounted at a higher rate, but also because the average return on the fund is assumed to increase with the illiquidity premium and so the guarantee is less likely to bite. We also see that the main component of the liability, the value of the policyholders' claim to the underlying fund, is always equal to 100% of the initial market value of the assets in the fund and does not depend on the illiquidity premium. The rate used to discount is exactly equal to the average return on the underlying fund and so cancels out in the valuation.

3 Such an approach is proposed in *Practical application of Liquidity Premium to the valuation of insurance liabilities and determination of capital requirements*, CRO Forum (2011), which suggests "a proportion of the liquidity premium should be added to the swap curve for both the accumulation and discount rate."
4 Valuations assume a Black-Scholes model with a "risk-free" rate of 2% (+ illiquidity premium) and fund implied volatility of 10%.

From an implementation point of view, the single yield curve approach simply involves replacing the risk-free yield curve in the ESG with the liability discount curve. We note, however, two potential issues with the approach, the first practical and the second theoretical:

» When you change the risk-free yield curve in an ESG, it typically has a knock-on effect on asset prices that are calculated in the ESG. Risk-free bond prices obviously change, as do corporate bond prices, and option prices.

  Some insurers have tried to adjust for such impacts by recalibrating other parameters in the ESG to compensate for these changes. In particular, if the liability discount curve incorporates an illiquidity premium (and so risk-free rates are higher than those implied from risk-free assets in the market), the insurer can recalibrate the ESG credit spread model to ensure that the model still recovers market corporate bond yields. This is achieved by assuming that model credit spreads are lower than market spreads to offset the assumed illiquidity premium. However, this approach has its limits: where corporate bond prices are trading at a spread that is lower than the assumed illiquidity premium,[5] these prices cannot be matched by the model unless it permits negative spreads.

  More importantly, such changes to risk-free rates and credit spreads could (depending on the choice of ESG models) result in changes to volatility of asset returns, which in turn result in changes to prices of options on those assets. Though such changes could be allowed for in recalibration of other model parameters, this creates an additional calibration effort which could be significant.

  The calibration issues can be avoided by applying the illiquidity premium as an adjustment to ESG outputs, such as asset returns and discount factors, rather than adjusting the ESG's input risk-free yield curve (and other calibration parameters). However, application of such adjustments is likely to require implementation effort within the ESG and/or cash flow model.

» If you assume an illiquidity premium on liability discount rates, it seems natural to expect a corresponding illiquidity *discount* in liability valuations. Using the Single Yield Curve approach, we observe this behavior in the valuation of the Cost of Guarantees. However, we do not see it in the valuation of the policyholders' claim to the underlying fund, which is always equal to the market value of the underlying fund regardless of the assumed illiquidity premium. If we expect to see that the illiquidity premium is reflected in the valuation of the policyholders' claim to the underlying fund, we need a different approach.

The Dual Yield Curve approach

An alternative approach is to use two different rates:

1. Rate used to discount liability cash flows = risk-free rate + liability illiquidity premium.
2. Expected return on underlying items = risk-free rate + asset illiquidity premium.[6]

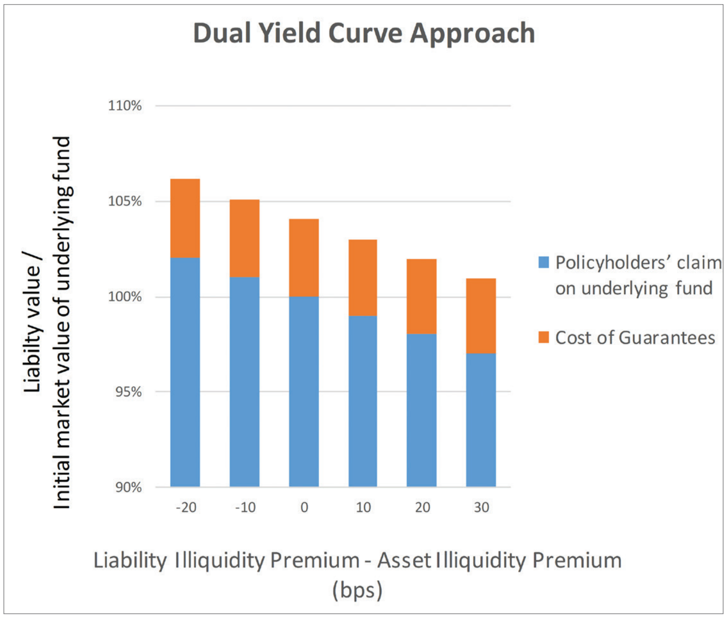
We call this approach the Dual Yield Curve approach.

Figure 2 shows how the value of the example contract varies with the liability illiquidity premium under the Dual Yield Curve approach. Here we assume an asset illiquidity premium of 20 bps, and the liability illiquidity premium is expressed in terms of its difference relative to the assumed asset illiquidity premium.

5 For example, this could be the case for bonds with a higher credit quality than the average rating of the bonds in the reference portfolio used to derive the illiquidity premium.

6 Strictly speaking, expected returns on each individual asset class are adjusted for their specific illiquidity premia.

Figure 2: Example liability valuations under the Dual Yield Curve approach



As with the Single Yield Curve approach, the Cost of Guarantees decreases with increasing illiquidity premium because the cash flows are being discounted at a higher rate. However, the effect is less than in the Single Yield Curve approach (as under the Single Yield Curve approach there is an additional effect due to the liability illiquidity premium impacting on the expected return on assets).

More significantly, the value of the policyholders' claim to the underlying fund is only equal to the market value of the underlying fund in the case where liability and asset illiquidity premia are the same. If the liability illiquidity premium is greater than that on the underlying assets, the policyholders' claim to the underlying fund is valued at a discount to the market value of the fund, reflecting that the policyholder has given up some liquidity by accessing the fund through an insurance "wrapper" (rather than buying the fund assets directly). On the other hand, if the liability illiquidity premium is less than that on the underlying assets, the policyholders' claim to the underlying fund is valued at a premium to the market value of the underlying assets, reflecting that the insurance wrapper provides additional liquidity in this case (relative to buying the fund assets directly).[7]

In terms of practical implementation within an ESG, both the Single Yield Curve and Dual Yield Curve approaches assume that the expected return on assets includes an illiquidity premium relative to the risk-free rate, with the liability illiquidity premium being used in the former case and the asset illiquidity premium being used in the latter. As noted in the discussion of the Single Yield Curve approach in the previous section, the implementation of an illiquidity premium as an adjustment to the risk-free curve can create issues related to calibration of other ESG assumptions, in the event that the liability illiquidity premium exceeds the market spread on assets. The Dual Curve approach should avoid this problem, as the assumed asset illiquidity premium should never exceed the asset's market spread. Alternatively, the asset illiquidity premium can be implemented as an adjustment to ESG output asset returns, rather than adjusting the ESG's input risk-free yield curve. Either way, the liability illiquidity premium would be applied as an adjustment to output discount factors.

7 Similar differences are observed in closed-end funds, which often trade at a discount or premium to the underlying Net Asset Value. This "puzzle" is sometimes (at least partly) attributed to relative liquidity differences between the underlying assets and the closed-end fund.

What is the 'right' approach?

As far as we are aware, there is no standard accepted theory of valuation incorporating illiquidity. In particular, the classic option pricing literature is based on a dynamic replication argument that makes no allowance for the illiquidity characteristics of the cash flows being replicated, nor those of the replicating portfolio. So what is the "right" approach?

Unfortunately, the standard itself does not provide a definitive answer. As IFRS 17 does not prescribe the methodology and assumptions to be used in valuing liabilities, insurers need to use judgment as to the appropriate approach given their views on illiquidity, and be able to justify such assumptions to auditors. In particular, the incorporation of illiquidity premia into existing stochastic modeling approaches could result in changes to the interpretation of standard accepted tests of appropriateness (in particular "martingale" or "1=1" tests), requiring careful communication with auditors.

BP57816

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@moodys.com

Asia-Pacific
+852.3551.3077
clientservices@moodys.com

Japan
+81.3.5408.4100
clientservices@moodys.com

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