IFRS 17 – Default Model – Historic Calibration

1. Executive Summary

This paper looks at the practical issues with developing a credit model in the calculation of the IFRS 17 discount rate. A recent paper (henceforth known as "the Educational Note") by the Canadian Institute of Actuaries[1] includes a discussion of various credit models and this paper looks at one particular application of the Through-The-Cycle (TTC) type model. One of the models referenced in the Educational Note is an implementation of the Vasicek model[2] (a type of TTC credit model), and this model is investigated in this paper. There are many possible credit models that could be used, and no model is endorsed by the working party, but we show some of the issues by investigating this particular model (i.e. the Vasicek) referenced in the Educational note.

The credit model mentioned in the Educational Note is described together with some sources for data that can be used to calibrate it. Some of the advantages and key limitations of this model are described. Finally, a paragraph-by-paragraph summary shows how the TTC model meets the IFRS 17 standard.

2. Background

The calculation of the IFRS 17 discount rate requires one of two approaches:

- **The top-down approach** - Calculate the yield on assets backing liabilities and subtract a default allowance; with the default allowance calculated from a credit model
- **The bottom-up approach** - Calculate the "risk free" rate and add on a liquidity premium

Some firms have applied a third hybrid type approach where a default allowance is calculated on the assets backing the liabilities (in line with the top-down approach). This is removed from the yield on these assets to give a liquidity premium, which is then added to the "risk free" rate (in line with the bottom-up approach). This hybrid approach is similar to the Solvency II Matching Adjustment style calculation. The main two (non-hybrid) approaches are shown below:

[1] "IFRS 17 Discount Rates for Life and Health Insurance Contracts" Canadian Institute of Actuaries [https://www.cia-ica.ca/publications/publication-details/220079]

[2] "A one-parameter representation of credit risk and transition matrices" D Belkin, L Forest 1998 [https://www.z-riskengine.com/media/1032/a-one-parameter-representation-of-credit-risk-and-transition-matrices.pdf]

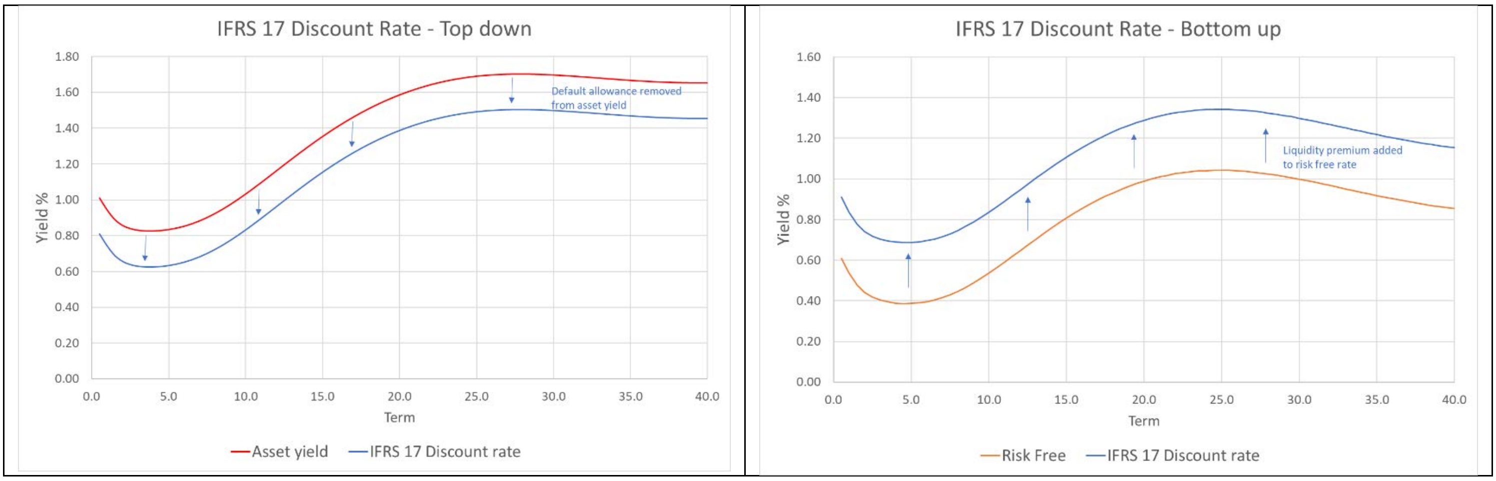


Figure 1 – Bottom-up and top-down approaches to IFRS 17 discount rate calculation

In section 3 of this paper, a credit model is described in some detail including a description of transition matrices in section 3.1. Section 3.2 describes different sources of unexpected default risk and section 3.3 describes the Belkin model. Section 3.4 comments on possible data sources and 3.5 gives a practical example of the credit model including results and sensitivities. Section 4 includes a comparison with how the credit model described in this paper compares to the IFRS 17 standard.

3. The Credit Model

This paper focuses on the calculation of the default allowance which is required whether a top-down approach or a hybrid approach are used (as described above). This paper does not consider how to calculate a liquidity premium directly (other than by calculating the default allowance and subtracting from the credit spread). This paper does not endorse a hybrid or top-down approach – but shows some of the issues with such approaches. To quantify the default allowance a credit model is required. The credit model for the IFRS 17 default allowance is required to include both expected and unexpected defaults[3]. The Educational Note described two possible credit models that allow for expected and unexpected defaults; a Point in Time (PIT) approach and a Through the Cycle (TTC) approach. The credit model considered in this paper is as referenced in the Educational Note[4].

In this paper we focus on the TTC approach and show the considerations for applying it in practice; how it meets the IFRS 17 standard, as well as issues and limitations. The model considered is known as the Belkin implementation of the Vasicek model (henceforth known as the Belkin model). The model uses historic transition matrices to calibrate the Vasicek model.

We start by giving a brief overview of transition matrices and how these are used to calculate expected defaults. We then consider different ways to allow for unexpected defaults. There is then a review of the Belkin model and possible sources of data that can be used to calibrate it.

[3] See Canadian Institute of Actuaries Educational note: "IFRS 17 Discount Rates for Life and Health Insurance Contracts" June 2020 P26 section 4.2.2

[4] "A one-parameter representation of credit risk and transition matrices" D Belkin, L Forest 1998 [https://www.z-riskengine.com/media/1032/a-one-parameter-representation-of-credit-risk-and-transition-matrices.pdf]

3.1 Transition matrices and expected defaults

Transition matrices are used to present historic probabilities of moving between different credit ratings and defaults. They are constructed by counting the number of corporate bonds that have moved credit rating or defaulted over a particular time period.

An example from S&P is shown below which captures the one-year transition and default probabilities calculated based on averages over the period 1981-2018.

From/to	AAA	AA	A	BBB	BB	B	CCC/C	D
AAA	89.82%	9.42%	0.55%	0.05%	0.08%	0.03%	0.05%	0.00%
AA	0.52%	90.63%	8.17%	0.51%	0.05%	0.06%	0.02%	0.02%
A	0.03%	1.77%	92.30%	5.40%	0.30%	0.13%	0.02%	0.06%
BBB	0.01%	0.10%	3.64%	91.63%	3.86%	0.49%	0.12%	0.18%
BB	0.01%	0.03%	0.12%	5.35%	85.80%	7.36%	0.61%	0.72%
B	0.00%	0.02%	0.09%	0.19%	5.63%	85.09%	5.05%	3.93%
CCC	0.00%	0.00%	0.13%	0.24%	0.70%	15.63%	51.49%	31.82%
D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%

From this transition matrix the probability of going from AAA to AA is 9.42% over a one-year time period. The probability of a B rated asset defaulting over a one-year time period is 3.93%.

One of the strengths of the transition matrix is the simplicity with which probabilities at other terms can be found. Using Markov assumptions, we can simply multiply a one-year transition probability matrix by itself to get the two-year transition probabilities. For example, the above matrix multiplied by itself gives the two-year probability of transitioning between ratings or defaults.

Two-year transition probabilities (based on 1981-2018 data).

From/to	AAA	AA	A	BBB	BB	B	CCC/C	D
AAA	80.72%	17.00%	1.77%	0.18%	0.16%	0.08%	0.08%	0.02%
AA	0.94%	82.33%	14.97%	1.37%	0.14%	0.13%	0.04%	0.06%
A	0.07%	3.24%	85.54%	9.96%	0.76%	0.28%	0.05%	0.14%
BBB	0.02%	0.24%	6.71%	84.36%	6.88%	1.17%	0.22%	0.43%
BB	0.02%	0.07%	0.42%	9.51%	74.24%	12.70%	1.21%	1.83%
B	0.00%	0.04%	0.18%	0.66%	9.66%	73.61%	6.93%	8.92%
CCC	0.00%	0.01%	0.21%	0.41%	1.85%	21.40%	27.31%	48.83%
D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%

The probability of a B rated asset defaulting over a two-year time period is 8.92%.

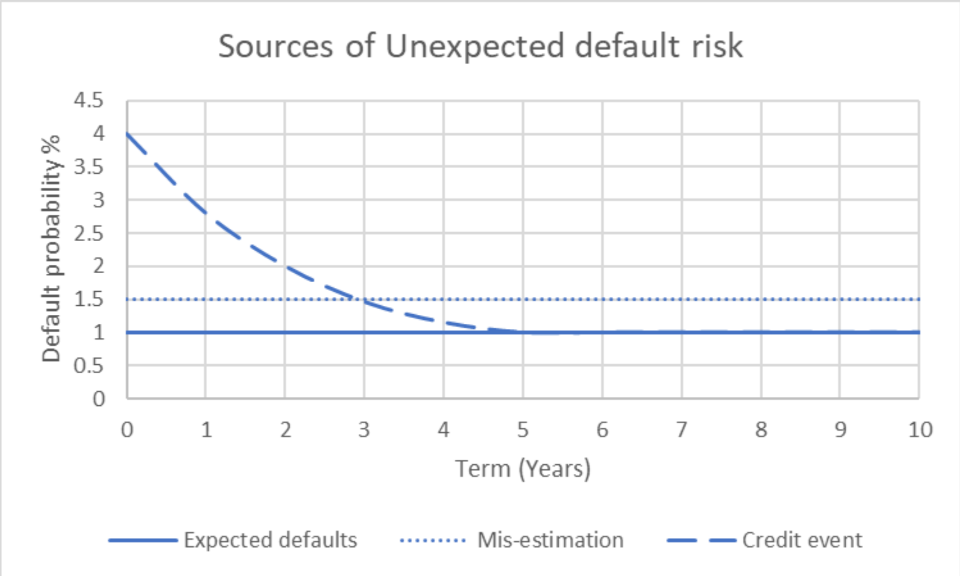
In principle we can use this approach to calculate default probabilities over any time frame. This is the approach use to calculate "expected defaults", which give the best estimate without any margin for unexpected defaults.

3.2 Unexpected defaults

The credit model should include an allowance for unexpected defaults over and above the best estimate. For a credit risk there are two potential sources of unexpected defaults:

- An unexpected credit event
- Mis-estimation of long term expected defaults

These are shown graphically in the plot below:



The plot above shows representative example for two sources of unexpected default risk.

- An unexpected credit event is an event where credit defaults are higher than has been seen on average historically (e.g. 1932 or the 2008 financial crisis). This event might last a number of years as is shown in the plot above. The unexpected event does not need to be an extreme event as might be required for capital calculations, but some margin needs to be allowed for to cover unexpected defaults
- Mis-estimation of long term expected defaults is the risk that the estimate of the expected defaults is too low.

A TTC model for the IFRS 17 discount rate credit model could include one or both of these elements to cover the firm's view of how much reserves it needs to hold for unexpected defaults. The exact allowance for unexpected defaults is not specified in the IFRS 17 standard.

3.3 The Belkin Model

The Belkin Model is well described in a note by JP Morgan[5] which includes a precise description of its calibration using historic transition matrices. There is also a more recent article in The Actuary magazine[6] describing some of the historic context and practical issues associated with this model.

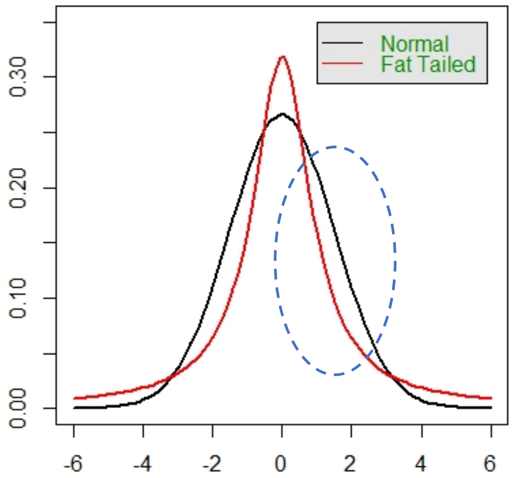
The main strength of this model is its simplicity and ease of explanation as each transition matrix is represented by a single number. In principle this number represents whether the year was a good or bad year and by what magnitude, for transitions and defaults. Once the model has been calibrated, transition matrices at different percentiles can be generated, which could be used to allow for the unexpected default risk.

[5] "A one-parameter representation of credit risk and transition matrices" Belkin B, Suchower S [a-one-parameter-representation-of-credit-risk-and-transition-matrices.pdf (z-riskengine.com)]
[6] "Glide rule: credit migration and default risk" | The Actuary Ginghina F, Kapadia A [https://www.theactuary.com/features/2021/02/26/glide-rule-credit-migration-and-default-risk]

3.3.1 Model limitations

The main limitation of the model is that it represents an entire transition matrix with just a single number, which inevitably results in the loss of information. It is possible to measure the volatility of the transition probability for each rating in each transition matrix and these vary considerably across the different ratings. To improve the information contained in this single number, it is possible to use the market value of assets in the reference portfolio as weightings for each rating in the calibration of the Belkin model to create a weighted average.

Another limitation is that the model uses the Normal distribution to model credit risk. At the high percentiles this is not a good representation of the underlying risk which is typically fat tailed (and skewed). This is shown in the plot below:



However, the IFRS 17 credit model is a model for best estimate plus a margin for unexpected defaults and the percentile used is likely to be in the range where the Normal is above a fatter tailed distribution (i.e., the range highlighted with a blue circle above), on this basis this limitation is not expected to understate the risk, as it would where an extreme percentile is being considered.

Users of this model need to ensure they are familiar with the model limitations and how these limitations impact the use to which the model is being put.

3.4 Data for calibration

This section gives a summary of the main data sources used for transition matrices.

It is possible to find S&P transition matrix data online (without charge) back to 1981 (with the exception of a few years). However, the main data source of historic transition matrices (requires a subscription) is the Moody's data source which includes annual transition matrices from 1920-2019. A plot showing historic transition matrices calibrated to the Belkin model is shown below[7].

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[7] "Glide rule: credit migration and default risk" | The Actuary Ginghina F, Kapadia A [https://www.theactuary.com/features/2021/02/26/glide-rule-credit-migration-and-default-risk]

This plot shows the Z score values for each historic transition matrix back to 1920. The black bars are from a standardised Normal distribution (grey bars from using a fatter tailed standardised Student T distribution). The left scale in the plot above shows how many standard deviations from the mean each historic transition matrix is represented by (e.g. 1932 is just under 4 standard deviations from the mean using the Normal distribution Belkin model as described in that article). (Right axes in the above plot relates to change in Global GDP and not directly relevant to this paper.)

This plot gives a full range of historic data to calibrate a model to, including:

- The 1930s Great depression
- The "Golden era" from 1945-1970 of economic growth
- The 2008-09 Great financial crisis

3.5 Example model calibration

This section gives a simple example calibration for illustrative purposes. In practice, significantly more rigour would be expected for a default allowance calibration.

The Belkin model described in the previous section has been calibrated to the freely available data source described in section 3.4 as well as a year of extreme stress[8] (i.e. years 1932, 1981-2003, 2006-2018).

For unexpected defaults a simple approach was used and in practice significantly more justification would be required. This simple approach was to use:

- No weighting between the different ratings in the calibration of the Belkin model
- The 95th percentile for the long-term mis-estimation risk
- No allowance for a short-term unexpected credit event (see section 3.2)
- 30% recovery rate

Using this version of the model, default allowance can be calculated as a probability, which can then be converted to a spread.

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[8] 1932 year from [https://www.bundesbank.de/resource/blob/635454/3d26f24706559d386b04a2efd06d5d7c/mL/2011-10-19-eltville-11-varotto-paper-data.pdf]; remaining years sourced from Extreme Events Working Party

Some credit spreads for various ratings and durations during recent periods together with the Covid stress as at 31 March 2020 are shown below.

Spread over LIBOR (rounded to nearest 5bps)					
	Duration (yrs)	31-Mar-21	31-Dec-20	31-Mar-20	31-Dec-19
AAA	14	35	35	140	50
AA	10	50	40	165	50
A	9	90	80	220	100
BBB	8	125	130	290	145

The expected default allowance as a percentage of these credit spreads is shown in the table below:

% of credit spread expected defaults (rounded to nearest 5%)					
	Duration (yrs)	31-Mar-21	31-Dec-20	31-Mar-20	31-Dec-19
AAA	14	15%	15%	5%	10%
AA	10	10%	15%	5%	10%
A	9	10%	15%	5%	10%
BBB	8	25%	25%	10%	20%

The expected defaults shown in the above table allows for all the possible ways a bond could move between ratings to default over the duration. For example, the 15% shown in the top left cell is the probability of default for a AAA rated bond over 14 years moving over any possible rating over that period and ending in default. (This calculation is done using the multiplication of transition matrices as described in section 3.1, which captures the movement between ratings and ending in default at or before 14 years.)

The expected and unexpected default allowance as a percentage of these credit spreads is shown in the table below:

% of credit spread expected and unexpected defaults (rounded to nearest 5%)					
	Duration (yrs)	31-Mar-21	31-Dec-20	31-Mar-20	31-Dec-19
AAA	14	25%	25%	5%	15%
AA	10	15%	20%	5%	15%
A	9	20%	20%	10%	15%
BBB	8	35%	35%	15%	30%

Note that these results hold for as a percentage over swaps, but the results would be different if gilt rates were used as the risk free.

The results for 31 March 2020 show that when credit spreads are much higher (as was the case at this point in the Covid crisis) the default allowance takes a significantly lower proportion of credit spreads (i.e. default allowance remains stable, but is a lower proportion of a higher credit spread).

3.5.1 Sensitivity

In this section we include a sensitivity on the final table in the previous section, showing the impact of a higher recovery rate of 40% (all other assumptions the same).

% of credit spread expected and unexpected defaults (rounded to nearest 5%)					
	Duration (yrs)	31-Mar-21	31-Dec-20	31-Mar-20	31-Dec-19
AAA	14	20%	20%	5%	15%
AA	10	15%	20%	5%	15%
A	9	15%	20%	5%	15%
BBB	8	30%	30%	15%	25%

The exact percentile used is a subjective choice, which has some dependence on the firms view of how risk averse investors are with respect to unexpected credit risk.

4 Consistency with IFRS 17 standard

This section shows an interpretation for how a TTC model meets the IFRS 17 standard.

Discount rates are covered in Paragraphs 36 and B72 – B85 of the IFRS 17 standard. Specific points that apply to the default allowance for discount rates are given in paragraphs 36, B78, B82, B83, B85. These are shown in the table below, together with a justification for how the TTC approach meets the standard.

Paragraph	Wording	How the TTC model meets the standard
36	An entity shall adjust the estimates of future cash flows to reflect the time value of money and the financial risks related to those cash flows, to the extent that the financial risks are not included in the estimates of cash flows. The discount rates applied to the estimates of the future cash flows described in paragraph 33 shall: (a) reflect the time value of money, the characteristics of the cash flows and the liquidity characteristics of the insurance contracts; (b) be consistent with observable current market prices (if any) for financial instruments with cash flows whose characteristics are consistent with those of the insurance contracts, in terms of, for example, timing, currency and liquidity; and (c) exclude the effect of factors that influence such observable market prices but do not affect the future cash flows of the insurance contracts.	The TTC approach uses the market value of assets in the reference portfolio (a) (b). The default allowance is excluded from the discount rate by using a historic approach to the default allowance calculation (c).
B78	Discount rates shall include only relevant factors, i.e. factors that arise from the time value of money, the characteristics of the cash flows and the liquidity characteristics of the insurance contracts. Such discount rates may not be directly observable in the	For the TTC model the observable inputs to the liquidity premium calculation are: 1. The market value of the reference portfolio

	market. Hence, when observable market rates for an instrument with the same characteristics are not available, or observable market rates for similar instruments are available but do not separately identify the factors that distinguish the instrument from the insurance contracts, an entity shall estimate the appropriate rates. IFRS 17 does not require a particular estimation technique for determining discount rates. In applying an estimation technique, an entity shall: (a) maximise the use of observable inputs (see paragraph B44) and reflect all reasonable and supportable information on non-market variables available without undue cost or effort, both external and internal (see paragraph B49). In particular, the discount rates used shall not contradict any available and relevant market data, and any non-market variables used shall not contradict observable market variables. (b) reflect current market conditions from the perspective of a market participant. (c) exercise judgement to assess the degree of similarity between the features of the insurance contracts being measured and the features of the instrument for which observable market prices are available and adjust those prices to reflect the differences between them.	2. The credit rating of the assets in the reference portfolio 3. The gilt or swap rate used for the "risk free" A key question is whether the credit rating is maximising the use of observable inputs. For some assets there may be specific instruments that represent the default probability (e.g. CDSs). However, these are not available for the full portfolio of assets in most insurance company balance sheets which would include illiquids. CDS markets are also subject to liquidity issues and so the default price from a CDS is not just default expectations but also liquidity in those markets as well.
B82	In estimating the yield curve described in paragraph B81: (a) if there are observable market prices in active markets for assets in the reference portfolio, an entity shall use those prices (consistent with paragraph 69 of IFRS 13). (b) if a market is not active, an entity shall adjust observable market prices for similar assets to make them comparable to market prices for the assets being measured (consistent with paragraph 83 of IFRS 13). (c) if there is no market for assets in the reference portfolio, an entity shall apply an estimation technique. For such assets (consistent with paragraph 89 of IFRS 13) an entity shall: (i) develop unobservable inputs using the best information available in the circumstances. Such inputs might include the entity's own data and, in the context of IFRS 17, the entity might place more weight on long-term estimates than on short-term fluctuations; and (ii) adjust those data to reflect all information about market participant assumptions that is reasonably available.	The market price of assets in the reference portfolio is used.
B85	IFRS 17 does not specify restrictions on the reference portfolio of assets used in applying paragraph B81.	The reference portfolios used are bond (and similar) portfolios and the credit

	However, fewer adjustments would be required to eliminate factors that are not relevant to the insurance contracts when the reference portfolio of assets has similar characteristics. For example, if the cash flows from the insurance contracts do not vary based on the returns on underlying items, fewer adjustments would be required if an entity used debt instruments as a starting point rather than equity instruments. For debt instruments, the objective would be to eliminate from the total bond yield the effect of credit risk and other factors that are not relevant to the insurance contracts. One way to estimate the effect of credit risk is to use the market price of a credit derivative as a reference point.	(default) risk not relevant to insurance contracts is removed with the use of a historic default allowance calculation, based on the credit rating of the assets. The wording says "one way" to estimate the default allowance is by using credit derivatives. But it does not specify this as the only method. This shows the wording of the IFRS 17 standard considers other approaches also appropriate.

5 Summary and Conclusions

In this paper, the IFRS 17 discount rate calculation is presented and the role of the credit model in the IFRS 17 discount rate is given. The credit model mentioned in the Educational Note is described together with some sources for data that can be used to calibrate it. Some of the advantages and key limitations of this model are described. Finally, a paragraph-by-paragraph summary is given for why a TTC model is in line with the IFRS 17 standard.