Expected Loss Credit Rating Methodology

Expected loss credit rating methodology used for fedafin's credit rating assignments to real estate secured debt instruments and mortgage collateralized asset backed securities.

Mortgage Credit Rating
Secured Debt Credit Rating
Covered Bond Credit Rating
Structured Notes Credit Rating

March 2018

Credit Rating Methodology and Key Risk Drivers

The credit risk on a secured debt instrument reflects the expected loss a lender may potentially suffer due to adverse developments of key risk drivers resulting in the borrower's failure to service periodic payments or to refinance the debt (see figure 1). Fedafin assesses the expected loss (EL) of a secured debt instrument by analyzing its probability of default (PD), future loss given default (FLGD), and exposure at default (EAD)[1]. A Monte Carlo method is employed to randomly simulate the stochastic key drivers affecting the various components of an instrument's expected loss (see figure 2).[2] Main risk drivers in fedafin's quantitative analysis are:

- hazard rate estimation of monthly PDs, developed and calibrated using a representative mortgage portfolio replicating the default pattern in the 1990s Swiss real estate bubble burst,
- Monte Carlo simulation of short-term interest rates, real estate price indices, and unemployment rates following a mean-reverting process including floors and ceilings,
- Monte Carlo based estimation of an instrument's PD, FLGD, and EL distributions, taking into account real estate segment-specific assumptions on (1) foreclosure duration, (2) foreclosure costs, and (3) countercyclical liquidity and market premiums,

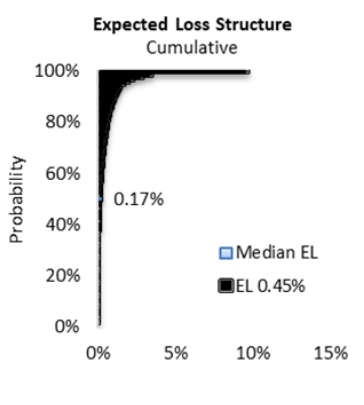


Figure 1: Expected loss estimation for a single real estate secured debt instrument

[1] Based on the SCSC (Real Estate Secured, Covered, Securitized, and Company Debt Analyzer) risk-tool developed specifically for the Swiss real estate market.
[2] Many expected loss methodologies use macro scenarios to determine an instrument's risk profile. By using the term *scenario* in this expected loss credit rating methodology fedafin rather refers to a single simulation (path) in a random Monte Carlo environment.

- time-varying capital and interest exposure originating from loan level data including an instrument's rank within the debt's seniority structure (2nd lien mortgages, structured notes tranches),
- time-varying prepayment rates and prepayment penalties, which may optionally be applied on an instrument's cash-flow depending on specific prepayment covenants, and
- collateral documentation in terms of rental income reports and real estate property valuations provided by a third-party real estate appraiser.

Probability of Default (PD)

To quantify the PD of a real estate secured debt instrument, fedafin estimates the time-dependent hazard rate of a default event using Cox regression techniques (see figure 3). A common formulation for survival analysis is

$$h(t) = h_0(t) * \exp [\beta_1*X_1(t) + \beta_2*X_2(t) + ... + \beta_k*X_k(t)]$$

where h(t) is the hazard rate, or the conditional probability that a mortgage survives until time t but fails during the next time interval; t represents age of mortgage; $h_0(t)$ is the baseline hazard, which captures the shape of the hazard function; $X_1(t)$, $X_2(t)$, ... $X_k(t)$ are time varying explanatory variables that influence risk of mortgage default and β_1, β_2, ... β_k are coefficients that measure the impacts of the explanatory variables on the hazard rate. The coefficients selected are:

β_1 real estate segment
β_2 updated Loan-to-Value (LTV)
β_3 updated mortgage spread (short-term interest rate minus coupon)
β_4 coupon
β_5 updated 3-year unemployment rate trend

Properties are assigned to standard real estate segments according to their purposes and risk profiles. Real estate segments are:

(1) condominium properties
(2) residential properties
(3) multifamily properties
(4) office properties
(5) industrial properties
(6) retail properties

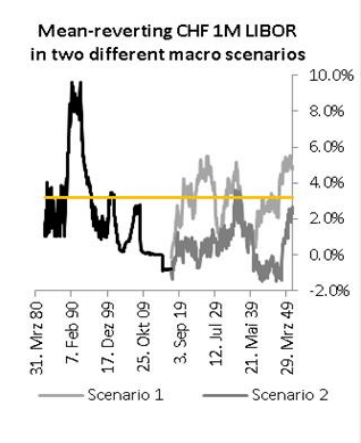


Figure 2: Short-term interest rate simulation

Figure 3: Hazard rate simulation for a single real estate secured debt instrument

Properties with other than the before-mentioned purposes are assigned to the segment which best fits the property's risk profile. For example, properties such as hotels and restaurants may be assigned to the retail property segment due to their elevated risk profile.

Future Loss Given Default

A loss may only occur if revenues from the sale of a defaulted instrument's real estate collateral fall short of an investor's outstanding claims at that point in time. Fedafin endogenously estimates the potential shortfall from collateral value at foreclosure covering outstanding principal and interests as the FLGD (see figure 4). Third-party appraiser's estimates of the property value serve as a starting point for projecting future values until maturity and beyond.

For an instrument's expected loss assessment, fedafin chose a stochastic simulation approach, which allows for a significant downturn in real estate valuations caused by demand-supply dynamics, limited credit availability, and/or an adverse change of legislative framework. The analysis of future property values is based on a Monte Carlo simulation of real estate price indices with mean-reversion behavior and segment-specific standard assumptions on:

- foreclosure periods, ranging from 18 months for residential properties up to 30 months for retail properties,
- workout costs, ranging from CHF 10'000 for residential properties up to CHF 40'000 for retail properties, and
- time-dependent liquidity and market risk premium, ranging from 12.5% of collateral value for residential properties up to 25% of collateral value for retail properties (increasing with falling property values and vice versa).

Figure 4: Future loss given default simulation for a single real estate secured debt instrument

Exposure at Default (EAD)

The debt exposure at default significantly contributes to the endogenous FLGD estimation. Debt exposure consists of outstanding principal and interest payments at any point in time until maturity according to a secured instrument's initial terms and conditions. Fedafin's expected loss approach differentiates between current balance exposure and current interest payment exposure for a better understanding of these components' impact on the risk pattern of the analyzed debt instrument (see figure 4).

Main key drivers for current balance exposure are (1) amortization schedules due to contractual repayment requirements and, optionally, (2) prepayment rates depending on contract-specific prepayment covenants. The most common prepayment covenant in domestic markets is a yield maintenance penalty provision, which significantly reduces financial incentives for premature debt redemption. This is confirmed by the finding that outstanding balance is rarely redeemed voluntarily in a declining interest rate environment until refinancing is due at the end of the instrument's term. Sometimes, penalty-free annual prepayment limits are contractually agreed upon. This premise given, a conditional prepayment rate may be applied on the penalty-free mortgage tranche.

Main key drivers for current interest exposure are (1) interest payment conditions, (2) payments due to contractual fee requirements and, optionally, (3) possible penalty payments conditional on prepayments during an instruments lifetime. Delinquency rates on due interest payments are only applied to collateral asset pools in a structured finance framework. Since delinquency in a single instrument environment can only be cured by repaying the missed interest payments without leading to a default, interest payment exposure remains unaffected by delinquency considerations.

Single-Borrower Pooling Approach

The analysis of creditworthiness of a secured debt instrument becomes more challenging when various collateral features have to be adequately considered (see figure 5).[3] Single private person borrowers usually collateralize their mortgage with the residential property they live in. A frequent characteristic of commercial mortgages are portfolios with a bundle of real estate properties serving as collateral. Fedafin differentiates between single-asset mortgages (SASB) and multi-asset mortgages (MASB) of a single borrower. The expected loss calculation of a MASB considers the secured real estate portfolio mix of different property types as described above.

A frequent feature of a single borrower's real estate funding is one property serving as collateral for several mortgages. Single borrowers frequently combine fixed-rate mortgages (FRM) and adjustable Libor-rate mortgages (ARM) with different maturities. A combination of several mortgages usually allows for a better match between the

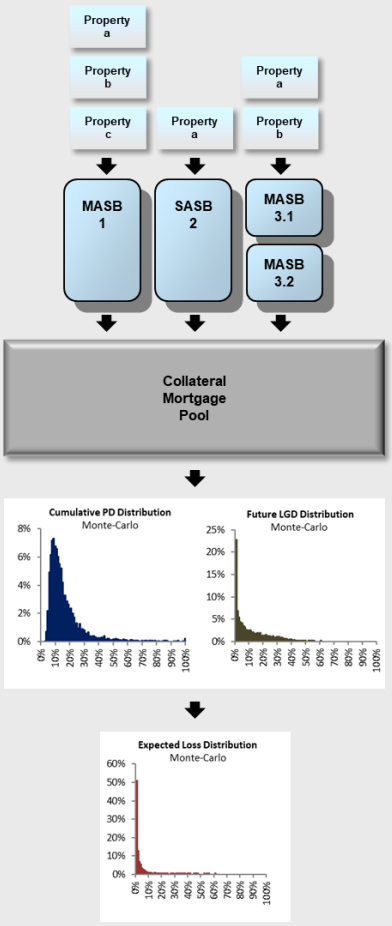


Figure 5: Pooling and aggregation approach

[3] The following explanations generally apply to all kinds of real estate secured debt instruments, privately placed or exchange-traded. For simplicity reasons, fedafin refers to the term *mortgage* as a prominent and well-known example for real estate secured debt.

borrower's funding needs and his interest rate expectations. Regulatory requirements and eligibility criteria in Switzerland demand amortization of a borrower's mortgage debt depending on initial LTV. The prevailing domestic amortization schedule corresponds to constant amortization mortgages (CAM); other than constant payment mortgages (CPM) with fixed annuity payments and increasing amortizations prevailing in many market places abroad. Second lien mortgages are treated as junior to first lien mortgages with expected loss calculation of the junior mortgage being subject to cash flow waterfall dynamics due to time-varying exposure contribution of a single borrower's mortgages.

Multi-Borrower Pooling Approach

Pools of mortgages from different borrowers serving as collateral for asset backed securities can be as small as half a dozen up to more than a thousand mortgages. There are two aggregation approaches to assess the pooled cash-flow and risk dynamics. Their application usually depends on the availability of sufficiently detailed mortgage data. The mortgage-by-mortgage approach (MMA) achieves more reliable credit risk estimates of a mortgage pool than the representative line approach (RLA), due to non-linear cash-flow and risk factor dynamics. The preferred MMA analyses a mortgage pool in five steps.

- Step 1: Generation of monthly economic scenarios over a 25-year horizon using random variables with mean-reversion behavior for real estate price indices, short-term interest rates, and unemployment rates.
- Step 2: Calculation of monthly default probabilities, future loss given default estimates, and expected loss in a single scenario for each mortgage depending on specific cash-flow and economic factors.
- Step 3: Aggregating mortgages' weighted average default probabilities and future loss given default estimates in a single scenario resulting in a mortgage pool's scenario-specific default probability, future loss given default, and expected loss.
- Step 4: Aggregating mortgage pool's default probability, future loss given default, and expected loss distribution for equally-weighted scenarios (standard 5'000 simulated paths).
- Step 5: Calculation of asset-backed securities' expected loss distribution for equally-weighted scenarios applied on transaction-specific waterfall structure in terms of priority of payments and loss distributions (credit enhancement, trigger provisions).

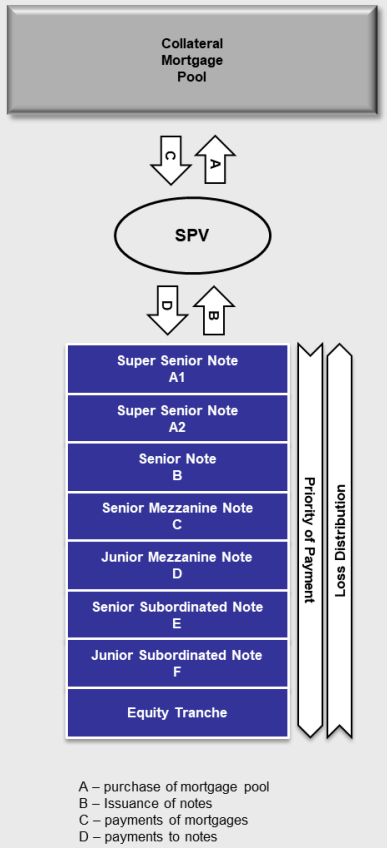


Figure 6: Structured finance transaction

Default and loss correlations between mortgages are modelled endogenously through common dependence on macroeconomic and mortgage cash flow specific factors.

The RLA analyses a mortgage pool identically to the MMA, except for the replication of the mortgage portfolio with a reduced level of detail. The construction of representative mortgages aims to capture the mortgage pool's features in terms of credit rating relevant factors such as real estate segment, Loan-to-Value, interest and amortization cash-flows pattern.

Structured Finance Risk Dynamics

Structured finance transactions contribute additional complexity and potential pitfalls to an instrument's risk profile (see figures 6 and 7). For example, residential mortgage backed securities (RMBS) or commercial mortgage backed securities (CMBS) are commonly known structured finance instruments. The transaction usually involves many counterparties with a special-purpose vehicle (SPV) typically serving as issuer of the notes. A variety of transaction-specific features impact the cash flow dynamics and risk profiles of structured notes. Core features of structured finance transactions are:

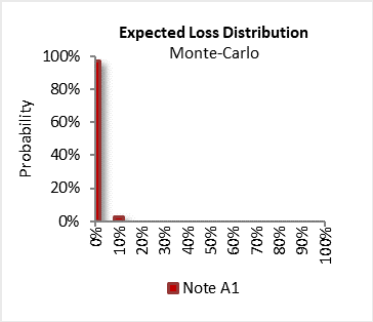
(1) a tranche structure designed to absorb losses in favor of higher ranked tranches with the lowest ranked equity tranche being non-rated,

(2) a non-revolving collateral asset pool with the longest maturity asset determining the maximum possible life of the notes, and

(3) credit enhancement measures and covenant features designed to build a transaction-specific waterfall structure in terms of priority of payments and loss distribution.

For a thorough understanding and risk assessment of structured finance instruments these additional key risk drivers have to be adequately incorporated in a quantitative methodology. Important drivers in fedafin's assessment of credit enhancement measures and covenant features impacting structured cash flow dynamics are:

- liquidity facilities designed to provide a maximum liquidity line subject to potential triggers such as current collateral balance,
- further advances covenant designed to provide additional liquidity for a certain period of time after issuance of notes,
- reserve funds designed to provide a maximum first loss buffer



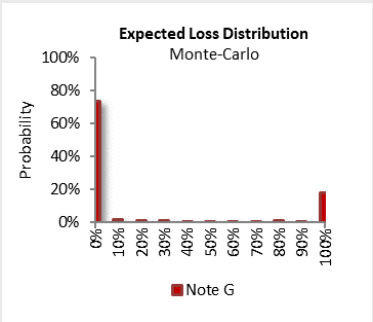


Figure 7: Expected loss distribution for two tranches in a structured mortgage-backed security transaction

subject to potential triggers such as current collateral balance,

- interest-rate swaps designed to protect investors against interest-rate risk,
- fee covenants designed to compensate for services of other parties involved in structured finance transaction,
- clean-up call covenants designed to prematurely redeem notes subject to triggers such as current collateral balance,
- lock-out period covenants designed to prevent amortization payments during a specified period of time after issuance of notes, and
- margin step-up covenants designed to compensate investors for increased payment risk inflicted by a trigger breach.

Main risk drivers in fedafin's assessment of trigger provisions impacting waterfall structure in terms of priority of payments and loss distribution dynamics are:

- pro-rata versus sequential payment triggers between equally ranking tranches,
- unpaid principal deficiency ledger provisions subject to note-specific triggers, and
- default and delinquency rate triggers for equity tranche.

The tail-loaded expected loss distribution profile of tranche notes is a somewhat typical result of the structured finance transaction features (see figure 7).

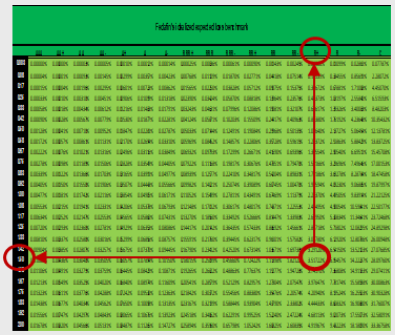


Figure 8: Fedafin's idealized EL benchmark

Expected Loss Credit Rating Assignment

Based on the previous assessment, fedafin assigns expected loss credit ratings to a debt instrument according to its idealized expected loss rate benchmark for senior unsecured debt. The benchmark results from exponentiating the generator matrix built from a generalized credit rating transition matrix based on fedafin's default rate history. By multiplying the resulting default probabilities with credit rating-specific estimates for FLGD[4], fedafin arrives at the idealized expected loss rate benchmark for each credit rating category for up to 25 years (see figure 8 and annex 1). The credit rating assignment corresponds to the idealized expected loss rate benchmark of the instrument's remaining life to maturity.

[4] The FLGD estimates are generated by a logarithmic regression on empirical findings for credit rating-specific recovery rates of senior unsecured bonds. The results range from a FLGD as low as 29.6% for the highest credit rating Aaa up to a value of 61.8% for the lowest credit rating C.

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Annex 1: fedafin's Idealized Annual Cumulative Expected Loss Rates Benchmark

	Aaa	Aa+	Aa	Aa-	A+	A	A-	Baa+	Baa	Baa-	Ba+	Ba	Ba-	B+	B	B-	C
1	0.0008%	0.0021%	0.0041%	0.0077%	0.0133%	0.0224%	0.0381%	0.0671%	0.1381%	0.2227%	0.3516%	0.5417%	0.9052%	1.7767%	3.4083%	7.1046%	17.1281%
2	0.0019%	0.0052%	0.0104%	0.0194%	0.0331%	0.0567%	0.0949%	0.1690%	0.3244%	0.5212%	0.8072%	1.2200%	2.0093%	3.7514%	6.7317%	12.7277%	27.6912%
3	0.0036%	0.0099%	0.0197%	0.0357%	0.0605%	0.1038%	0.1702%	0.3020%	0.5501%	0.8792%	1.3456%	2.0065%	3.2534%	5.8093%	9.8635%	17.2548%	34.3875%
4	0.0061%	0.0165%	0.0325%	0.0572%	0.0965%	0.1641%	0.2644%	0.4636%	0.8098%	1.2860%	1.9508%	2.8772%	4.5891%	7.8746%	12.7598%	20.9610%	38.7799%
5	0.0094%	0.0254%	0.0495%	0.0847%	0.1418%	0.2381%	0.3774%	0.6515%	1.0999%	1.7338%	2.6091%	3.8110%	5.9779%	9.8988%	15.4105%	24.0441%	41.7784%
6	0.0139%	0.0372%	0.0713%	0.1185%	0.1969%	0.3262%	0.5091%	0.8642%	1.4176%	2.2166%	3.3095%	4.7899%	7.3901%	11.8521%	17.8238%	26.6473%	43.9171%
7	0.0196%	0.0523%	0.0982%	0.1593%	0.2623%	0.4284%	0.6593%	1.0999%	1.7607%	2.7292%	4.0421%	5.7988%	8.8026%	13.7177%	20.0164%	28.8752%	45.5125%
8	0.0270%	0.0709%	0.1308%	0.2076%	0.3383%	0.5450%	0.8276%	1.3574%	2.1271%	3.2670%	4.7987%	6.8247%	10.1986%	15.4870%	22.0082%	30.8052%	46.7543%
9	0.0361%	0.0937%	0.1695%	0.2636%	0.4252%	0.6758%	1.0136%	1.6353%	2.5146%	3.8260%	5.5720%	7.8569%	11.5659%	17.1571%	23.8196%	32.4950%	47.7579%
10	0.0472%	0.1208%	0.2147%	0.3278%	0.5232%	0.8208%	1.2167%	1.9321%	2.9215%	4.4025%	6.3560%	8.8870%	12.8957%	18.7290%	25.4703%	33.9886%	48.5950%

Annex 2: fedafin's Idealized Annual Cumulative Default Probability Benchmark

	Aaa	Aa+	Aa	Aa-	A+	A	A-	Baa+	Baa	Baa-	Ba+	Ba	Ba-	B+	B	B-	C
1	0.0026%	0.0056%	0.0097%	0.0171%	0.0279%	0.0448%	0.0738%	0.1261%	0.2531%	0.3995%	0.6187%	0.9368%	1.5410%	2.9819%	5.6459%	11.6273%	27.7188%
2	0.0065%	0.0140%	0.0247%	0.0428%	0.0691%	0.1136%	0.1835%	0.3175%	0.5946%	0.9348%	1.4201%	2.1096%	3.4207%	6.2961%	11.1510%	20.8301%	44.8133%
3	0.0123%	0.0264%	0.0467%	0.0787%	0.1264%	0.2078%	0.3293%	0.5676%	1.0084%	1.5769%	2.3674%	3.4698%	5.5386%	9.7498%	16.3389%	28.2391%	55.6502%
4	0.0205%	0.0440%	0.0773%	0.1263%	0.2016%	0.3286%	0.5115%	0.8711%	1.4844%	2.3065%	3.4321%	4.9753%	7.8125%	13.2161%	21.1366%	34.3047%	62.7584%
5	0.0318%	0.0680%	0.1178%	0.1868%	0.2962%	0.4768%	0.7301%	1.2243%	2.0161%	3.1098%	4.5904%	6.5901%	10.1770%	16.6133%	25.5275%	39.3505%	67.6109%
6	0.0469%	0.0995%	0.1695%	0.2615%	0.4114%	0.6531%	0.9848%	1.6239%	2.5985%	3.9757%	5.8226%	8.2829%	12.5810%	19.8917%	29.5252%	43.6109%	71.0721%
7	0.0664%	0.1396%	0.2336%	0.3515%	0.5480%	0.8578%	1.2753%	2.0669%	3.2274%	4.8950%	7.1115%	10.0274%	14.9857%	23.0227%	33.1572%	47.2570%	73.6541%
8	0.0912%	0.1895%	0.3111%	0.4579%	0.7068%	1.0912%	1.6009%	2.5508%	3.8989%	5.8596%	8.4426%	11.8014%	17.3623%	25.9921%	36.4566%	50.4155%	75.6637%
9	0.1220%	0.2501%	0.4031%	0.5815%	0.8883%	1.3531%	1.9606%	3.0729%	4.6093%	6.8622%	9.8031%	13.5864%	19.6899%	28.7953%	39.4573%	53.1811%	77.2878%
10	0.1595%	0.3226%	0.5105%	0.7232%	1.0930%	1.6434%	2.3535%	3.6307%	5.3550%	7.8962%	11.1823%	15.3676%	21.9539%	31.4334%	42.1915%	55.6255%	78.6425%