BlackRock Solutions CMBS Modeling Framework

BlackRock Solutions uses a bottom-up approach to analyzing CMBS, built on loan-level data and a forward-looking deterministic modeling framework

- BlackRock Solutions sources data directly from CMBS servicers and trustees, reviewing monthly loan information for data errors and qualitatively reviewing property financials quarterly to assess whether reported data reflects property risk profiles
- Forward-looking real estate assumptions, combined with a deterministic credit loss model project outcomes for each loan backing a CMBS trust under multiple scenarios
- Loan-level loss outcomes are passed through Trepp's waterfall engine to generate bond-level cashflows, which BlackRock Solutions uses to estimate CMBS intrinsic valuations, loss projections and related security-level analytics

**Loan & Property Database**
- Comprehensive CMBS deal database comprised of over 800 CMBS deals secured by ~50k loans and covering ~75k properties
- Data directly sourced from issuers, master servicers, and trustees and loaded on a real-time basis
- Data reviewed monthly to check for inconsistencies in servicer reporting
- Complex loan capital structures modeled correctly

**Loan-Level Underwriting & Review**
- Review process creates a starting point for forward-looking modeling by incorporating property-level risk attributes
- Underwriting and surveillance process incorporates both property-specific and market data
- Quantitative loan review includes designation of a Property Score and evaluation of market level data

**Rent & Vacancy Projections**
- Regression based framework that establishes the link between rents and vacancies and their macroeconomic drivers
- Discrete Market and Property Type level forecasts by scenario
- Utilizes actual rent roll data where available
- DCF / Terminal Cap based property valuation

**Property Cash Flow Model**
- Framework utilizes rent and vacancy projections and incorporates rent roll data to model lease rolls, renewals, and dark periods to arrive at monthly property level revenue and expense projections

**Loan Cash Flow Model**
- Deterministic credit model projects loan outcomes across scenarios
- Term and Maturity Default triggers
- Prepayment and extension parameters
- Workout period with servicer advancing assumptions
- Liquidation costs and loss severity calculations
- Loan outcomes and loss estimates are vetted through a monthly credit review process

**CMBS Deal Waterfall**
- Deal collateral and tranche level cash flows across scenarios
- Deal level collateral loss
- Tranche cashflows and analytics including principal loss, interest shortfalls, weighted average life, option adjusted spread, yield, and duration

**SPEAR**
- Real-time market and property level data
- Regression based framework that establishes the link between rents and vacancies and their macroeconomic drivers
- Discrete Market and Property Type level forecasts by scenario
- Utilizes actual rent roll data where available
- DCF / Terminal Cap based property valuation

**CMBS Cash Flows & Analytics**
- Deal collateral and tranche level cash flows across scenarios
- Deal level collateral loss
- Tranche cashflows and analytics including principal loss, interest shortfalls, weighted average life, option adjusted spread, yield, and duration

**Trepp® SPEAR**
- Deal collateral and tranche level cash flows across scenarios
- Deal level collateral loss
- Tranche cashflows and analytics including principal loss, interest shortfalls, weighted average life, option adjusted spread, yield, and duration
BlackRock Solutions maintains its own database of commercial mortgage and property information backing US CMBS transactions

- All loan- and bond-level analysis and projections are derived using this data
- The initial dataset is aggregated from the original offering documents
- Updates are sourced directly from CMBS servicers and trustees on a monthly basis
- The dataset includes > 800 CMBS transactions, comprised of ~50k loans and ~75k properties

The BlackRock Solutions CMBS database is organized to relate multi-note loan structures with underlying properties and reported financials

Property and loan data are reviewed period-over-period and versus issuance to assess any potential servicer reporting errors or data ambiguities

### Examples of BlackRock Solutions CMBS Loan Database Structure & Process

<table>
<thead>
<tr>
<th>Data</th>
<th>BlackRock Solutions Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan Capital Structure</td>
<td>- BlackRock Solutions manually maps the capital stacks for all multi-note loans included in CMBS trusts from original Offering Documents</td>
</tr>
<tr>
<td></td>
<td>- Tie-out of note/loan information to capture and attribute property cash-flows on complete loan capital structures</td>
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<tr>
<td></td>
<td>- Identify cross-default provisions with associated loans / ‘notes’</td>
</tr>
<tr>
<td>Financial Reporting</td>
<td>- Partial-year financials reported by servicers are compared to prior reported periods to determine whether the amounts reported are annualized, partial or errant</td>
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<tr>
<td></td>
<td>- BlackRock Solutions identifies the controlling servicer for multi-note loans (dubbed the “Paymaster”) and uses its financial reporting for all notes associated with the unique underlying property(s)</td>
</tr>
</tbody>
</table>
BlackRock Solutions performs a qualitative review of large loans along with any other loans meeting certain review criteria (e.g. delinquent or specially serviced loans)

- All other loans undergo a quantitative vetting process

**Loan review process assesses the reasonableness of servicer reported information to account for the following:**

- Stale or dated income information (e.g. income reporting 9 – 12 months old) or partial year reporting
- Recent credit events that may materially alter property values (e.g. tenant/sponsor bankruptcy)
- Idiosyncratic credit characteristics (e.g. credit tenant or ground leases, environmental issues)

**Loan reviews create a starting point for forward-looking modeling by incorporating property-level risk attributes, which are not captured by static income reporting**

As a final step, loan outcomes are reviewed for consistency with underwriting inputs

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**Loans for Qualitative Review**

- Large loans by balance or % of deal
- Loans meeting other review criteria
  - Loans moving in/out of Special Servicing
  - Delinquent or REO loans
  - Loans with deteriorating financials
  - Newly modified

**CRE Professionals**

- Review disclosure documents
- Assess recent financials and servicer commentary
- Research tenancy and sponsor developments
- Review market specific developments

**Outputs from Loan-Level Review**

- BlackRock Solutions underwritten cashflows are used as the starting point for all performance forecasting
- Property grades for location, size and property condition
- Model valuations are reviewed for reasonableness
Property-level Cap Rate and NCF projections vary by scenario and are used to estimate loan outcomes.

NCF Generation Process

**Property-Level Data**
- Recently reported income and operating history

**CRE Projections**
- BlackRock Solutions leverages third party data on historical rent and vacancy rates as well as market discount and cap rates
- BlackRock Solutions econometrically forecasts rent and vacancy at the market and property type level

**BlackRock Solutions Commercial Real Estate Professional Review**
- Analysis and review of forecast information
- Review of property level data and outcomes

**NCF Curves**
- BlackRock Solutions underwritten cashflows are used as the starting point in forecasts
- NCF curves project property income and value across multiple scenarios
- Capitalization rates are applied to NCF projections to determine property valuations over time

**Illustrative NCF Growth Curves**
BlackRock Solutions employs a forward-looking deterministic credit model to estimate loan-level outcomes. Major assumptions and credit model parameters include the following:

### Primary Deterministic Model Parameters

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rent and Vacancy</strong></td>
<td>- MSA and property-type based projections of property-level performance through time</td>
</tr>
<tr>
<td><strong>Discount rates and cap rates</strong></td>
<td>- Cap rate curves (term structure) by MSA and property type&lt;br&gt;- Adjusted by property grades to account for individual property location and quality&lt;br&gt;- Combined with income projections to determine property value</td>
</tr>
<tr>
<td><strong>Property grades</strong></td>
<td>- Individually assigned grades based on location, condition and size&lt;br&gt;- Used to adjust cap rates to account for individual property quality</td>
</tr>
<tr>
<td><strong>DSCR default trigger</strong></td>
<td>- Monthly test that results in a term default if DSCR and LTV cross threshold levels&lt;br&gt;- Triggers are property type based</td>
</tr>
<tr>
<td><strong>Loan extensions</strong></td>
<td>- Loans are extended at maturity if LTV falls within a defined band</td>
</tr>
<tr>
<td><strong>Loan prepayment</strong></td>
<td>- Loans are prepaid during their open period if LTV and Debt Yield falls within specified levels</td>
</tr>
<tr>
<td><strong>Workout period</strong></td>
<td>- Time to resolution after a term or maturity default&lt;br&gt;- Period length based on loan size and jurisdiction (by State)</td>
</tr>
<tr>
<td><strong>Liquidation costs</strong></td>
<td>- Percentage of property value at liquidation</td>
</tr>
<tr>
<td><strong>Servicer reserves</strong></td>
<td>- Reserves held by the servicer are used to fund debt service payment shortfalls if income drops below the DSCR threshold</td>
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</tbody>
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Income growth curves and cap rates are stressed across scenarios.
Loan outcomes are determined by a series of DSCR and LTV tests over time.

**Loan Outcome Logic Tree**

- **Term Default**: DSCR < Default Triggers at any point during initial term of loan extension
- **Pay off at original maturity**: LTV < Pay-off LTV requirement
- **Default at original maturity**: LTV > Extension LTV limit at original maturity
- **Extension at original maturity**: LTV between extension LTV bounds at original maturity
- **Default at extension maturity**: LTV > Refinance Threshold at extension maturity

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(1) DSCR tests are run throughout the extended lifetime of the loan. If a DSCR test fails, the loan will go into default.
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