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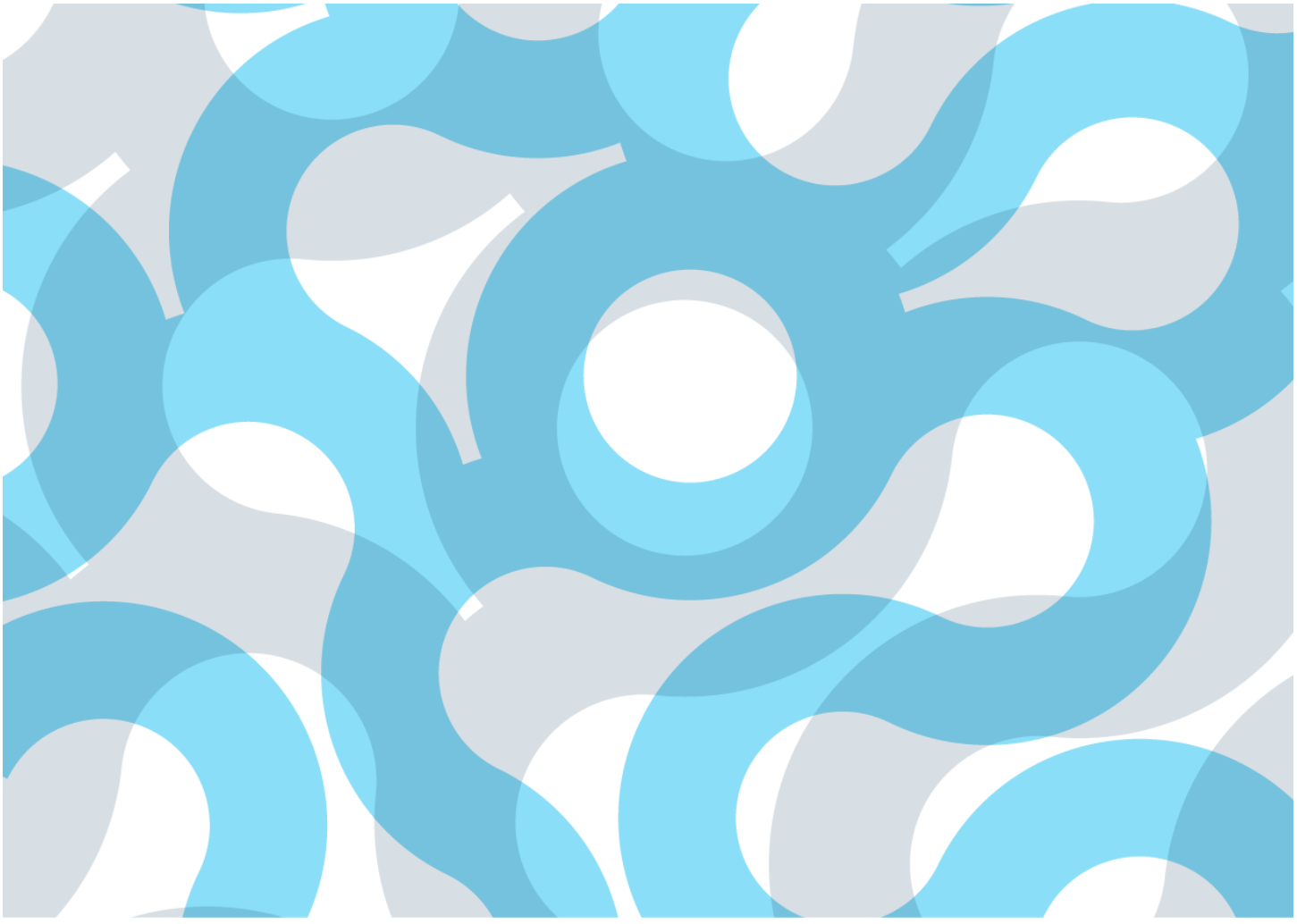
BlackRock Solutions CMBS Credit Model

June 2017



Introduction

OVERVIEW

The BlackRock Solutions ("BRS") CMBS Modeling framework is a comprehensive analysis, reporting, and surveillance framework for Non-Agency US Commercial Mortgage Backed Security ("CMBS") transactions secured by Commercial Real Estate ("CRE") assets. Freddie Mac K deals are also covered by framework. The framework encompasses the entire end-to-end process necessary for analyzing CMBS deals from deal onboarding and data scrubbing, to property underwriting and review, to forecasting property- and loan-level cash flows, to ultimately producing CMBS deal and tranche-level analytics and cash flows across macroeconomic scenarios.

The framework leverages BRS's extensive data and analytical capabilities, utilizing a platform that encompasses a proprietary loan and property database, augmented by expert analysis from CRE professionals, and an industry-leading, fundamentally driven, simulation-based credit modeling framework to appropriately model the performance characteristics and risks associated with investments in commercial real estate assets.

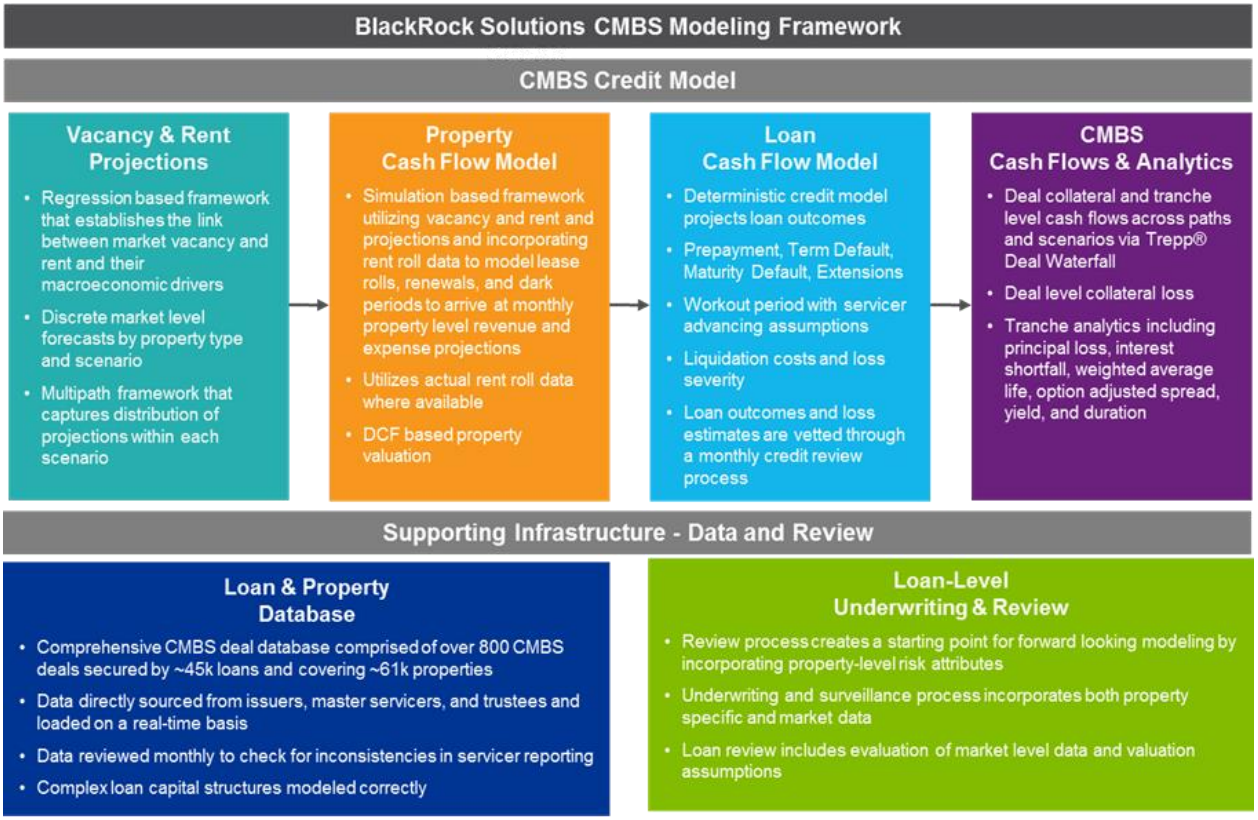
The core analytical engine is the BRS CMBS Credit Model, which simulates property-level performance along with deterministic loan-level outcome modeling to project loan performance while accounting for idiosyncratic and tail risks. This methodology is applied across a range of macro scenarios, and within each scenario, across a series of model simulation paths for each property/loan underlying a CMBS transaction. The result is a full spectrum of property and loan performance projections that accurately depict central tendencies as well as capturing tail events.

The loan-level outcomes across model simulation paths within each scenario are passed through the Trepp CMBS waterfall engine to generate scenario-specific collateral and tranche cash flows and losses

MODEL OBJECTIVE

The BRS CMBS Credit Model is designed to assess credit risk across all US Non-Agency CMBS and Freddie Mac K deals by assessing (1) systematic risks associated with the macroeconomic drivers and market-level vacancy and rent, as well as (2) property-level idiosyncratic risks associated with individual property performance and tenant lease structure.

The graphic below highlights the components of the BRS CMBS framework and the interaction between them.



Data Infrastructure and Review

LOAN AND PROPERTY DATABASE

The starting point for the CMBS modeling framework is the BRS Loan and Property Database, which covers all Non-Agency US CMBS transactions as well as Freddie Mac CMBS transactions, both Legacy (Pre-Crisis) and Post-Crisis. The database contains detailed information that is critical in the modeling process of upwards of 800 US CMBS deals, backed by 45,000 loans and more than 60,000 properties. Crucially, the database also maintains the complex relationships that exist between all these pieces of data, including complex multi-note loan structures.

Examples of BlackRock Solutions CMBS Loan Database Structure & Process

Data	BlackRock Solutions Structure
Loan Capital Structure	• BlackRock Solutions manually maps the capital stacks for all multi-note loans included in CMBS trusts from original Offering Documents • Tie-out of note/loan information to capture and attribute property cash-flows on complete loan capital structures • Identify cross-default provisions with associated loans / 'notes'
Financial Reporting	• Partial-year financials reported by servicers are compared to prior reported periods to determine whether the amounts reported are annualized, partial or errant • 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)

LOAN-LEVEL UNDERWRITING AND REVIEW

As part of the onboarding and monthly update process, BRS uses information from the original deal documents and from the monthly servicer reporting to create rent rolls and operating statements for all properties across the covered CMBS universe. The rent rolls and operating statements form the foundation of the property cash flow model. During this process, BRS reviews servicer data files for reporting issues and quality assurance.

Supporting the database and modeling framework is a team of dedicated CRE professionals who ensure that the data being used in the model is up to date and accurate, as high-quality data is essential to producing meaningful results in any modeling framework. As such, BRS employs a hybrid quantitative / qualitative loan review process that incorporates information gathered by CMBS servicers and trustees, publicly available information, and third-party and proprietary research.

Model Methodology

CMBS CREDIT MODEL BACKGROUND

Historically, CMBS models have generally taken one of two approaches: either a fundamentally-driven deterministic model in which property cash flow and value projections are applied against loan terms to determine discrete loan outcomes, or a probabilistic model which projects default and loss vectors based upon historically observed data. In designing the enhanced version of the CMBS Credit Model, BRS sought to leverage the strengths of both model types by developing a hybrid model that incorporates elements of both deterministic and probabilistic models. The result is a enhanced methodology leveraging a lease level Monte Carlo simulation incorporating econometric vacancy and rent projections to model property performance (cashflow and valuation), the outputs of which are used in a deterministic framework to model discrete loan outcomes, which are then used to derive collateral and tranche cash flows.

The econometric and simulation components model a property's income and value by generating a range of vacancy and rent projections and simulating tenant lease renewal decisions over each projection period. Projected loan performance is then assessed as to whether the property generates (1) sufficient net cash flow to cover debt service payments during the loan term or future value appreciation which justifies interim sponsor support through debt service deficiency payments and (2) sufficient value on the maturity date of the loan to retire the debt. This model has numerous advantages over more traditional models, including:

- Assessing property-level idiosyncratic risks associated with lease rollovers
- Incorporating property-level CRE analysis, underwriting, and review
- Incorporating macroeconomic factor inputs across a variety of scenarios
- Better capturing of property-level tail risks associated with tenant leasing behavior

MODEL METHODOLOGY OVERVIEW

The CMBS Credit Model is composed of four key components:

- **Component 1:** Vacancy and Rent Projections
- **Component 2:** Property Cash Flow Modeling
- **Component 3:** Loan Cash Flow Modeling
- **Component 4:** CMBS Cash Flows and Analytics

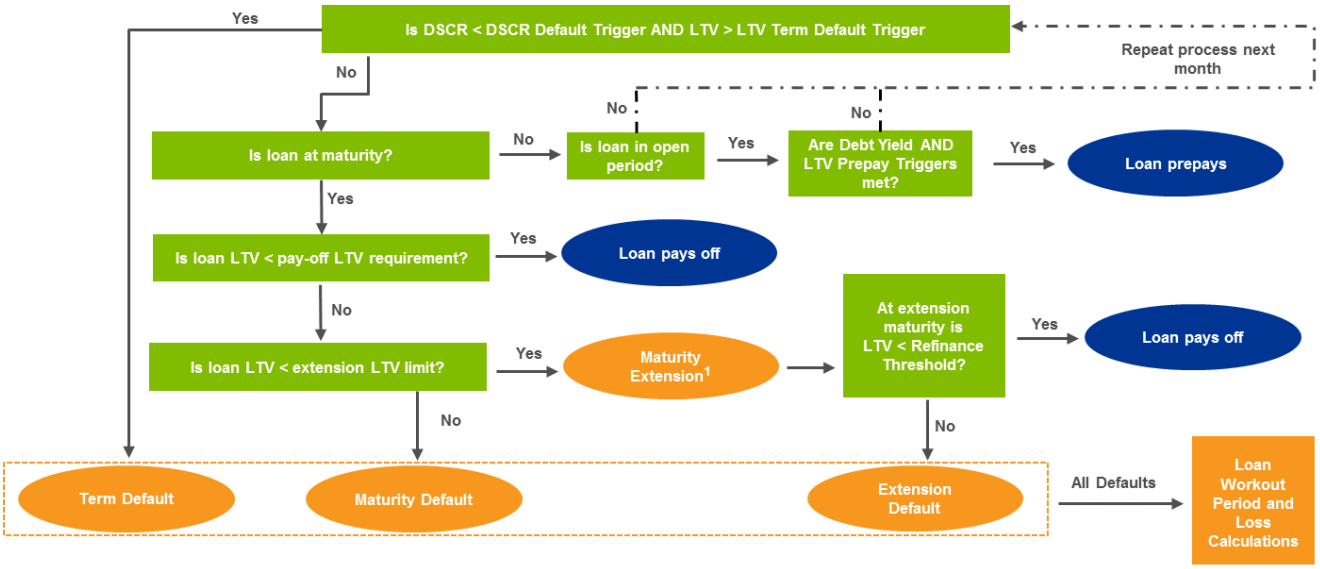
	Component 1	Component 2	Component 3	Component 4
	Vacancy & Rent Projections	*Property Cash Flow Modeling*	*Loan Cash Flow Modeling*	*CMBS Cash Flows and Analytics*
	Econometric Simulation	Tenant-Level Simulation	Deterministic Loan Outcome Model	Waterfall Model
Description	• Regression framework to generate forward vacancy and rent forecasts for each market and property type pair	• Property cash flow modeling including simulation of lease renewals	• Deterministic framework to determine loan outcomes and cash flows	• CMBS waterfall model used to calculate deal collateral level and tranche level cash flows and analytics
Input	• Historical Vacancies and Rents • Macroeconomic Factors (employment, income, etc.)	• Rent and vacancy projections from Component 1 • Synthetic Rent Roll • Synthetic Operating Statement	• Property cash flow and value projections from Component 2	• Loan cash flows and outcomes from Component 3
Output	• Vacancy and Rent projections for all model simulation paths across all scenarios	• Property cash flow and value projections for all model simulation paths across all scenarios	• Loan cash flows and outcomes for all model simulation paths across all scenarios	• Deal and tranche level cash flows and analytics for each scenario

An outline of the methodology follows.

Component 1, the Vacancy and Rent Projections, was derived using an econometric model based on a regression framework that establishes a link between market vacancy/rent levels and national and local economic factors such as Employment, Income, and CRE Supply (Stock). Projections are generated for each Market and Property Type Pair ("M/PT Pair"), for example New York Office, within a deal. The levels of the macroeconomic factors vary by scenario (e.g., different projections of employment growth across base and stress scenarios). The econometric estimations of vacancy and rent in Component 1 also contain a random deviance factor to give rise to a simulation framework where a series of vacancy and rent paths are projected for a given set of macroeconomic projections ("model simulation paths") in each scenario.

Component 2 of the model, Property Cash Flow Modeling, utilizes the market-level vacancy and rent vectors produced by Component 1, in conjunction with an additional level of simulation around property-specific tenant-level lease renewals based on property rent rolls, to determine projections of property-level occupancy and rent. The incorporation of tenant-level simulation across model simulation paths further helps capture the distribution of possible outcomes and idiosyncratic events inherent in commercial real estate assets. Using these property-level occupancy projections, the market-level rent forecasts from Component 1, and the operating statement, forecast are generated for monthly property-level revenue items (e.g., gross rent, expense reimbursements, etc.) and expense items (e.g., taxes, insurance, management fees, etc.) to derive property cash flows. Property values are then calculated using a discounted cash flow methodology.

Component 3 of the model, Loan Cash Flow Modeling, utilizes the property cash flow and value projections from Component 2 to calculate loan-level metrics such as LTV and DSCR by applying the property-level projections against the loan terms. A series of deterministic tests is then conducted over the term of the loan to determine the loan outcome and the corresponding timing. Possible loan outcomes include payoff at maturity, prepayment, and term or maturity default with an associated workout period and ultimate liquidation/loss calculation. A loan outcome is generated for every loan in the transaction, in every simulation path across all scenarios. The range of loan outcomes across paths and scenarios helps capture the wide distribution of potential outcomes. The figure below illustrates the various branches of the loan credit model decision tree.



(1) Term Default tests are run throughout the extended lterm of the loan. If a test fails, the loan will term default

In Component 4 of the model, the loan-level outcomes from Component 3 are aggregated and passed through the Trepp deal waterfall structure to derive deal- and tranche-level cash flows. Cash flows are averaged across model simulation paths within each scenario to arrive at a final set of tranche cash flows by scenario. Finally, the BRS analytics engine is used to calculate tranche-level analytics such as weighted average life, yield and duration.

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