

Calculation Models for the Investment Portfolio's Mark-to-Market Effect on Other Comprehensive Income

BNY Mellon Corporate Treasury
Interest Rate Risk Group

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List of Acronyms

- AFS – Available For Sale
- ALCO – Asset and Liability Committee
- ALM – Asset Liability Management Group
- APD – Active Passive Decomposition
- BHC – Bank Holding Company
- BFV – Bloomberg Fair Value
- BSP – Balance Sheet Planning
- BVAL – Bloomberg Valuation
- CCAR – Comprehensive Capital Adequacy Review
- CCR – Current Coupon Rate
- DFAST - Dodd-Frank Act Stress Testing
- DUS – Delegated Underwriting and Servicing
- EVE – Economic Value of Equity
- FAS – Financial Accounting Standards
- FASB – Financial Accounting Standards Board
- FHFA – Federal Housing Finance Authority
- GO – General Obligation
- EVE – Value Of Equity
- HPI – Housing Price Index
- HTM – Hold To Maturity
- HQLA – High Quality Liquid Asset
- HUD – Department of Housing and Urban Development
- IDC – Interactive Data Corporation
- IRR – Interest Rate Risk
- NII – Net Interest Income
- OAS – Option Adjusted Spread
- OCI – Other Comprehensive Income
- OCIVC – Other Comprehensive Income Valuation Committee
- OTTI – Other than Temporarily Impaired
- QRM – Quantitative Risk Management (Treasury Management System)
- RWA – Risk Weighted Asset
- WAL – Weighted Average Life
- WAM – Weighted Average Maturity

1. Overview

1.1 Introduction to Other Comprehensive Income and its Role in CCAR

1.1.1 Other Comprehensive Income (OCI)

Other Comprehensive Income (OCI) is the difference between net income on the Income Statement and Comprehensive Income¹, and represents the certain gains and losses of the firm not recognized on the Income Statement (P&L Account). OCI enables a more expansive view of net income, in which changes to a firm's profits that are deemed to be outside its core operations are permitted to flow through to shareholders' equity.

The United States Financial Accounting Standards Board (FASB) issued Statement on Financial Accounting Standards No. 130, Reporting Comprehensive Income (FAS 130) in 1997. All income statement items under FAS 130 are to be reported either as a regular line item in the income statement, or a special line item as other comprehensive income.

OCI consists of the following items:

- Unrealized gains and losses on Available-For-Sale securities (see IAS 39/ "FAS 115" - "Accounting for Certain Investments in Debt and Equity Securities")
- Gains and losses on derivatives held as cash flow hedges (only for effective portions, see IAS 39/ "FAS 133" - "Accounting for Derivative Instruments and Hedging Activities")
- Actuarial gains and losses on defined benefit plans recognized (Minimum pension liability adjustments, see IAS 19/ "FAS 158" - "Employers' Accounting For Defined Benefit Pension And Other Postretirement Plans")
- Changes in the revaluation surplus (see IAS 16 and IAS 38)

1.1.2 Comprehensive Capital Adequacy and Review (CCAR)

The Comprehensive Capital Adequacy and Review (CCAR) is performed annually by the Federal Reserve to assess whether a US Bank Holding Company (BHC) has adequate capital for the continuity of operations in the event of economic and financial stress, and that the processes are in place to assess their capital requirements. CCAR requires a BHC to

¹ the sum of net income and other items that bypass the income statement as they have not been realized

comprehensively identify the full range of relevant risks in its exposures and business mix including those risks which may only become evident under stress.

BHC's are expected by the Federal Reserve to:

- have sufficient capital to continue operations
- maintain access to funding
- meet obligations to creditors and counterparties
- serve as credit intermediaries, and
- demonstrate robust, forward-looking capital-planning processes for their individual risks

The CCAR quantitative assessment is based on the results of a BHC's internal stress tests under supervisory scenarios, internally designed scenarios and post-stress capital ratios as estimated by the Federal Reserve (CCAR supervisory post-stress capital analysis).

The supervisory projections are conducted under three hypothetical macroeconomic and financial market scenarios developed by the Federal Reserve: baseline, adverse, and severely adverse supervisory stress scenarios. The internal scenario stress tests are conducted using at least one stress scenario developed by the BHC (BNY Mellon idiosyncratic stress scenario).

The CCAR post-stress capital analysis is based on the estimates of losses, revenues, balances, risk-weighted assets, and capital from the Federal Reserve's supervisory stress test conducted under the Dodd-Frank Act Stress Testing (DFAST)².

For CCAR, BHC's are also required to submit a capital plan that is approved by the BHC's board of directors and that is supported by the BHC's internal capital adequacy assessment and capital planning processes. A capital plan also includes pro forma analyses. One component BHCs should include in their pro forma estimates is OCI.

In the context of CCAR, OCI is the sum of incremental quarterly changes in unrealized losses/gains on AFS securities, and on any HTM securities that have experienced other than temporary impairment, net of taxes. The market value at each of the nine future states includes

² The Dodd-Frank Act Stress Testing (DFAST) is a complementary exercise to CCAR, and is a forward-looking component conducted by the Federal Reserve to assess whether an institution has sufficient capital to absorb losses and to support operations during adverse economic conditions.

the outstanding beginning portfolio balance, and the new portfolio balance. The new portfolio balance includes the existing portfolio at the future state, any portfolio reinvestment, and a forward hypothetical portfolio that is a component of the BNY Mellon CCAR balance sheet forecast.

The difference in market value between the current and future investment portfolios is also a function of changes in future interest rate and macro-economic factors. The Federal Reserve publishes these macro-economic factors, and they include exchange rates, credit spread shocks, mortgage rates and housing price index (HPI). BHCs should project OCI, and the effect of changes in accumulated OCI on capital, under each requested scenario in a manner consistent with the phasing-in of the revised capital requirements over the nine-quarter planning horizon³.

1.2 Revisions to OCI Calculations for CCAR 2016

BNY Mellon continuously reviews its processes for capital and planning analysis with the goal to optimize the process and increase accuracy of the results. For 2016 and pursuant to guidance from the Federal Reserve⁴, a steering committee chaired by Corporate Treasury and comprised of members from the CFO and CRO teams was formed to review the OCI calculation process, enhance the fair value estimation framework, ensure alignment with objectives and streamline communication between interested parties and the Federal Reserve. A working group met twice weekly to review progress, agree on next steps, exchange knowledge and escalate issues to Corporate Treasury group leadership.

1.3 OCI Calculation Enhancement 2016 Project Scope

The project's scope was the BNY Mellon Investment Portfolio in which assets are split between Available-for-Sale and Hold-to-Maturity. The model to calculate OCI for CCAR was enhanced based on sound assumptions that can be clearly explained and were properly supported using empirical evidence wherever possible. A detailed segmentation of the investment portfolio by asset class, sub-asset class, credit rating and other risk factors was developed. Market data was a core component of the model and was aligned with identified asset parameters and adequately supported. Per expectations, market data was primarily sourced externally; internal

³ Refer to the Appendix for an illustration of an OCI calculation

⁴ Refer to the Appendix for guidance from the Federal Reserve

data filled any gaps.

In order to mitigate the risk, a focus was placed on documentation. New methodologies were fully documented and time allotted for management reviews and challenges. Additionally, documentation defined governance, ownership and controls, methodology for review and feasibility of implementation.

1.3.1 Calculation and Governance Framework Enhancements 2016

BNY Mellon engaged a third party with proven success in the CCAR/Stress Testing arena for producing benchmark OCI projections. . The primary-benchmark comparisons allows for review of progress and validation of assumptions while providing BNY Mellon exposure to best practices employed by peer organizations.

BNY Mellon will continue to improve the governance structure that oversees the OCI modeling team. These improvements for 2016 included a newly created Asset and Liability Committee (ALCO) sub-committee with representatives from the Treasury, Market Risk, and Model Validation teams.

1.3.2 Action Plan for 2016 OCI Calculation Enhancements

To adequately capture specific risks inherent in it, BNY Mellon segmented the investment portfolio. The teams assessed each segment's materiality and the feasibility of the QRM calculation framework given increased granularity. Further, the teams sourced the historical data by segment. This included establishing data requirements, finalizing the segmentation and working to identify the best data sources and vendors for this data. This led to development of a process for the capture, parsing, cleaning, archiving and sharing of the data sets.

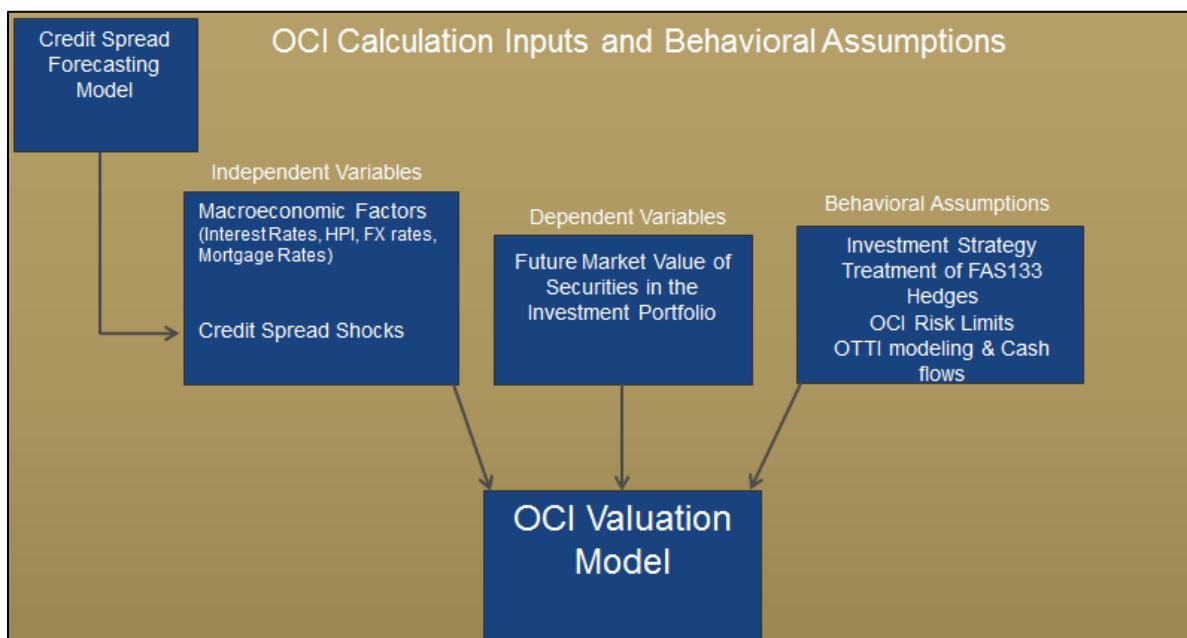
Statistical approaches and OCI calculation models were enhanced by developing primary and benchmark frameworks to project the spreads using forecasted economic variables. Macroeconomic variables were chosen by their effect on the future market valuation. Final steps for this year's enhancement included the validation and documentation of the framework.

2. Design Methodologies

2.1 Overview

OCI is one component of the pro forma analysis that will be included in the capital plan as part of the requirements for CCAR. In the context of CCAR, OCI is the sum of incremental quarterly changes in unrealized losses/gains on AFS securities, net of taxes. It is also calculated on any HTM securities that have experienced other than temporary impairment (OTTI) also net of taxes and OTTI. BHCs are required to project OCI, and the effect of changes in accumulated OCI on capital, under each requested scenario, in a manner consistent with the phasing-in of the revised capital requirements over the nine-quarter planning horizon⁵.

The market value at each of the nine future states includes the outstanding beginning portfolio balance, and the investment strategy (reinvestment of securities, sales and/or purchases of new securities), consistent with the BNY Mellon CCAR balance sheet forecast. The market value is a function of future balances, yield curves and projected spreads as well as particular security characteristics (coupon, maturity, prepayment, etc.). The figure below illustrates the overall structure of the process.



⁵ Refer to the Appendix for an illustration of an OCI calculation

The primary macroeconomic risk factors to the investment portfolio are independent variables and inputs into the OCI Valuation Model. The Federal Reserve publishes these macro-economic factors, and the relevant inputs to the OCI model include interest rates, exchange rates, mortgage rates and the housing price index (HPI)⁶. BNY Mellon engaged Moody's Analytics to provide detailed interpolations for these factors. ALM-IRR used the Credit Spread Forecasting model⁷ to create credit spread shocks that were also fed as independent variables into the OCI valuation model (see Figure 1 above). For the Credit Spread Forecasting Model, representational asset classes were segmented as finely as possible in order to accurately model their reactions to future market changes. BNY Mellon followed a four step process to ensure that the segmentation was complete across all asset classes. Historical spreads for these segments were loaded as dependent variables into the Credit Spread Forecasting Model for regression and to create the credit spread shocks for the OCI Valuation Model.

The stress scenarios reflect the firm's unique vulnerabilities to factors that affect its firm wide activities and risk exposures, including macroeconomic, market-wide, and firm-specific events. These scenarios are based on factors such as the business model, the mix of assets and liabilities, the geographic footprint, any portfolio characteristics, and the revenue drivers.

The foundation of the OCI Valuation Model is the QRM Balance Sheet Model. Reinvestments, growth and sales were incorporated into the QRM Balance Sheet Model, as were assumptions to synchronize cash flow with OTTI Modeling,⁸ the current treatment of FAS133 hedges and the tax rates across BNY Mellon's foot print. This Balance Sheet Model formed the base for the OCI Valuation model that then projected the future market valuations and calculated the OCI.

BNY Mellon maintains a governance structure and validation process that is continually updated and analyzed against the primary and benchmark framework to ensure the optimization of analysis.

⁶ Refer to the Appendix for background on QRM's methodology

⁷ Refer to section 2.5 for details on its design

⁸ BHCs are required to test all credit-sensitive Available-for-Sale (AFS) and Held-to-Maturity (HTM) securities for potential other-than-temporary impairment (OTTI) regardless of current impairment status. The threshold for determining OTTI for structured products is based on cash-flow analysis and credit analysis of underlying obligors.

2.2 Primary Macroeconomic Risk Factors

BNY Mellon's Investment Portfolio has the following primary macroeconomic risk exposures.

Interest Rate Risk (IRR) is the risk that an investment's value will change due to a change in the absolute level of interest rates, in the spread between two rates, in the shape of the yield curve, or in any other interest rate relationship. This is typically modeled as the respective risk free yield curve or swap curve for a given currency, depending on market convention.

Option Adjusted Spread/Prepayment (OAS) is the risk associated with the early unscheduled return of principal on a fixed-income security. Some fixed-income securities, such as MBS, have embedded call options which may be exercised by the issuer, or in the case of a mortgage-backed security, the borrower. BNY Mellon's MBS Pass-through, CMO and RMBS portfolios were modeled against Option-Adjusted-Spreads (OAS). Prepayments for these portfolios are often driven by changes in mortgage rates, which causes consumers to refinance their mortgages. A key input into the OCI valuation is the 30Y Mortgage rate forecast provided by the Federal Reserve.

Credit Spread (CS) is the spread between the risk free yield on default free securities (for example, Treasuries for USD denominated securities) and those securities which do carry some risk of default. BNY Mellon's Investment Portfolio assets that have credit spread exposure include the non-Agency RMBS portfolios, municipal bonds, covered bonds, structured securities (ABS, CMBS, and CLO), agency debentures and corporate bonds. Sovereign bonds excluding U.S. Treasury, U.K, Germany and Singapore Sovereign bonds are also considered credit sensitive. BNY Mellon created credit spread shocks using granular segmentation of representational asset classes and a credit spread forecasting model⁹.

Foreign exchange (FX) risk exists when a financial transaction is denominated in a currency other than that of the base currency of the firm.

⁹ Please refer to sections 2.3, 2.4 and 2.5 for details.

Housing Price Index (HPI) Risk is the risk that changes in housing prices can affect the value of the mortgage portfolio for certain BHC's. The HPI forecast is provided by the Federal Reserve.

2.3 The Granular Segmentation of Credit Spread Projections

BNY Mellon's Portfolio Management Group manages the liquid assets on Corporate Treasury's Balance Sheet. This portfolio hedges interest rate risk, maintains a liquidity buffer and seeks to maximize yield through a portfolio of fixed income and other securities. The investment portfolio operates within the firm's operational, market and credit risk frameworks and is subject to risk limits defined in the Firm's risk policies. Ongoing portfolio reviews assess liquidity, rate of return, valuation, creditworthiness and duration. Sources of funds are fungible and include, without limitation, deposits, term debt and repurchase agreements. Composition of the portfolio is governed by the Fixed Income Portfolio Committee, the Asset and Liability Committee (ALCO) and Corporate Treasury with oversight from BNY Mellon's Board of Directors.

Portfolio activity is fully documented to support all risk, accounting and regulatory requirements. Documentation included support for portfolio segmentation (AFS vs HTM), asset class designation and appropriate reference data.

Assets are limited to:

- U.S. Treasury and U.S. Government Agency Securities
- Securities of the Government Sponsored Enterprises
- Corporate Bonds and Obligations
- Municipal Securities
- Money Market Instruments
- Foreign Sovereign and Supranational Organization Debt
- Covered Bonds
- Non-Agency RMBS
- CLOs, CMBS and consumer ABS
- Asset backed commercial paper

2.4 The Four Step Process for Segmenting Risk within Asset Classes

When segmenting securities within asset classes, BNY Mellon applied its four step process to ensure granularity assesses risk appropriately and rational spread modeling was applied, thereby focusing resources on critical exposure that could affect capital. Risk that could not be modeled was a candidate for liquidation.

Step 1: GRANULARITY

Dodd Frank Act and CCAR Stress Testing require that the Investment Portfolio's risk profile is sufficiently detailed to support model development, baseline assumptions and documentation in accordance with supervisory expectations. Each asset class was thoroughly vetted to understand its inherent market and product risks. Individual risk positions were disaggregated by the following criteria (where appropriate):

Criteria for Disaggregating Risk at a Granular Level (Table 2.3A)		
Rating	Remaining life and/or Duration	Currency
Collateral	Valuation Base Rates	Domicile
Year of Issue	Level within the Capital Structure	Original Term

Investment Portfolio transactions were recorded in the firm's trade and portfolio risk management system, Aladdin. Asset reference data, including credit ratings from S&P, Moody's and Fitch, were sourced independently from Blackrock.

Step 2: CONSOLIDATION BASED ON MATERIALITY

Asset spreads were modeled at their most detailed level where possible. However, immaterial risk exposure and other idiosyncratic considerations may have resulted in risk exposures being modeled at a consolidated level when necessary. In determining alignment between forecasted market rates to individual assets, BNY Mellon applied the following rules for materiality:

Materiality threshold:

Asset class represents <0.5% of *Available-for-Sale* portfolio by:

[Market Value] AND [DV01] AND [Spread DV01]

Step 3: DATA CONSTRAINTS

Limitations in historical market data may result in risk exposures being modeled at a consolidated level. Data gaps (missing dates), insufficient coverage (time-series only started recently and does not capture critical market events), deficient granularity by product type (coupon or tranche not available) and significant outliers mean time series may have been unusable.

Step 4: GOVERNANCE PROCESS

Any consolidation was vetted and approved within the Governance Framework overseeing DFAST and CCAR Stress Testing. Rationale for consolidation was supported by empirical evidence and fully documented. Consolidated segments must have had a similar risk profile to allow use of proxy time series. Product specific risks were considered in their entirety to allow for consolidation.

2.5 The Credit Spread Forecasting Model

2.5.1 Framework

The Investment Portfolio's OCI Stress Testing Framework employed Moody's spread projection models as the primary model for BNY Mellon's CCAR process and an internally developed benchmark model. Projection models were based on historical market spreads and macroeconomic factors. Modeled historical market spreads were on a rolling monthly basis using the last observable spot rate for the month.

During model development, variables were selected to identify core drivers which best explained the dynamic behavior of each dependent variable (e.g. the credit spreads or OAS). Variable selection was based on a combination of economic principle, regulatory assumptions and strong theoretical underpinnings. Model development combined expert judgment and statistical optimization. All combination of variables were tested including lag combinations up to two quarter ensuring the most robust and predictive models available from the tested variables.

2.5.2 Primary-Benchmark Methodology

In order to properly manage the risk associated with the breadth of new CCAR and DFAST requirements, the statistical modeling framework was thoroughly tested under a primary-benchmark methodology to validate its assumptions, strengths, effectiveness, and flexibility. In order to allow for optimal comparisons, both the primary and benchmark models were given the same sets of historical data and macroeconomic factors. A comprehensive and efficient testing process provided a structure where methodologies could be compared and contrasted. These comparisons allowed for review of progress and validation of assumptions while providing BNY Mellon exposure to best practices in forecasting market data employed by peer organizations.

The process for the primary and benchmark models for credit spread forecasting was:

- BNY Mellon collected, cleansed and distributed historical market data.
- Primary and benchmark teams developed spread forecasting models in isolation
- Models forecasted future spreads in stress scenarios going out nine quarters¹⁰
- Modeled outputs and assumptions across both platforms were compared and contrasted.

Primary model was amended, if required, while considering practicality

2.5.3 Primary credit spread forecasting Model

The primary credit spreads statistical forecasting model was developed by Moody's. Moody's has a global analytical team including approximately one hundred economists and data specialists. Employing years of experience in analyzing the dynamics of financial market environment and developing robust macroeconomic forecasting models, Moody's team derived the Primary credit spreads statistical forecasting model for BNY Mellon through a well-established procedure. The procedure includes data preparation, methodology exploration, candidacy driver identification, variable selection, model diagnostics and forecasting outlook. The Primary model also tested effects of OCI shocks, assessed scenario impacts, implemented sensitivity analysis and generated narratives describing assumptions and detailing methodologies.

The primary credit spread forecasting model development includes below phases:

¹⁰ Refer to Section 3 for the list of Curves Provided to Moody's for Stress Testing

- Data Preparation - Historical market credit spreads data were sourced, aggregated and distributed by BNY Mellon. The spreads data were on a rolling monthly basis using the last observable spot rate for the month. From the perspective of independent variable data collection, macroeconomic and financial market variables were obtained from Moody's core macroeconomic model system which incorporated the regulatory assumptions on CCAR and DFAST exercises.
- Methodology Exploration – Linear regression model, time series model and multiple stage regression models were considered when modeling efforts were initialized. For each OCI asset classes, experimental models were explored before final modeling methodology was selected. In summary of selected final model methodology, two types of models were used in the Primary framework: Two-stage linear regression¹¹ and Single-stage linear regression. For asset classes of Agency RMBS, CMOs and US Corporate Bond, Two-stage linear regression models with rigorous variable selection process were developed by incorporating principal component analysis to generate the approximation of overall spread trend in the first stage; For other asset classes, single stage linear regression was directly applied. Maximum likelihood estimation is used as the model estimation methodology. When autocorrelation or heteroskedasticity were present in corresponding linear regression models, Newey-West standard errors estimators were employed to correct the p-value estimations.
- Candidacy Driver Identification– Selection of drivers started from identifying a valid view of candidacy variables. Potential drivers were selected based on macroeconomic theory, prediction accuracy and consistency with regulatory assumptions. General economic indicators as well as credit market indicators and real estate related variables were considered thoroughly as the credit spreads greatly align with these variables from historical perspective. Interest rates and market benchmark spreads were also involved in the pool of potential drivers. International factors such as Global Growth Factor, Global Equity Factor, and Global Equity Volatility Factor were derived from Moody's macro system as extended variables using Federal Reserve's regulatory stress testing assumptions, in order to describe the global economic stress conditions. Country-wise and regional market information was included as critical candidacies as well.
- Variable Selection– Best subset selection process was implemented after an initial filtering of candidacy drivers through bivariate charts and correlation analysis. For each

¹¹ Please see section 4.2 for additional details

model, drivers were selected with the criteria that to maximize the ratio of Adjusted R-Square and Root Mean Squared Error. In this best subset selection process, all possible combinations of the potential drivers, including all lag combinations of up to three periods, were tested to ensure that the most robust and predictive model was available from the tested variables. Following principle of parsimonious model with no multicollinearity, up to three core drivers could be selected, and a maximum correlation of ± 0.75 between explanatory variables was imposed. To further strengthen the robustness of final model selected, the significance level of selected drivers must be no less than 5%, and the sign of the coefficient estimate should be consistent with the expectation based on business intuition and economic theory.

- Model Diagnostics– The assessment of selected model's goodness-of-fit went through a list of statistics: 1. In-sample fitting performance: R Square, Adjusted R Squared, AIC(Akaike Information Criterion), BIC(Bayesian Information Criterion), MSE(Mean Squared Error), RMSE(Root Mean Squared Error), MAPE(Mean Absolute Percentage Error), MSPE(Mean Squared Percentage Error) and RMSPE(Root Mean Square Percentage Error); 2. Multi-collinearity measurement: Maximal VIF(Variance Inflation Factor); 3. Heteroskedasticity tests: Breusch-Pagan test, Cameron & Trivedi's IM test and LM (Lagrange Multiplier) test; 4. Autocorrelation analysis: Breusch-Godfrey LM test, Durbin's alternative test, ACF (Autocorrelation Function), PACF(Partial Autocorrelation Function); 5. Residual diagnostics: Histogram graph, Q-Q plot, P-P plot, Kernel Density Distribution, Skewness-Kurtosis test, Shapiro-Wilk test and Portmanteau white noise test; 6. Outlier analysis: studentized residuals, DFBETA measure, Cook's distance and Leverage value; 7. Hold-Out sample testing: 3/6/9/12/15/18 months' hold-out sample prediction vs. actual charts and corresponding residuals statistics; 8. Stationarity test for dependent variable, independent variables and residuals: DF(Dickey-Fuller) unit root test, PP(Philips-Peron) unit root test and KPSS(Kwiatkowska, Phillips, Schmidt, Shin) stationarity test; 9. Driver robustness: coefficient stability test, sigma elasticity and sensitivity analysis; 10. For two-stage regression models, details of Principle Component Analysis such as scoring and factoring matrices.
- Forecasts Outlook – Nine quarter forecasting of credit spreads were produced for Supervisory scenarios and BHC idiosyncratic scenario per CCAR requirement. Forecasting shape and magnitude under different scenarios were compared and investigated. Economic and financial intuition of spreads movement under stress

scenarios was scrutinized to assess the forecasting performance of these credit spreads projection models.

2.5.4 Benchmark Credit Spread Forecasting Model

The benchmark statistical forecasting model for credit spreads was developed internally. In providing a parallel approach, BNY Mellon tested the underlying assumptions of the current policy. ALM-IRR developed its models drawing on quantitative expertise while collaborating with subject matter experts (SMEs) across the organization. ALM-IRR confirmed all first principles including (a) product background and (b) assumptions on factors potentially affecting valuations. During the internal model development life cycle, the data sets were scrutinized to identify their characteristics while statistical verification reviewed correlations. These reviews eventually began to create a pool of candidate variables to be used in preliminary models. A stepwise process was applied based on selected business-intuitive drivers and their transformations.

ALM-IRR reviewed its models for goodness of fitness by interpreting testing results for statistical significance using parameters such as coefficients, F-statistics, autocorrelation, multicollinearity, nine-quarter fitness and heteroskedasticity.

Once all models had been reviewed individually, the team began the selection process to identify satisfactory candidates with acceptable results. Top models were then selected for socialization across the organization. The wider group provided feedback, adjustments were made, and the process was recycled as necessary until final models were confirmed.

2.6 The OCI Valuation Model

To calculate the OCI, BNY Mellon engaged Blackrock Advisory services to work in tandem with BNY Mellon's QRM model to produce valuation models in the primary-benchmark format.

BNY Mellon's primary model uses the QRM modeling framework (BAU Balance Sheet Management Framework) to project the FMV of the investment securities portfolio and to calculate the OCI for stress testing reports. The FMV configuration in QRM allows the calculation of the market value of securities at future time steps through a full revaluation. Each planning scenario's projected market data (yield curve, exchange rates) is used to produce the spot market rate for future time steps. The spot market rates are then used to generate an

implied forward interest rate curve for each of the nine quarters into the future. This, along with the macroeconomic factors and the credit spread shocks, is used to calculate the future valuation of the securities in the investment portfolio. The QRM framework performs this using a Monte Carlo simulation¹².

ALM-IRR engaged Blackrock Advisory Services for the benchmark valuation model to provide modeling, scenario analysis and related services to generate CCAR risk assessments and related analytics. BNY Mellon provided portfolio position data and assumptions related to macro-economic variables rates, credit spreads/OAS and dynamic future portfolio composition, while Blackrock's deliverables included portfolio valuations, risk metrics, risk factor attribution analysis and model documentation for various simulated scenarios.

For the benchmark model, Blackrock Advisory services calculated the projections of the investment portfolio OCI based on forecasted changes in market and book value for each position at each quarterly horizon date and is aggregated at the portfolio level to compute OCI.¹³ The Blackrock model is based on a Generalized Additive model and uses two main input variables: future market value forecasts and estimated future book values. The difference between the estimated market value and book value of securities in the investment portfolio is aggregated (at segmented levels) to calculate the OCI¹⁴.

2.7 Incorporating Reinvestments, Growth and Sales

The OCI valuation model forecasts have the investment portfolio strategy assumptions embedded for every scenario consistent with the BNY Mellon CCAR Balance Sheet forecasts. The projected portfolios include assumptions for the reinvestment of all asset classes as they roll off, incremental purchases of new securities and sales of existing positions. In order to incorporate reinvestments, growth and sales into the calculation for OCI, BNY Mellon ALM-IRR works with the portfolio management group to evaluate the bank operating plan for the coming year, the annual target for the portfolio composition, the group's assessment of coming market movements and the anticipated reactions to these movements under various scenarios. Investment portfolio strategy is driven by balance sheet optimization from a funding, regulatory

¹² Please see section 4.5 for a more detailed description of the QRM OCI Valuation model and the Appendix for a detailed description of the QRM framework and calculation design.

¹³ Please refer to BRS_US Agency MBS Model Documentation

¹⁴ Please see section 4.6 for a detailed description of the Blackrock Advisory OCI Valuation model.

compliance and NII perspective. Forecasting the investment portfolio balances for CCAR follows a qualitative approach as described in the balance sheet forecasting model documentation. The qualitative approach is based on a decision tree with funding being a central driver along with additional risk considerations (leverage ratio and OCI at risk). These investment strategies are entered into the QRM framework to inform the portfolio under all four scenarios for CCAR stress testing.

The market risk oversight group runs further OCI risk tests, additional stressing of the credit spreads and yield curves under various stress scenarios to recalculate stressed OCI relative to capital limits. If changes are suggested to the investment strategies, ALM-IRR consults again with the Portfolio Management Group and reviews the results.

Furthermore, when projections are made, Corporate Treasury first determines whether liquidity needs will affect the investment portfolio and follows the decision tree as outlined in the qualitative approach. Then, the portfolio is shocked to check the risk metrics. If OCI at the risk metrics has been breached, there may be steps taken to limit the breach. The tactics employed vary depending on the scenarios, but if, for example, the strategy calls for a reduction, the first step could be to let go of incremental growth. The second could be the change in the reinvestment strategy. All of this would vary depending on the projected interest rates and macroeconomic environment.

These two above factors, deposit dynamics and OCI risk tests, are the main factors in the construction of the strategy for reinvestment, growth and sales within the investment portfolio.

Everything is entered in the QRM framework using planning trade tickets, whereby growth and reinvestments can be embedded in the forecasts. The QRM framework computes a future investment portfolio with these planning scenarios and behavioral assumptions as basic constraints. QRM calculates the future book value using the projected future market valuation to predict the price at which the security should be purchased (depending on the entered growth and reinvestment strategies). This forecasting is modeled monthly. The same is done for future forecasts of sales. QRM calculates the price at which the gain and loss are realized on sales. QRM projects all of this at the cusip level, using representative cusips from the current investment portfolio as proxies for the future portfolio. All calculations based on strategies and

governed by the macroeconomic variables and growth assumptions happen in these representative cusips¹⁵.

2.8 Other than Temporary Impairment (OTTI) Considerations

Another important accounting issue, particularly for banks, is the treatment of other-than-temporary impairment (OTTI) for investments. OTTI is the impairment charge taken on a security whose fair value has fallen below the carrying value on the balance sheet when its value is not expected to recover during the holding period of the security. OTTI can have a significant effect on earnings and regulatory capital of BHC's. A debt or equity investment is impaired if its fair value is less than its amortized cost basis. If that happens, the BHC must determine whether the impairment is permanent, meaning principal will not be returned. Factors to consider in making this determination include:

- The length of time the security's fair value has been below its carrying amount,
- The issuer's near-term prospects, and
- The BHC intent and ability to hold the investment long enough to allow for any anticipated recovery in value.

If the BHC determines that a debt security is other-than-temporarily impaired, and it intends to sell the security before its anticipated recovery, the total amount of OTTI is written down and recognized in earnings. If it's not likely to be sold, only the credit component of OTTI that is, the loss attributable to the issuer's inability or unwillingness to pay, is recognized in earnings. The non-credit component which reflects losses caused by illiquidity, fluctuating interest rates or other factors is recognized as other comprehensive income (OCI).

Practical Application to BNY Mellon

The models used to calculate OTTI and AOCI are generated by two separate teams, Credit Risk and ALM Interest Rate Risk however, plans are afoot to have an integrated process in the very near future. Until such time, there is a process in place to synchronize the behavioral cash flows generated by the credit risk model prior to OCI model calculation¹⁶. OTTI is applicable to all securities in the AFS and HTM portfolios, but not in the trading accounts. In the event that credit impairment is required, a write-down (reflecting current value) is taken through income

¹⁵ For a detailed description of the model and its calculation process, please see the documentation on QRM OCI model #2122.

¹⁶ see the Appendix for a QRM model description

with any pull to par or recovery value being amortized in over time. The impairment adjustments are made in QRM prior to fair value calculation to prevent double counting. For BNY Mellon's OCI portfolio, only AFS is valued, because it has the potential to be sold, with marks going through equity. If a HTM asset becomes impaired, it must go to AFS and follow the same accounting treatment. The HTM portfolio is largely made up of positions hedging interest rate risk (i.e. treasuries) which are unlikely to become impaired.

2.9 Treatment of FAS133 Hedges

Statements of Financial Accounting Standards No. 133 (FAS133), Accounting for Derivative Instruments and Hedging Activities requires firms to measure all assets and liabilities on their balance sheet at fair value. The FAS133 statement establishes accounting and reporting standards for derivative instruments, including certain derivative instruments embedded in other contracts, (collectively referred to as derivatives) and for hedging activities. It requires that an entity recognize all derivatives as either assets or liabilities in the statement of financial position and measure those instruments at fair value. If certain conditions are met, a derivative may be specifically designated as:

- a hedge of the exposure to changes in the fair value of a recognized asset or liability or an unrecognized firm commitment
- a hedge of the exposure to variable cash flows of a forecasted transaction, or
- a hedge of the foreign currency exposure of a net investment in a foreign operation, an unrecognized firm commitment, an available-for-sale security, or a foreign-currency-denominated forecasted transaction.

The accounting for changes in the fair value of a derivative (that is, gains and losses) depends on the intended use of the derivative and the resulting designation. The four designations are outlined below.

Hedging Changes in Fair Value Exposure

For a derivative designated as hedging an exposure to changes in the fair value of a recognized asset, liability or a firm commitment (a fair value hedge), the gain or loss is recognized in earnings in the period of change together with the offsetting loss or gain on the hedged item attributable to the risk being hedged. The effect of that accounting is to reflect in earnings the extent to which the hedge is ineffective in achieving offsetting changes in fair value.

Hedging Forecasted Transaction Variable Cash Flows

For a derivative designated as hedging the exposure to variable cash flows of a forecasted transaction (referred to as a cash flow hedge), the effective portion of the derivative's gain or loss is initially reported as a component of other comprehensive income (outside earnings) and subsequently reclassified into earnings when the forecasted transaction affects earnings. The ineffective portion of the gain or loss is reported in earnings immediately.

Hedging Currency Exposure of Foreign Operation

For a derivative designated as hedging the foreign currency exposure of a net investment in a foreign operation, the gain or loss is reported in other comprehensive income (outside earnings) as part of the cumulative translation adjustment. The accounting for a fair value hedge described above applies to a derivative designated as a hedge of the foreign currency exposure of an unrecognized firm commitment or an available-for-sale security. Similarly, the accounting for a cash flow hedge described above applies to a derivative designated as a hedge of the foreign currency exposure of a foreign currency denominated forecasted transaction.

Non Hedging Derivatives

For a derivative not designated as a hedging instrument, the gain or loss is recognized in earnings in the period of change. Under this statement, an entity that elects to apply hedge accounting is required to establish at the inception of the hedge the method it will use for assessing the effectiveness of the hedging derivative and the measurement approach for determining the ineffective aspect of the hedge. Those methods must be consistent with the entities approach to managing risk.

2.10 The Application of Different Tax Rates and the Effect on OCI

Post-tax OCI is included in the calculation of regulatory capital for the capital plan. Taxation rates on the Accumulated Other Comprehensive Income (AOCI) are determined by the legal entity and geographical jurisdiction. The future market valuations and calculations of the projected investment portfolio are done at the cusip level in the QRM framework. This ensures that the existing and forecasted book position data is available at the legal entity level. To account for these different taxation rates and the effect that they will have upon the forecasted balance sheet, the corporate taxation group provides the current tax rates for each legal entity.

The projection calculates for the taxation on OCI with an assumption that the tax rates are held constant for the nine quarters of forecasting, under all tested scenarios.

The projected AOCI by legal entity would be dynamic, informed by the existing positions, shaped by the existing positions and investment strategy under each stress scenario. To incorporate post-tax AOCI for calculating regulatory capital, the effect of tax rates is modeled with AOCI for each legal entity for each of the nine quarters to horizon.

2.11 Challenge and Review

BNY Mellon uses a two-step challenge and review process for both main components of the OCI valuation model. Working groups that include members of senior management, treasury risk committee, portfolio management group and the risk oversight group come together to perform these two-step validation processes and provide a second line of defense. Please see section 6 for more details.

3. The Data

3.1 The Data Sources

Historical market data is sourced from four external vendors: Bloomberg, JP Morgan Markets, Interactive Data Corp and Barclays Live. Reviews of available data formed the basis of vendor selection. These reviews considered reporting frequency, continuity of time series, extensiveness and consistency within a product range and alignment with market and industry and economic expectations.

Time series data can be published in various forms (rates, index levels, spreads) and frequencies (daily, monthly, weekly). To whatever degree possible, data for each individual time series is collected from the same vendor across the full range of dates in scope. A single vendor for each individual data series minimizes risk of non-market volatility that could be introduced if multiple vendors were to be used. For example, vendors use proprietary models to generate spreads when underlying data is not available, which prevents consistency in the data series across vendors. Historical spread data is statistically modeled to forecast credit spread shocks in stress scenarios in order to create the inputs for forecasting OCI market value.

In order to comply with the year-end and mid-year CCAR and DFAST reporting cycles, semi-annual reviews of the list of market data vendors and the products require historical modeling are performed. Any updates that are made ensure that the data scope matches the portfolio composition. All selected data were analyzed for continuity, history, appropriateness and consistency with macroeconomic conditions, and outliers. The table below lists the vendors and products as of 4Q2015.

Data Source	Product
Barclays Live	MBS Agency Passthrough MBS Agency Hybrid ARMS MBS Agency CMO Floater Strips Non-Agency CMBS Int'l RMBS Commercial Paper
Bloomberg	US Corporates

	EUR Corporates GBP Corporates Sovereign Municipals
IDC	Agency Debentures Non-Agency RMBS
JP Morgan Markets	MBS Agency CMO Agency CMBS Covered Bonds CLO ABS

As a rule of thumb a regression model requires thirty or more sample observations. The Central Limit Theorem summarizes important facts about the distribution of possible sample means. If a random sample N is drawn from a population with mean μ and standard deviation σ , then the sampling distribution of the mean has a mean equal to the population mean and a standard deviation equal to the population standard deviation. The shape of the sampling distribution of the mean approaches normal as N increases. For example, the shape of the sampling distribution approaches normal as the size of the sample increases, regardless of the shape of the population distribution.

3.2 Descriptions of the Variables

3.2.1 Agency MBS

Original Maturity

Agency MBS Pass-through bonds are issued with maturities of 10, 15, 20 and 30 years. For modeling purposes, only the 15 and 30 year MBS spreads were considered. The 10 and 20 year fixed Agency MBS portfolio were consolidated into 15 year MBS per market standards. Issuance of the 10 and 20 year mortgages are immaterial (see the table below). Traders generally price any MBS Pass-through less than 30 Years off the 15 year curve. BNYM exposure to the 10 year and 20 year MBS pass-through is immaterial.

	MBS Currently Outstanding in \$Trillions				
Agency	10yr	15yr	20yr	30Yr	Total
FHLMC	0	6	0	4	10
FNMA	0	15	0	72	87
GNMA	0	0	0	10	10
Grand Total	0	21	0	86	107
	0%	20%	0%	80%	

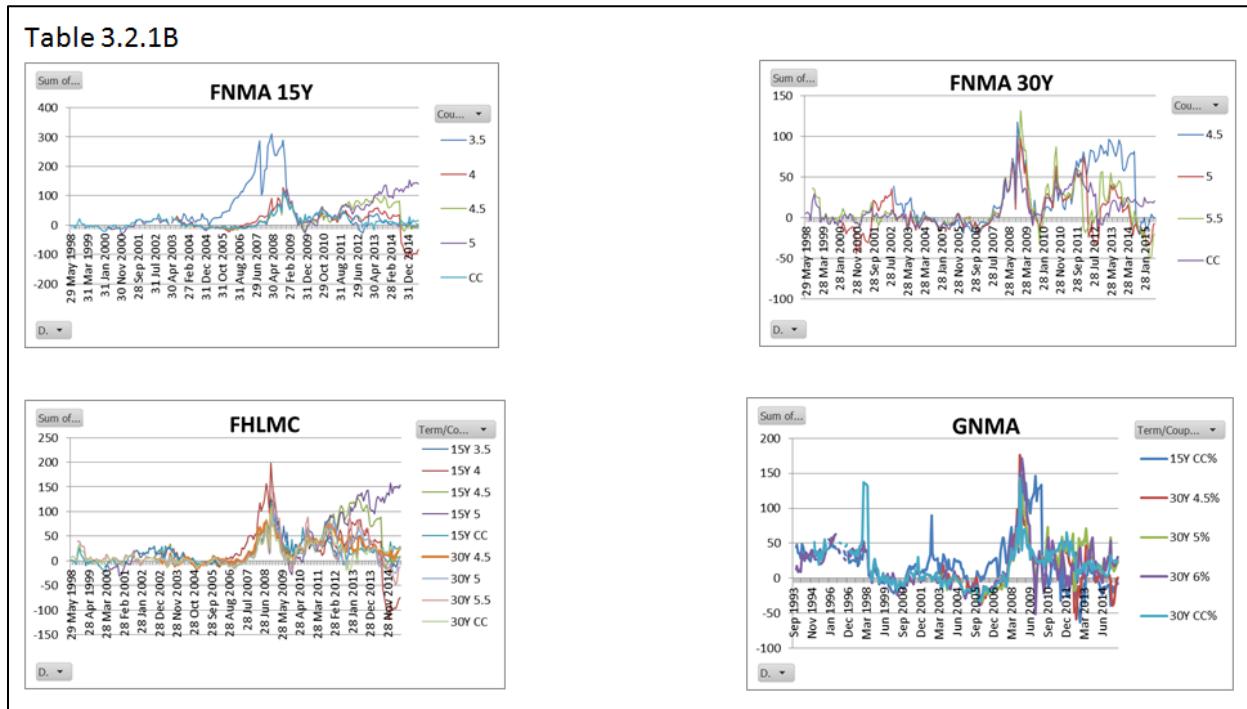
BNYM exposure in the 10YR and 20YR Agency MBS pass-through as of 12/31/2015 is

	Market Value	DV01	CS01
Agency MBS 10YR	\$ 113	\$ 0.02	\$ 0.03
Agency MBS 20YR	\$ 56	\$ 0.01	\$ 0.02

Data Availability

MBS Pass-through historical data availability is a function of the underlying agency and coupon. Pass-through issuance will reflect the then-current interest rate environments. Published option-adjusted-spreads (OAS) are a composite of spreads on TBAs issued in the current year and model-generated spreads looking at all coupons.

The following tables describe the OAS across the different maturities and outline the dates for which historical OAS become available for each agency and coupon. For example, GNMA had no 3% 15 year pass-through bonds until September 2011.

Table 3.2.1B

Market Data Availability : Start Date

	GNMA 15Y	GNMA 30Y	FNMA 15Y	FNMA 30Y	FHLMC 15Y	FHLMC 30Y
CC	Oct 1993	Oct 1993				
2%			Jun 2012	Jun 2012	Jun 2012	Jun 2012
2.5%		Jan 2012	Aug 2011	Sep 2011	Aug 2011	Jan 2012
3%	Sep 2011	Jan 2009	Jan 2009	Jan 2009	Jul 2010	Jan 2009
3.5%	Aug 2011	Jan 2009	May 2003	Jan 2009	Jan 2009	Jan 2009
4%	Apr 2009	Jan 2009	Apr 2003	May 2003	Sep 2003	Jan 2005
4.5%	Mar 2009	Sep 2002	Sep 2002	Sep 2002	Sep 2002	Sep 2002
5%	Apr 2002	Sep 2002	Feb 2000	Feb 2000	Feb 2000	Sep 2002
5.5%	Jan 2000	Dec 1998	Sep 1993	Sep 1998	Sep 1993	Sep 1998
6%	Jan 2000	Sep 1993	Mar 1993	Sep 1992	Mar 1993	Sep 1993
6.5%	Mar 1993	Feb 1993	Sep 1992	Sep 1992	Sep 1992	Mar 1993
7%	Sep 1992	Sep 1992				
7.5%	Sep 1992	Sep 1992				
8%		Sep 1992	Sep 1992	Sep 1992	Sep 1992	Sep 1992
8.5%		Sep 1992	Sep 1992	Sep 1992	Sep 1992	Sep 1992
9%			Sep 1992			

Source: agency mbs coupon segmentation.xlsx

ALM-IRR analyzed the Agency MBS portfolio by tenor, coupon, issuer, vintage and structure to draft the initial Agency MBS segmentation, and then reviewed the data availability to finalize segmentation¹⁷.

Current Coupon Rate (CCR)

Barclays Live defines current coupon as follows:

CCR and OAS both involve finding a yield after removing the embedded-option value. OAS is a constant spread added to the spot yield curve to equate model price to market price. In computing CCR, conversely, the yield curve is left intact but cash flow stream are adjusted (by moving the mortgage rate).

The fair loan condition requires that, at loan origination, the mortgage cash flows present value ($PV(CF)$) less the value of the prepayment option (PP) equals the initial principal payment (BB). The mortgage rate that satisfies this condition in the current interest rate environment is called the Current Coupon Rate (CCR).

[The formula for this is:] $PV(CF) - PP = BB$

To achieve this equality, the term $PV(CF)$ is adjusted because PP and BB are fixed at loan origination. The adjustment to $PV(CF)$ is accomplished by leaving the current yield curve intact but changing the mortgage rate, thus changing the CF stream.

Over time, as the mortgage seasons, the yield curve evolves, and so must the current coupon rate. This is in contrast to the existing mortgage rate, fixed since origination or since the most recent re-financing negotiation. The difference between the two rates is one of the factors that influence the incentive function in the prepayment.¹⁸

Low Coupons

As demonstrated in the previous tables, Pass-throughs with coupons below 3%-4% (depending on the agency and maturity) had limited data scope (e.g. 3-6 years of data as opposed to 17-

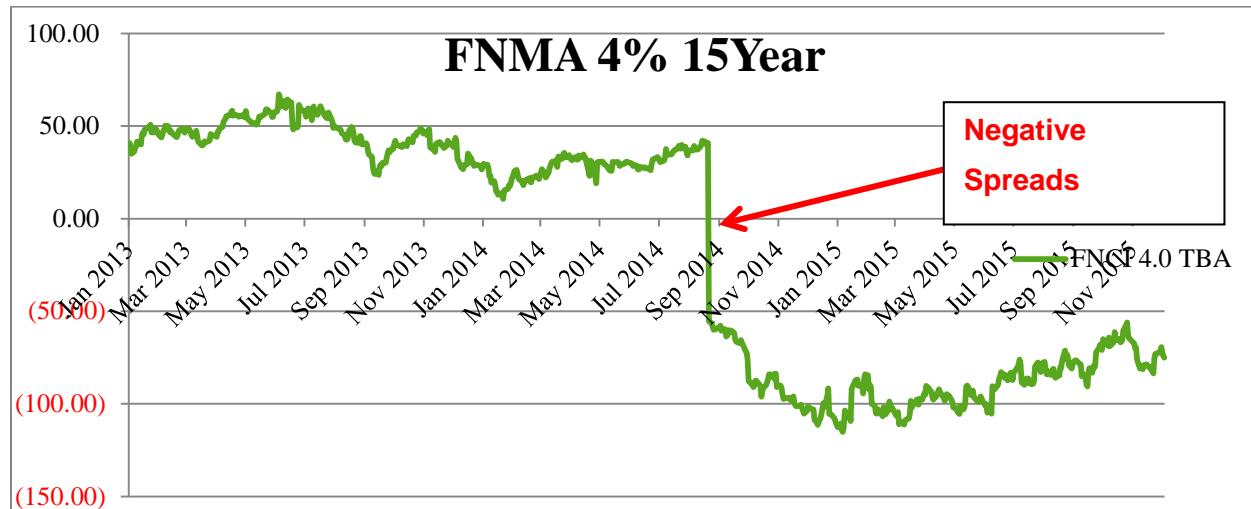
¹⁷ Please refer to the Appendix for descriptions of the specific spreads, bond descriptions, the agency and coupons

¹⁸ Please refer to the Appendix for background on deriving CCR and OAS and mortgage rates

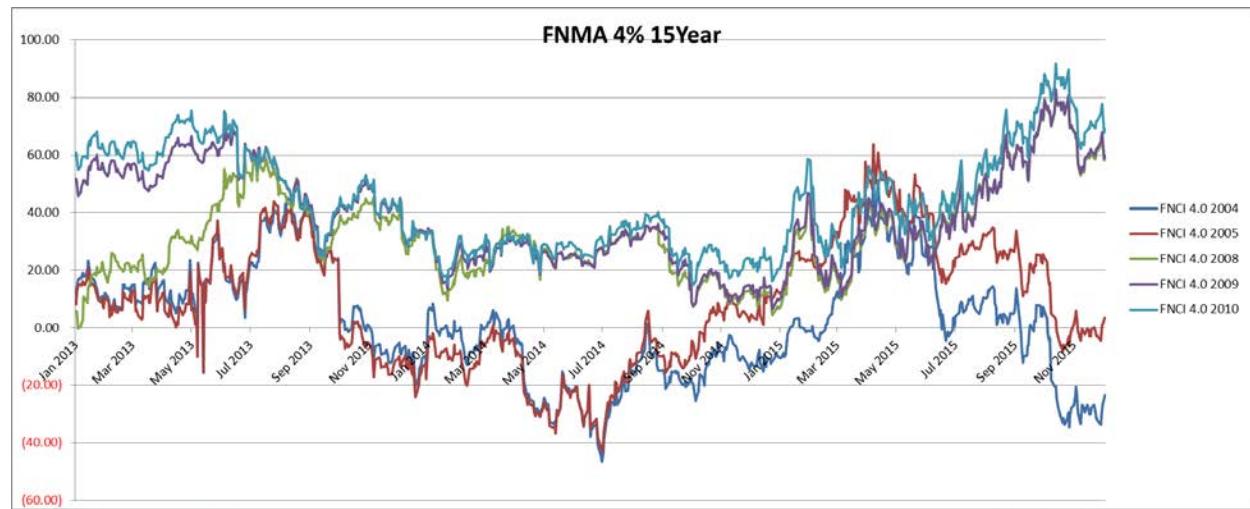
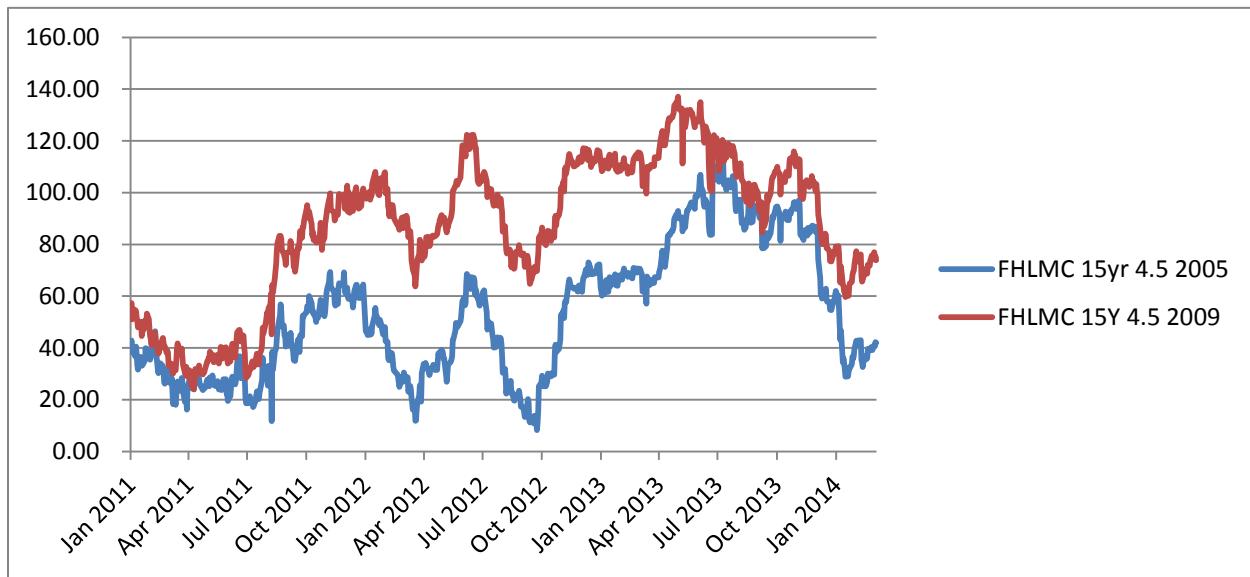
23+ years of data on higher coupons) and did not cover any periods of vulnerability. Because the low interest rate environment did not exist before 2008, MBS Pass-throughs with low coupons also did not exist and had not been issued. For forecasting purposes, ALM-IRR based the modeling of low coupons with limited data scope on the aforementioned CCR in order to reflect the current interest rate environment and extend the data series for modeling. For example, in FNMA & FHLMC limited data was available for 2.5%-3.5%; therefore, ALM-IRR used CCR OAS as a proxy for low coupon pass-throughs.

Vintage

Analysis of composite coupon time series revealed some OAS to be inconsistent with economic expectations. In the below table, OAS falls to negative levels after 2013. Negative spreads or other unintuitive results are a function of modeling techniques used to calculate OAS. In order to more accurately forecast spreads on the OCI portfolio, the year of issuance (the vintage) is included when identifying the time series.



Cash flow and prepayment activity on Agency MBS Pass-through issued bonds are generally consistent within the same coupon and year of issue. However, depending on macroeconomic activity, underlying borrowers across specific coupon levels (for example, a borrower with a 4% mortgage issued in 2005 vs a borrower with a 4% mortgage issued in 2009) may have different likelihoods of prepayment and therefore different OAS across vintages. The below charts illustrate the OAS for 4.5% FHLMC 15yr Pass-through bonds issued in 2005 and 2009 and demonstrate the OAS on the FNMA 15 Year 4% across various vintages respectively.



The BNY Mellon risk management system can capture the vintage as a data field. Spread forecasts based on vintage time series are mapped to risk exposures with similar vintages on the BNY Mellon balance sheet. For Hybrids and ARMs, the coupon is fixed for a defined number of years and then set annually. For example, the coupon that denotes "7/1" is fixed for seven years and then set annually. ALM-IRR aggregates the data by Agency, by coupon and by reset structure.

Hybrid Time Series

Hybrid adjustable-rate mortgages blend the characteristics of fixed-rate and adjustable-rate mortgages. Hybrid mortgages have an initial fixed-rate period followed by an adjustable-rate period. After the fixed interest rate period expires, the interest rate starts to adjust based on an index plus a margin with caps that limit the amount of movement from one period to the next.

The diversity in hybrid products is reflected in the high number of time series available for modeling. Each agency has initial lockouts of 3, 5, 7 and 10 years with varying caps on the year-on-year and overall rate changes. The below table illustrates the variety of time series available for modeling Hybrid Arms. Barclays Live is the data source for Agency MBS Pass-throughs and ARMs.

Agency	Lockout / Caps	Initial Coupon								
		3	3.5	4	4.5	5	5.5	6	6.5	7
GNMA	5-1 1-1-5	✓	✓	✓	✓	✓	✓	✓	✓	✓
	3-1 1-1-5	✓	✓	✓	✓	✓	✓	✓	✓	
FNMA	3-1 2-2-6	✓	✓	✓	✓	✓	✓	✓	✓	
	5-1, 2-2-5		✓	✓	✓	✓	✓	✓	✓	
	5-1, 5-2-5		✓	✓	✓	✓	✓	✓	✓	✓
	7-1, 5-2-5		✓	✓	✓	✓	✓	✓	✓	✓
	10-1, 5-2-5			✓	✓	✓	✓	✓		
FHLMC	3-1, 2-2-6	✓	✓	✓	✓	✓	✓	✓	✓	
	5-1, 2-2-5	✓	✓	✓	✓	✓	✓	✓	✓	✓
	7-1, 5-2-5				✓	✓	✓	✓	✓	
	10-1, 5-2-5		✓	✓	✓	✓	✓	✓		

3.2.2 Agency Collateralized Mortgage Obligations (CMO's)

Agency CMOs are created by pooling mortgage pass-throughs and splitting their cash flows into a number of tranches. A CMO is self-supporting, i.e. the collateral cash flow is able to meet the tranches' cash flow requirement. Agency CMOs carry the same guarantee/insurance as agency MBS. There is no need for credit enhancement in these structures owing to the agency guarantee/insurance; so tranching is used to create bonds of different average lives or performance characteristics.

Spreads are published monthly from JP Morgan Markets by structure (Sequential, PAC/TAC, Floaters, and Strips). Data is not segmented by Issuing agency based on accepted market standards for Agency CMO valuations and risk characteristics that are specific to prepayment speeds. CMO data comes from both JP Morgan Markets and Barclays Live.

Series Mnemonic	Start Date
CMO PAC - 2Yr WAL	8/31/2007
CMO PAC -10Yr WAL	8/31/2007
CMO SEQ - 2Yr WAL	12/30/2011
CMO SEQ - 10Yr WAL	8/31/2007
CMO Flt - DM / 6.5 Cap	5/28/2010
CMO Flt - DM / 7.0 Cap	8/31/2007
Floater Conventional Strips 6.5 Cap,:DM	10/15/2008
Floater Conventional Strips 7.0 Cap,:DM	10/15/2008

3.2.3 Agency CMBS

Agency Commercial Mortgage Backed Securities (CMBS) are structured into different time tranches, sequential pay class bonds with varying weighted average lives (WAL) which determines their ranking in the capital structure.

Agency CMBS deal structures vary by agency as each agency has different structuring criteria, different collateral characteristics and different levels of guarantees. Spreads are only published on a weekly or monthly basis. For forecasting purposes, the last published spread level from each month is modeled. The data source for Agency CMBS is JP Morgan Markets. The following represents the full set of published Agency CMBS time series and the date ranges for available spreads:

Name	Start Date	End Date	Data Gaps
GNMA-CMBS			
GNMA 3.5yr Spread	Aug 2010	Jul 2015	No Gaps
GNMA 7.5yr Spread	Aug 2010	Jul 2015	No Gaps
GNMA 12yr Spread	Aug 2010	Jul 2015	No Gaps
FNMA-CMBS			
FNMA DUS 5 -10yr Spread	Aug 2005	Jul 2015	No Gaps

FHLMC K-Program			
FHLMC A1 10yr	Mar 2012	Jul 2015	No Gaps
FHLMC 10yr A2	Mar 2012	Jul 2015	No Gaps

3.2.4 Non Agency CMBS

Non-agency CMBS are structured into different tranches based on their level of subordination, which determines their ranking and rating. The below tables lists the time series spreads, their start date and their index for both Barclays Live Weekly and JP Morgan Markets Weekly.

Barcap Weekly		JPM Morgan - Weekly	
Start Date	Index	Start Date	Index
29 Sep 2005	CMBS 2005 A	9 Mar 2012	Cash Spreads 10yr A1 Spread
29 Sep 2005	CMBS 2005 AM	9 Mar 2012	Cash Spreads 10yr A2 Spread
29 Sep 2005	CMBS 2005 AJ	9 Mar 2012	Cash Spreads 10yr B (Legacy 7.5%) Spread
15 Feb 2007	CMBS 2007 A1	3 Jan 2014	Cash Spreads 10yr B (10%) Spread
15 Feb 2007	CMBS 2007 A2	3 Jan 2014	Cash Spreads 10yr C (7.5%) Spread
15 Feb 2007	CMBS 2007 AM	9 Mar 2012	Cash Spreads 7yr A1 Spread
17 Feb 2011	CMBS 2011 Mez AA	9 Mar 2012	Cash Spreads 7yr A2 Spread
17 Feb 2011	CMBS 2011 Mezz A	9 Mar 2012	Cash Spreads 7yr B (10%) Spread
17 Feb 2011	CMBS 2011 Sub BBB-	9 Mar 2012	Cash Spreads 7yr C (7.5%) Spread
		1 Jun 2012	Cash Spreads 5yr A1 Spread
		1 Jun 2012	Cash Spreads 5yr A2 Spread
		14 Feb 2014	Cash Spreads X1 (Spread to Treasuries) Spread
		14 Feb 2014	Cash Spreads X3 (Spread to Treasuries) Spread

Non-agency CMBS data is published weekly by both Barclays Live and JP Morgan Markets. Barclays Live data had an earlier start date which allows for modeling of Non-agency CMBS by vintage. Therefore, the data source for Non-agency CMBS is Barclays Live.

3.2.5 Covered Bonds

Covered Bond time series are available for a wide range of issuing currencies and domiciles. However, to date, there have been few covered bond offerings in the US due to concerns regarding taxation and issuer insolvency related to mortgages. Spreads are typically published on a weekly basis with generally excellent coverage for 3-6 years. For forecasting purposes, the last observed spread level for the month is modeled. The data source for Covered Bonds is JP Morgan Markets. The below table illustrates available covered bond time series and their start dates.

Covered Bond Time Series and their Start Date		
EUR Covered: 1-3, 3-5, 5-7, 7-10, 10+	EUR GB	EUR Portugal
Aug 2009	Aug 2009	Jul 2010
EUR Australia	EUR Germany: Hypo, Oeff	EUR Scandi
May 2013	Aug 2009	Jul 2010
EUR Austria	EUR Ireland	EUR Spain: Multis, Single
Aug 2009	Aug 2009	Jul 2010
EUR Belgium	EUR Italy	EUR Sweden
May 2013	Aug 2009	Jul 2010
EUR Canada	EUR Luxembourg	EUR Switzerland
Aug 2009	May 2013	Jul 2010
EUR Denmark	EUR Netherlands	EUR US
May 2013	Aug 2009	Jul 2010
EUR Finland	EUR NZ	USD Canada Covered
May 2013	Jul 2010	Jul 2010
EUR France: Legal, SFH, Structured	EUR Norway	
Aug 2009	Jul 2010	
As of 30 September 2015, only those Time Series in Yellow are used for Segmentation		

3.2.6 Corporate Bonds

Corporate Bond Spreads are taken from Bloomberg's Fair Value (BFV) service. Bloomberg Valuation (BVAL) has recently been introduced and is expected to become the primary pricing service for fixed income and derivative markets. However, BVAL has limited historical data (i.e. recent start dates) which makes it insufficient for modeling purposes. BNY Mellon uses BFV for modeling Corporate Bond spreads.

USD Corporates			EUR Coporate		
Credit Rating	Start Date	End Date	Credit Rating	Start Date	End Date
AAA	Sep-02	Mar-09			
AA	Sep-02	Mar-12	AA	Mar-02	Sep-02
A	Sep-02	Oct-15	A	Mar-02	Jun-09
BBB	Sep-02	Oct-15	BBB	May-00	Jun-09
1, 3, 5, 7, 10, 15, 20 Yield Curve Points					

3.2.7 Agency Bonds and Debentures

Three Agency Debenture spread series were identified in the segmentation process, Agency Debentures Short, Agency Debentures Intermediate, and Agency Debentures Long. The three series start January 2007 and end June 2015; there were no data gaps in the series. Spot rates

are reported for the last business day of each month. The data source for Agency Debentures is Interactive Data Corporation (IDC). IDC provides updates semi-annually for June and December approximately two weeks after the period closes. IDC defines spread tenor as follows: short term spreads are inclusive of 1 to 5 year durations, intermediate spreads are inclusive of 6 to 10 year durations, and long term spreads are derived from durations greater than 10 years.

3.2.8 Asset Backed Securities

Asset Backed Security (ABS) spreads are reported by underlying consumer debt receivables: Autos, Credit Cards, Home Equity Loans and Student Loans. Spreads are typically published on a weekly basis with excellent coverage for 12-18 years. For forecasting purposes, the last observed spread level for the month is modeled. The data source for ABS is JP Morgan Markets.

Asset Backed Securities	Start Date	1Yr	2Yr	3Yr	5Yr	7Yr	10Yr
Student Loans AAA	Nov 2003	✓	✓		✓	✓	
HEL Fixed AAA	May 1999	✓	✓	✓	✓	✓	✓
HEL Fixed AA, A, BBB	May 1999				✓		
Cards Fixed AAA, A, BBB	May 1998			✓	✓	✓	
Autos Fixed AAA	Jun 1997	✓	✓	✓			
Autos Fixed A, BBB	Jun 1997			✓			

3.2.9 Collateralized Loan Obligations (CLO)

The Collateralized Loan Obligation (CLO) spread data is reported by credit rating and vintage. The vintage captures market characteristics at the time of issuance as the market developed and reacted to the financial crisis. The spreads are reported monthly on the last business day. The data source for CLOs is JP Morgan Markets.

CLO Spread to 3M Libor		
Program	Credit Rating	Start Date
Primary USD	AAA, AA, A, BBB, BB B	Feb 1999 Nov 2013
Seasoned USD (04-05 vintage)	AAA Sr AAA, AA, A, BBB, BB	Sep 2009 Jan 2004
Benchmark USD (06-07 vintage)	AAA Sr	Sep 2009
Benchmark USD (06-07 vintage)	AAA, A, BBB, BB	Jan 2006

3.2.10 Municipal Bonds

Municipal Bond Spreads are taken from Bloomberg's Fair Value (BFV) service. Bloomberg Valuation (BVAL) has recently been introduced and is expected to become the primary pricing service for fixed income and derivative markets. However, BVAL has limited historical data (i.e. recent start dates) which makes it insufficient for modeling purposes. Therefore, BNY Mellon uses Bloomberg's Fair Value (BFV) for modeling Municipal bonds. The range of all Municipal bond time series used for modeling is October 2000 through August 2014.

Municipal Bond Spreads	Data Start Dates			
	Maturities (Yrs)			
	1	5	10	20
General Obligation: AA				
General Obligation: A				
Transportation: AA				
Education: AA				
Utility: AA				
Utility: A				

Municipal Bond Spreads	Data Start Dates			
	Maturities (Yrs)			
	1	5	10	20
Transportation: AA	Oct 2000 - Nov 2014			
Education: AA	Oct 2000 - Oct 2008			
Utility: AA	Oct 2000 - Nov 2014			
Utility: A	Oct 2000 - Nov 2014			
Revenue: A	Oct 2000 - Aug 2014			

3.2.11 Non-Agency RMBS

Non-Agency RMBS were originally issued with credit ratings of "A" or higher. However, the market has seen significant downgrades across the asset class. Due to illiquid markets, there is limited availability of historical data bucketed by current ratings. For that reason, original rating

is used when modeling. Non-Agency RMBS are structured into three collateral types as illustrated below. Spreads are reported for the last business day of each month. The data source for Non-Agency RMBS is IDC. IDC provides updates semi-annually for June and December approximately two weeks after the period closes.

Non-Agency RMBS	Prime RMBS	High quality borrowers, typically large loans
	Alt- A RMBS	High quality borrowers with specific loan characteristics precluding "Prime" status
	Subprime	Lower quality borrowers, smaller sized loans

Non-agency RMBS: Time Series start dates						
Prime AAA	Prime AA	Prime A	Alt-A AAA	Alt-A AA	Alt-A A	Subprime AAA
Jan 2007			Jan 2007			Jan 2007

3.2.12 International RMBS

International RMBS represent non-USD denominated bonds collateralized by residential mortgages. BNY Mellon only has international RMBS exposures in the Euro or in the British Pound Sterling (GBP). All instruments are floaters vs. 6-month Libor. The data source for the International RMBS is Barclays Live.

International RBMS							Start date	
Euro_MBS-UK	Floating Prime	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007
	Floating Non-conforming	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007
UK_RMBS-GBP	Floating UK Prime	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007
UK_RMBS-Euro	UK Prime - Euro 5 Year	AAA			AA	A	BBB	Jan 2006
Euro_RMBS-Ireland	Floating Irish	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007
Euro_RMBS-Italy	Floating Italian	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007
Euro_RMBS-Dutch	Floating Dutch	AAA 0-3	AAA 3-5	AAA 5-10	AA	A	BBB	Sep 2007

3.2.13 Asset-Backed Commercial Paper (ABCP)

BNY Mellon's risk exposure is to Asset-Backed Commercial Paper (ABCP) issued by Barclay's Bank PLC. For risk modeling purposes, Barclay's senior credit curves (NY Close) are used. The spread series consists of the Barclays PLC (BARC) 6M, the shortest tenor for which data is available, and the senior spread NY close. There were no data gaps in these series. Starting in September 2008, rates are quoted daily for the following maturities: 6, 9 and 12 months and 1 year. The data source for ABCP is Barclays Live.

3.2.14 Money Market Mutual Funds and Equities

Underlying data for equities and funds is a composition pulled from the Investment Manager's website/publications. BNY Mellon's Market Risk group is responsible for gathering the underlying data and for all modeling. It is generally expected that Mutual Fund asset class breakdown is only available 2-3 weeks after month-end. Market Risk evaluates the funds in each stress scenario and determines if the fund breaks the buck. ALM-IRR incorporates the assumptions provided by the Market Risk group.

3.2.15 Government Guaranteed and Supranational

For modeling purposes, Government Guaranteed and Supranational bonds are modeled off of the Sovereign bond curves. No Government Guaranteed or Supranational curves were explicitly collected.

4. Modeling and Implementation

4.1 Segmentation for Credit Spreads and OAS

BNY Mellon's Portfolio Management Group manages the liquid assets on Corporate Treasury's Balance Sheet. This portfolio hedges interest rate risk, maintains a liquidity buffer and seeks to maximize yield through a portfolio of securities. The investment portfolio operates within the firm's operational, market and credit risk frameworks and is subject to risk limits defined in the Firm's risk policies. Ongoing portfolio reviews assess liquidity, rate of return, valuation, creditworthiness and duration. Sources of funds are fungible and include, without limitation, deposits, term debt and repurchase agreements. Composition of the portfolio is governed by the Fixed Income Portfolio Committee, the Asset and Liability Committee (ALCO) and Corporate Treasury with oversight from BNY Mellon's Board of Directors.

Portfolio activity is fully documented to support all risk, accounting and regulatory requirements. Documentation has included support for portfolio segmentation, accounting classification (AFS vs. HTM) and appropriate reference data.

Dodd Frank Act and CCAR Stress Testing require that the Investment Portfolio's risk profile is sufficiently detailed to support model development, baseline assumptions and documentation in accordance with supervisory expectations. Each asset class was thoroughly vetted to understand its inherent risks. Individual risk positions were characterized by the following criteria (where appropriate).

Criteria for Disaggregating Risk at a Granular Level		
Rating	Remaining life and/or Duration	Currency
Collateral	Valuation Base Rates	Country of Risk
Year of Issue	Level within the Capital Structure	Original Term

The BNY Mellon investment portfolio has a total market value of \$119B as of December 31, 2015, classified as AFS (\$75.9B) and HTM (\$43.3B) for accounting purposes. For the purpose of stress testing, OCI is calculated primarily for the AFS portion of the BNY Mellon investment portfolio. Any HTM securities which are found to have OTTI will also have an OCI component calculated. The BNY Mellon Investment Portfolio consists of Agency MBS, Agency CMBS, Non-

Agency CMBS, Sovereign Bonds, Municipal Bonds, ABS, Non-Agency RMBS, Covered Bonds, Collateralized Loan Obligations, Corporate Bonds, Agency Debentures, International MBS, ABCP, Money Market Funds, Government Guaranteed International Bonds, Supranational Bonds, Equities and Mutual Funds.

Investment Portfolio transactions are recorded in the firm's trade and portfolio risk management system, Aladdin. Asset reference data, including credit ratings from S&P, Moody's and Fitch, were sourced independently from BlackRock. In the QRM framework, assets are modeled at their most detailed level. However, market data limitations, immaterial risk exposure and other idiosyncratic considerations may result in risk exposures for OCI credit spreads being modeled at a consolidated level. In determining alignment between forecasted market rates to individual assets, BNY Mellon considered the following:

- Categories of assets
- Market data availability
- Materiality of positions
- Product specific risks

BNY Mellon consolidated exposures within asset class in order to reduce operational risk and to focus resources on critical exposure that could affect capital. Collapsing of immaterial exposures was done in a conservative manner, was fully documented, and was in alignment with data constraints and made with reasonable assumptions about the underlying assets. Final segmentation of the Investment Portfolio along with consolidation of risk positions was fully vetted within the Governance Framework that oversees DFAST and CCAR Stress Testing.

The stress scenario specific spreads applied to securities for OCI projection were segment specific in order to capture the risks to a reasonable degree of detail across the investment portfolio. There were some data availability and asset liquidity limitations in obtaining consistent data from the year 2000 to the present, with the pre/post 2008 financial crisis being one major threshold. As a result there were some constraints with regards to the segmentation process. ALM-IRR considered materiality in the segmentation process when assets with similar risk profiles were consolidated within the various sub asset classes.

Details of the final segments for CCAR 2016 are documented in Appendix 7.1

4.1.1 Agency Mortgage Backed Securities (MBS)

Description

Agency MBS securities have underlying collateral that is guaranteed or insured by one of three government or government-sponsored agencies: Government National Mortgage Association or “Ginnie Mae” (GNMA); Federal National Mortgage Association or “Fannie Mae” (FNMA); Federal Home Loan Mortgage Corporation or “Freddie Mac” (FHLMC).

GNMA is a wholly-owned entity of the Department of Housing and Urban Development (HUD) and is backed by the full faith and credit of the United States (US) government. FNMA and FHLMC are government sponsored entities that operate ideally as public companies, but have been managed by the FHA since 2008¹⁹. The agencies have a funding advantage over other mortgage investors. Agency debt trades tighter to treasuries than that of competitors due to “implied” government backing and credit line of the US.

Risk Profile

The risk characteristics of Agency MBS's were determined by the pre-payment characteristics of the underlying collateral and the structures principal and coupon payment rules. Although the basic CMO structure was designed to re-distribute pre-payment risk among the different tranches, total pre-payment risk of the underlying collateral remained the same. Therefore, accounting for total pre-payment risk of the underlying collateral was the key determinant for CMO valuations.

Agency Pass-through Segmentation

A “pass-through” is the basic MBS structure. Loans with similar characteristics were pooled together and securitized. The structure then passed the monthly principal and interest payments from a pool of mortgages to investors. Agency MBS securities are considered highly liquid. Pass-through MBS will have a fixed interest rate when the underlying collateral mortgages are fixed rate. If the underlying pool is resetting at a variable rate then the pass through will also pay a variable rate of interest.

¹⁹ As of September 6, 2008, both Freddie Mac and Fannie Mae went into conservatorship under the Federal Housing Finance Authority (FHFA) through The Housing and Economic Recovery Act of 2008. As of November, 2015, this conservatorship is still in place

Issuing agency, original tenor and coupon formed the basis of the initial segmentation at the granular levels. MBS positions with original maturities of 10 or 20 years were consolidated into the 15 year positions based on materiality and given that the assets have a similar risk profile.

Although TBA (pre and post crisis) pools with given coupons were available across multiple vintages, some blended time series (across all vintages) indicated spreads that were inconsistent with the pricing of the current portfolio. ALM-IRR determined vintage to be critical to model the pass-through risk on certain off-the-run coupons. Therefore, including vintage in time-series data provided more reasonable observed spread levels. ALM-IRR consolidated the vintages based on materiality and data availability. The final segmentation revealed there to be differing risk profiles of pre and post financial crisis vintages for some combinations of agency, tenor and coupon.

The charts below illustrate the process of analysis to arrive at the final segmentation during development. Multiple angles for each asset class were considered in order to arrive at a breadth of history and review of OAS levels to find the vintages most representatives for this asset class.

Agency	Vintage	Coupon												Market Value (\$mm)	DV01 (\$m)	Spread DV01 (\$m)	Materiality Test
		2.00	2.50	3.00	3.50	4	4.50	5.00	5.50	6.00	6.50						
FNMA 10YR	2013			125		-							125	30	32		
FNMA 15YR	2002					-		0	0	0	0		0	0	0		
	2003					-		0	0	0	0		16	2	2		
	2004					-		35	7	0	0		43	6	6		
	2005					-		24	2	0	0		26	4	4		
	2006					-		22	9	0	0		31	4	4		
	2007					-		15	0	0	0		15	2	2		
	2008					-		52	25	0	0		77	11	11		
	2009							169	119	13	0		301	70	75		
	2010							205	115	18	0		341	88	96	✓	
	2011							933	3	8	0		1,301	414	459	✓	
	2012							259	268	0	0		4,232	1,583	1,660	✓	
	2013							54	1,909	11	82						
	2014							547	676	10	661						
	2015							676	661	62	683						

Annotations:

- Arrows point from the 2013 vintage to the 2002 vintage, indicating a comparison or merge.
- A box labeled "FNMA 15YR CC" is positioned over the 2008 vintage data.
- A box labeled "FNMA 15 Yr 4.5 2005" is positioned over the 2011 vintage data.
- A box labeled "FNMA 15YR 4.0 2011" is positioned over the 2012 vintage data.

in millions\$

Coupon

Agency	Vintage	2.00	2.50	3.00	3.50	4	4.50	5.00	5.50	6.00	6.50	Market Value (\$mm)	DV01 (\$m)	Spread DV01 (\$m)	Maturity Test
FHLMC 15YR	2002					-	-	3		0		3	0	0	
	2003					-	17	6				23	2	2	
	2004					1	28	3				32	4	4	
	2005					4	22	8				34	5	5	
	2006					0	21	21				42	6	6	
	2007					0	12	6				18	3	3	
	2008					0	7	43				50	8	8	
	2009					82	200	28				309	63	67	
	2010					320	72	90				578	143	160	✓
	2011					40	179	9				852	256	287	✓
	2012					1,811	2,689	62				4,561	1,657	1,742	✓
	2013					2,079	165	88				2,333	923	963	✓
	2014					498	55	-				554	220	243	✓
	2015					1,862	-					1,862	740	846	✓

Certain low coupons (~3.5% or lower) had limited historical data availability and were generally of a more recent vintage; their time series have a later start date and shorter range. Given the lower interest rate environment, current coupon time series was used as a proxy on these lower coupons where satisfactory time series were unavailable. The charts below further illustrate the process of segmentation from the granular level to the best fit for that asset class based on coupon.

Agency	Coupon	Market Value (\$mm)	Segmentation
FNMA 10YR	2.5	125	FNMA 15YR CC
FNMA 15YR	2.5	156	FNMA 15YR CC
	3	1,449	
	3.5	1,631	
	4	635	FNMA 15YR 4.0 2011
	4.5	421	FNMA 15YR 4.5 2005
	5	194	
	5.5	1	
FHLMC 15YR	6	0	
	6.5	0	
	2.5	34	FHLMC 15YR CC
	3	2,089	
	3.5	1,202	
	4	553	FHLMC 15YR 4.0 2010
	4.5	384	FHLMC 15YR 4.5 2005-FHLMC 15YR 4.5 2009
GNMA 15YR	5	208	FHLMC 15YR 5.0 2005-FHLMC 15YR 5.0 2008
	6	0	
	2.5	1	GNMA 15YR CC
FNMA 20YR	4	1	
	7	0	
	2.5	13	FNMA 15YR CC
	4	5	FNMA 15YR 4.0 2011
	4.5	32	FNMA 15YR 4.5 2005
FHLMC 20YR	5	0	
	7	0	
	2.5	0	FHLMC 15YR CC
	4.5	0	FHLMC 15YR 4.5 2005
	5	12	FHLMC 15YR 5.0 2005
	5.5	0	
	7	0	

Agency	Coupon	Market Value (\$mm)	Segmentation
FNMA 30Y	2.5		
	3	31	
	3.5	186	FNMA 30Y CC
	4	101	
	4.5	60	FNMA 30Y 4.5 2005
	5	194	
	5.5	42	
	5.75	2	
	6	24	
	6.5	4	
	7	0	
	7.5	0	
	8	0	FNMA 30Y 5.5 2006
FHLMC 30Y	2.5		
	3		
	3.5		
	4	1	
	4.5	84	
	5	16	
	5.5	8	FHLMC 30Y CC
	5.75		
	6	7	
	6.5	1	
GNMA 30Y	7	0	
	7.5	0	
	8	0	
	2.5		
	3	1	
	3.5	35	
	4	17	
	4.5	6	
	5	28	
	5.5		GNMA 30Y CC

The segmentation approach during development²⁰ is described below

²⁰ Segmentation development was on the 6/30/2015 securities portfolio.

Phase 1: Initial data was analyzed and sorted by Security Type

Security Description	SECURITY TYP	Agency	Coupon
FNMA_15YR	MBS 15yr	FNMA_15YR	6.500
FNMA_20YR	MBS 20yr	FNMA_20YR	7.000
FNMA_15YR	MBS 15yr	FNMA_15YR	8.000
FNMA_20YR	MBS 20yr	FNMA_20YR	5.000
GNMA_30YR	MBS 30yr	GNMA_30YR	7.500
FGOLD_30YR	MBS 30yr	FHLMC_30YR	5.500
FNMA_30YR	MBS 30yr	FNMA_30YR	7.000

Conclusion: Security type is a material for segmentation. The 10Y and 20Y positions were immaterial and consolidated with the 15Y MBS positions.

Phase 2: Within each Security Type, each position was analyzed and bucketed by Issuing Agency.

Security Description	SECURITY TYP	Agency	Coupon
FNMA_15YR	MBS 15yr	FNMA_15YR	6.500
FNMA_20YR	MBS 20yr	FNMA_20YR	7.000
FNMA_15YR	MBS 15yr	FNMA_15YR	8.000
FNMA_20YR	MBS 20yr	FNMA_20YR	5.000
GNMA_30YR	MBS 30yr	GNMA_30YR	7.500
FGOLD_30YR	MBS 30yr	FHLMC_30YR	5.500
FNMA_30YR	MBS 30yr	FNMA_30YR	7.000

Conclusion: Issuing agency is material for segmentation based on historical OAS levels.

Phase 3: Within each Issuing Agency, each position was analyzed and bucketed by Coupon:

Security Description	SECURITY TYP	Agency	Coupon
FNMA_15YR	MBS 15yr	FNMA_15YR	6.500
FNMA_20YR	MBS 20yr	FNMA_20YR	7.000
FNMA_15YR	MBS 15yr	FNMA_15YR	8.000
FNMA_20YR	MBS 20yr	FNMA_20YR	5.000
GNMA_30YR	MBS 30yr	GNMA_30YR	7.500
FGOLD_30YR	MBS 30yr	FHLMC_30YR	5.500
FNMA_30YR	MBS 30yr	FNMA_30YR	7.000

MBS 15 Year Pass-Throughs

Coupon	Market Value (m)	DV01	Spread DV01
4.500	49,900	11	13
5.000	13,260,905	2,989	3,424
5.500	42,826	11	12
7.000	51,927	5	5

MV	DV01	Spread DV01
0.00%	0.00%	0.00%
0.02%	0.01%	0.02%
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%

FHUMC 20YR	13,405,558	3,017	3,454
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0.02%	0.01%	0.02%
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2.500	34,861,779	14,030	14,469
3.000	1,620,617,976	617,869	654,241
3.500	1,265,974,808	415,864	469,119
4.000	589,470,358	169,493	188,173
4.500	427,457,076	79,226	83,516
5.000	233,534,321	36,916	37,893
6.000	17,749	2	2

0.05%	0.04%	0.07%
2.10%	2.75%	3.35%
1.64%	1.84%	2.40%
0.76%	0.75%	0.96%
0.55%	0.55%	0.43%
0.30%	0.14%	0.19%
0.00%	0.00%	0.00%

FHUMC 15YR	4,185,339,624	1,336,418	1,450,867
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5.42%	5.90%	7.43%
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Coupon	Market Value (m)	DV01	Spread DV01
2.500	132,103,784	33,911	35,164

MV	DV01	Spread DV01
0.17%	0.15%	0.18%

FNMA 10YR	132,103,784	33,911	35,164
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0.17%	0.15%	0.18%
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4.000	13,312,581	4,111	4,975
4.500	5,391,629	1,544	2,030
5.000	34,154,364	7,628	8,640
7.000	84,448	11	12
7.500	54,945	8	8
8.000	182,461	27	27

0.02%	0.02%	0.03%
0.01%	0.01%	0.01%
0.04%	0.05%	0.04%
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%

FNMA 20YR	53,180,429	13,329	15,692
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0.07%	0.06%	0.08%
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2.500	161,475,613	66,311	67,813
3.000	1,426,679,546	561,488	596,011
3.500	1,710,037,299	597,865	664,128
4.000	673,496,406	199,664	219,701
4.500	470,166,419	87,521	91,913
5.000	222,219,081	35,218	35,765
5.500	555,170	97	107
6.000	32,948	3	3
6.500	907	0	0

0.21%	0.20%	0.38%
1.85%	2.43%	3.05%
2.21%	2.54%	3.40%
0.87%	0.88%	1.12%
0.61%	0.59%	0.47%
0.29%	0.14%	0.18%
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%

FNMA 15YR	4,849,947,553	1,595,406	1,726,296
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6.28%	7.04%	8.84%
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Coupon	Market Value (m)	DV01	Spread DV01
4.000	1,063,537	288	328
7.000	7,425	0	0

MV	DV01	Spread DV01
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%

GNMA 15YR	1,070,962	289	328
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0.00%	0.00%	0.00%
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Total MBS 15 Year	9,036,358,140	2,932,113	3,177,491
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11.70%	12.94%	16.26%
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MBS 30 Year Pass-Throughs

Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
4.000	1,052,056	429	605	0.00%	0.00%	0.00%
4.500	87,428,679	36,010	44,041	0.11%	0.16%	0.23%
5.000	16,891,632	7,107	9,073	0.02%	0.03%	0.05%
5.500	8,400,564	2,714	3,652	0.01%	0.01%	0.02%
6.000	7,399,436	1,894	2,868	0.01%	0.01%	0.01%
6.500	668,812	245	285	0.00%	0.00%	0.00%
7.000	76,920	30	31	0.00%	0.00%	0.00%
7.500	117,244	38	38	0.00%	0.00%	0.00%
8.000	26,024	8	9	0.00%	0.00%	0.00%

FHLMC 30YR	122,061,368	48,476	60,600	0.16%	0.21%	0.31%
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Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
3.000	25,887,797	16,689	18,423	0.08%	0.07%	0.09%
3.500	174,664,025	96,017	114,791	0.23%	0.42%	0.59%
4.000	100,670,656	46,931	59,753	0.13%	0.21%	0.31%
4.500	63,861,693	23,898	31,796	0.08%	0.11%	0.16%
5.000	207,745,849	67,509	95,895	0.27%	0.30%	0.49%
5.500	46,132,722	13,138	19,126	0.06%	0.06%	0.10%
5.750	1,927,748	488	760	0.00%	0.00%	0.00%
6.000	26,256,641	7,636	10,700	0.08%	0.03%	0.05%
6.500	4,188,659	1,375	1,735	0.01%	0.01%	0.01%
7.000	205,094	72	75	0.00%	0.00%	0.00%
7.500	41,638	12	12	0.00%	0.00%	0.00%
8.000	222,614	80	81	0.00%	0.00%	0.00%

FNMA 30YR	651,805,136	273,845	353,147	0.84%	1.21%	1.81%
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Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
3.500	30,496,201	12,062	15,989	0.04%	0.05%	0.08%
4.000	18,856,674	4,651	8,521	0.02%	0.02%	0.04%
4.500	6,246,761	1,240	2,796	0.01%	0.01%	0.01%
5.000	30,379,438	9,575	14,954	0.04%	0.04%	0.08%
6.000	22,592,074	9,494	11,889	0.08%	0.04%	0.06%
6.500	110,430	50	57	0.00%	0.00%	0.00%
7.000	1,094,020	322	339	0.00%	0.00%	0.00%
7.500	1,263,302	464	491	0.00%	0.00%	0.00%
8.000	171,463	43	45	0.00%	0.00%	0.00%

GNMA 30YR	111,210,364	37,899	55,080	0.14%	0.17%	0.28%
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Total MBS 30YR	885,076,868	360,220	468,827	1.15%	1.59%	2.40%
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Conclusion: Multiple coupons were identified as material. Certain low coupons (~3.5% or lower) had limited historical data available and were generally of a more recent vintage. These were consolidated with Current coupon.

Phase 4: Each position was further analyzed and bucketed by **Vintage**

Security Description	Agency	Security Type	Coupon	Issue Date
FGOLD 15YR	POOL	FHLMC 15YR	3.500	12/01/2010
FGOLD 15YR	POOL	FHLMC 15YR	3.500	02/01/2011
FGOLD 15YR	POOL	FHLMC 15YR	3.500	01/01/2011
FGOLD 15YR	POOL	FHLMC 15YR	3.500	12/01/2010
FGOLD 15YR	POOL	FHLMC 15YR	3.500	08/01/2011

Conclusion: Issuance year/Vintage was mostly immaterial from materiality threshold. Some vintage segments were considered when the historical spreads were significantly different between pre and post-crisis issuance.

Phase 5: Segmentation was reviewed for materiality of **Agency MBS Pass-through** based on Issuing Agency, Coupon, and vintage, Market Value, DV01, and Spread DV01. Coupons were consolidated based on materiality thresholds.

MBS 15 Year Pass-Throughs

Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
current coupon	2,921,454,562	1,047,764	1,137,830	3.78%	4.63%	5.82%
4.000	589,470,358	169,493	188,173	0.76%	0.75%	0.96%
4.500 pre crisis	111,423,029	16,040	16,264	0.14%	0.07%	0.08%
4.500 post crisis	316,083,947	63,197	67,264	0.41%	0.18%	0.34%
5.000 pre-crisis	66,613,573	11,264	11,908	0.09%	0.05%	0.08%
5.000 post-crisis	180,294,155	28,659	29,428	0.23%	0.13%	0.15%
FHLMC 15YR	4,185,339,624	1,336,418	1,450,867	5.42%	3.90%	7.43%
Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
current coupon	3,430,296,242	1,259,574	1,363,116	4.44%	5.36%	6.98%
4.000	686,808,987	208,775	224,676	0.89%	0.90%	1.15%
4.500	475,558,048	89,065	98,943	0.62%	0.39%	0.48%
FNMA 15YR	4,849,947,553	1,595,406	1,726,296	6.28%	7.04%	8.84%
Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
current coupon	1,070,962	289	328	0.00%	0.00%	0.00%
GNMA 15YR	1,070,962	289	328	0.00%	0.00%	0.00%
Total MBS 15 Year	9,086,358,140	2,932,113	3,177,491	11.70%	12.94%	16.26%

MBS 30 Year Pass-Throughs

Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
FHLMC 30YR	122,061,368	48,476	60,600	0.16%	0.21%	0.31%
Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
current coupon	301,222,477	159,637	192,966	0.39%	0.70%	0.99%
4.500	63,861,693	23,898	31,796	0.08%	0.11%	0.16%
5.500	286,720,966	90,310	128,384	0.37%	0.40%	0.66%
FNMA 30YR	651,805,136	273,845	353,147	0.84%	1.21%	1.81%
Coupon	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
GNMA 30YR	111,210,364	37,899	55,080	0.14%	0.17%	0.28%
Total MBS 30YR	885,076,868	360,220	468,827	1.15%	1.59%	2.40%
Total MBS Passthroughs	9,921,435,007	3,292,332	3,646,318	12.85%	14.53%	18.66%

Agency Hybrid ARMS Segmentation:

ALM-IRR segmented the Agency Hybrid ARMS portfolio by issuing agency (FNMA, FHLMC, and GNMA). ALM-IRR then further combined these positions by term structure (3/1, 5/1 fixed/float trait) within each issuing agency. Initially, ALM-IRR evaluated exposure by coupon within each term structure for materiality and consolidated accordingly. However, based on the materiality threshold outlined above, ALM-IRR determined that coupon segmentation did not meet the minimum criteria and was subsequently eliminated.

Data availability for Agency Hybrid ARMS was generally strong based on the criteria set forth for evaluating data quality. Data constraints were not applicable for this asset class. ALM-IRR segmented vendor sourced data by issuing agency, term structure, and reset caps (initial/periodic/life) and coupon.

From further analysis of materiality and exposure, and given that the risk profiles across the different term structures were closely correlated, ALM-IRR determined that the term structure segment could be consolidated with minimal effect on analytical results. Consequently, all term structure segments were consolidated into the 5/1 bucket for FNMA and FHLMC. Additionally, ALM-IRR determined that GNMA Hybrids could be modeled using the FNMA and FHLMC data as a more conservative approach given that GNMA is backed by the full faith and credit of the

US government and is, therefore, of a higher credit quality. The below figures illustrate the four step process for this asset class during development.

Phase 1: Initial data was analyzed and sorted by **Issuing Agency**:

LONG COMP NAME	MTG_COLLAT_TYP	Agency
Fannie Mae Pool	FNARM	Fannie Mae
Ginnie Mae II pool	GNMA	Government National Mortgage
Freddie Mac Non Gold Pool	FHARM	Freddie Mac

Conclusion: Issuing agency is material for risk profile segmentation but not by market value and credit risk exposure.

Phase 2: Within each agency, each position was analyzed and bucketed by **Fixed/Floating Trait**.

MTG_COLLAT_TYP	Fixed/Floating Trait	Security Type
FNARM	7/1	POOL
FNARM	10/1	POOL
FNARM	5/1	POOL
FNARM	7/1	POOL

Conclusion: Fixed/Float trait is not material by market value and credit risk exposure.

Phase 3: Initial Segmentation for Agency Hybrid ARMS based on issuing agency, Fixed/Floating Traits, Market Value, DV01, and Spread DV01.

FHLMC				MV	DV01	Spread DV01
Traits	Total Market Value (m)	Total DV01(m)	Total Spread DV01 (m)			
1/1	164,545	12	70	0.00%	0.00%	0.00%
3/1	20,272,958	1,246	7,805	0.03%	0.01%	0.04%
5/1	154,754,596	12,673	72,046	0.20%	0.06%	0.37%
7/1	273,411,247	57,220	101,389	0.35%	0.23%	0.52%
10/1	204,172,664	48,728	84,709	0.26%	0.22%	0.43%
Total FLMC	652,776,009	119,878	266,019	0.85%	0.53%	1.36%

FNMA				MV	DV01	Spread DV01
Traits	Total Market Value (m)	Total DV01(m)	Total Spread DV01 (m)			
1/1	10,097,013	811	4,187	0.01%	0.00%	0.02%
3/1	14,744,900	930	5,971	0.02%	0.00%	0.02%
5/1	394,894,613	39,375	166,457	0.51%	0.17%	0.85%
7/1	405,922,345	47,296	130,829	0.53%	0.21%	0.67%
10/1	435,681,554	124,163	190,213	0.56%	0.55%	0.97%
Total FNMA	1,261,340,426	212,575	497,658	1.63%	0.94%	2.55%

GNMA				MV	DV01	Spread DV01
Traits	Total Market Value (m)	Total DV01(m)	Total Spread DV01 (m)			
1/1	24,435	3	7	0.00%	0.00%	0.00%
3/1	305,238,062	83,150	95,662	0.00%	0.00%	0.00%
5/1				0.40%	0.37%	0.49%
7/1				0.00%	0.00%	0.00%
10/1				0.00%	0.00%	0.00%
Total GNMA	305,262,497	83,153	95,669	0.40%	0.37%	0.49%
Total Hybrid ARMS	2,219,378,932	415,606	859,346	2.87%	1.83%	4.40%

Conclusion: The exposure is not material for FHLMC and GNMA. FHLMC segment was retained due to different risk profile and GNMA hybrids will be modeled using the FNMA segment. Fixed/Float reset traits were mostly immaterial and consolidated.

Phase 4: Final Segmentation for Agency Hybrid ARMS based on 4 Step Process

Total FLMC	652,776,009	119,878	266,019	0.85%	0.53%	1.36%
Total FNMA	1,261,340,426	212,575	497,658	1.63%	0.94%	2.55%
Total Hybrid ARMS	2,219,378,932	415,606	859,346	2.87%	1.83%	4.40%

Agency Collateralized Mortgage Obligation (CMO) Segmentation:

Agency CMOs are mortgage-backed securities in which principal repayments are organized by maturities and into different classes based on risk. A CMO is a special purpose entity that owns a pool of mortgages from which it receives cash flows. These are transformed into payments made to various bondholders based on a structure of subordinated tranches. An

agency CMO is just a CMO formed with pools of mortgages conforming to agency standards and enhanced with the agencies' respective guarantees. Examples of such structures include Pass-throughs, PACs, TACS and, sequential. PACs and TACs reallocate prepayment risk while pass-throughs are subject to prepayment risk. Sequentials allocate principals over the entire structure and are retired in a pre-determined sequence.

The risk characteristics of Agency CMO's were determined by the pre-payment characteristics of the underlying collateral and the structure's principal and coupon payment rules. Although the basic CMO structure is designed to re-distribute pre-payment risk among the different tranches, total pre-payment risk of the underlying collateral remains the same. The key determinant for CMO valuations was the consideration for the total pre-payment risk of the underlying collateral. ALM-IRR performed the initial segmentation at the most granular level by issuing agency: FNMA, FHLMC, & GNMA and then made considerations for properties specific to coupon type. ALM-IRR then sourced relevant historical data and evaluated it to determine the depth of data (OAS type and granularity by asset type) the length of the time frame of the time series and the quality and consistency of accuracy as well as the existence of potential data gaps. Available data for Agency CMO's was satisfactory based on the criteria set forth for evaluating data quality.

For segmentation of the Agency CMO portfolio, ALM-IRR removed segmentation by issuing agency based on data availability and accepted market standard for Agency CMO valuation and risk characteristics. ALM-IRR then bucketed by coupon type (fixed or floating). Each coupon type was segmented by tranche type; pass-through, PAC/TAC, and Sequential. In addition, ALM-IRR segmented floating rate positions by applicable rate caps. Based on materiality, these caps were set at 6.5% and 7.0%. ALM-IRR then created additional segments for the fixed-rate coupon type based on WAL and evaluated them for materiality and further consolidated accordingly. ALM-IRR determined, based on the materiality threshold, to consolidate positions into two WAL buckets using the short-term and long-term lives. The charts below illustrate the segmentation development through each step of the four step process.

Phase 1: Initial data was analyzed and bucketed by Tranche Type and Coupon Type:

Security Description	MTG TRANCHE TYP	MTG TRANCHE TYP LONG
FNMA_08-19B AG	SEQUENTIAL	AD,SEQ
FNMA_08-36C AB	SEQUENTIAL	EXCH,SEQ
FNMA_09-52J KC	SEQUENTIAL	EXCH,SEQ

Security Description	MTG TRANCHE TYP	MTG TRANCHE TYP LONG	CPN TYP
FNMA_08-19B AG	SEQUENTIAL	AD,SEQ	FIXED
FNMA_08-36C AB	SEQUENTIAL	EXCH,SEQ	FIXED
FNMA_09-52J KC	SEQUENTIAL	EXCH,SEQ	FIXED
FNMA_09-19L ED	SEQUENTIAL	EXCH,SEQ	FIXED
FHLMC_2617 HC	SEQUENTIAL	EXCH,SEQ	FIXED
FNMA_14-14A BA	SEQUENTIAL	EXCH,SEQ	FIXED

Conclusion: Both Tranche type and coupon type have material risk profile for segmentation.

Phase 2: Fixed Rate bonds were analyzed and bucketed by WAL:

Security Description	MTG WAL	Market Value (m)	DV01 (m)	Spread DV01 (m)
FNMA_08-19B AG	1.00	17,054	2	2
FNMA_08-36C AB	0.00	738	0	0
FNMA_09-52J KC	1.00	10,297	1	1
FNMA_09-19L ED	1.00	4,085	0	0
FHLMC_2617 HC	1.00	3,950	0	0

Conclusion: A short-term and a long-term WAL bucket were chosen for segmentation.

Phase 3: Floating Rate bonds were analyzed and bucketed by Floater Cap:

Security Description	MTG TRANCHE TYP LONG	CPN TYP	MTG WAL	MTG LIFE CAP
FNMA_15-42E_LF	EXCH,FLT,PT	FLOATING	3.00	6.50
FNMA_07-88C_AF	EXCH,FLT,PT	FLOATING	3.00	7.00
FNMA_06-115C_EF	EXCH,FLT,PT	FLOATING	3.00	7.00
FNMA_07-75A_AF	EXCH,FLT,PT	FLOATING	3.00	7.50
FHLMC_4347B_FH	EXCH,FLT,PT	FLOATING	3.00	6.50
FHLMC_3871G_MF	EXCH,FLT,PT	FLOATING	3.00	7.50

Conclusion: floater cap is material for risk profile segmentation.

Phase 4: Initial Segmentation; Agency CMO and Floater Strip positions were segmented based on Tranche Type, WAL, Market Value, DV01, and Spread DV01. Floating Rate bonds were segmented by Coupon Cap in place of WAL. Materiality thresholds were calculated and evaluated to determine final segmentation.

Agency CMO's

Floater Strips				Exceeds materiality threshold		
Floater Cap	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
6.00	13,730,779	1,104	7,172	0.02%	0.00%	0.04%
6.50	508,109,864	37,223	247,720	0.68%	0.16%	1.27%
7.00	1,693,035,129	103,828	806,162	2.19%	0.48%	4.13%
7.50	132,587,604	7,939	64,197	0.17%	0.04%	0.33%
8.00	13,688,675	776	8,722	0.02%	0.00%	0.04%
8.50	280,368	12	115	0.00%	0.00%	0.00%
Total Floaters	2,361,432,420	150,883	1,134,089	3.08%	0.67%	5.81%
Total	3,690,886,878	656,977	1,699,121	4.78%	2.90%	8.70%

Floater Strips				Exceeds materiality threshold		
Floater Cap	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
6.00	10,736,470	850	5,087	0.01%	0.00%	0.03%
6.50	3,097,976,334	268,694	1,763,876	4.01%	1.19%	9.03%
6.75	174,357,952	10,143	84,318	0.23%	0.04%	0.43%
7.00	4,276,557,854	319,514	2,411,288	5.54%	1.41%	12.34%
7.25	10,232,110	785	5,845	0.01%	0.00%	0.03%
7.50	197,701,870	11,501	91,400	0.26%	0.05%	0.47%
8.00	4,354,484	140	1,081	0.01%	0.00%	0.01%
8.50	7,994,297	356	3,463	0.01%	0.00%	0.02%
Total Floater Strips	7,779,911,381	611,981	4,366,308	10.08%	2.70%	22.35%
Total Agency CMO's	11,470,798,259	1,268,958	6,065,429	14.86%	5.60%	31.05%

SEQUENTIAL / Pass-Throughs

Average Life (WAL)	Market Value (m)	DV01	Spread DV01
< 1.0	4,130,537	140	141
1.00	55,499,185	6,250	6,497
2.00	3,140,174	665	673
3.00	116,547,699	34,385	42,516
4.00	220,348,670	86,324	97,496
5.00	315,264,871	128,742	152,864
6.00	122,035,946	55,441	66,321

 Total SEQUENTIAL's **836,967,081** **311,946** **366,509**

Average Life (WAL)	MarketValue (m)	DV01	Spread DV01
1.00	56,205,215	6,971	7,017
3.00	15,576,777	4,467	4,948
4.00	109,607,366	45,295	47,963

 Total PassThroughs **181,389,358** **56,733** **59,928**

pink cells less than .5%

MV	DV01	Spread DV01
0.01%	0.00%	0.00%
0.07%	0.03%	0.08%
0.00%	0.00%	0.00%
0.15%	0.15%	0.22%
0.29%	0.38%	0.50%
0.41%	0.57%	0.78%
0.18%	0.24%	0.34%

1.08% 1.38% 1.88%

MV	DV01	Spread DV01
0.07%	0.03%	0.04%
0.02%	0.02%	0.03%
0.14%	0.20%	0.25%

0.23% 0.23% 0.31%

PAC/TAC's

Average Life (WAL)	MarketValue (m)	DV01	Spread DV01
< 1.0	677,080	41	41
1.00	5,964,995	541	543
2.00	19,595,104	4,272	4,623
3.00	3,894,923	1,283	1,445
4.00	76,357,536	30,057	30,267
5.00	100,748,339	46,615	45,448
6.00	105,860,042	54,606	56,229

 Total PAC/TAC's **311,098,019** **137,414** **138,596**

MV	DV01	Spread DV01
0.00%	0.00%	0.00%
0.01%	0.00%	0.00%
0.08%	0.02%	0.02%
0.01%	0.01%	0.01%
0.10%	0.13%	0.15%
0.13%	0.21%	0.23%
0.13%	0.24%	0.29%

0.40% 0.61% 0.71%

Phase 5: Final Segmentation for Agency CMO's and Floater Strips based on 4 step process:

SEQUENTIAL / Pass-Throughs				pink cells less than .5%		
Average Life (WAL)	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
ZY	399,666,264	120,709	140,013	0.52%	0.53%	0.72%
10Y	437,300,817	184,183	219,185	0.57%	0.61%	1.12%
Total SEQ UENTIAL's	836,967,081	311,946	366,509	1.08%	1.38%	1.88%
Average Life (WAL)	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
ZY	181,389,358	56,733	59,928	0.23%	0.25%	0.31%
Total Pass Throughs	181,389,358	56,733	59,928	0.23%	0.25%	0.31%
PAC/TAC's				pink cells less than .5%		
Average Life (WAL)	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
ZY	105,489,537	36,194	36,918	0.14%	0.16%	0.19%
10Y	204,608,382	101,221	101,677	0.27%	0.45%	0.52%
Total PAC/TAC's	311,098,019	137,414	138,596	0.40%	0.61%	0.71%
Floaters				pink cells less than .5%		
Floater Cap	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
6.50	521,840,643	38,327	254,892	0.68%	0.17%	1.30%
7.00	1,839,591,776	112,556	879,197	2.38%	0.50%	4.50%
Total Floaters	2,361,432,420	150,883	1,134,089	3.06%	0.67%	5.81%
Floater Strips				pink cells less than .5%		
Floater Cap	Market Value (m)	DV01	Spread DV01	MV	DV01	Spread DV01
6.50	3,283,070,756	279,685	1,853,231	4.25%	1.23%	9.49%
7.00	4,495,840,625	332,295	2,513,077	5.82%	1.47%	12.88%
Total Floater Strips	7,779,911,381	611,981	4,366,308	10.08%	2.70%	22.35%

4.1.2 Agency CMBS Segmentation

Description

The Agency CMBS market includes various mortgage-backed securities (MBS), where the underlying assets are commercial real estate, predominantly multifamily properties. Similar to Agency RMBS products, Agency CMBS have either an explicit US government guarantee or are guaranteed by one of the Government Sponsored Enterprises (GSEs). These are more similar to CMO's than pass-throughs, as they are structured typically into tranches. As with Agency MBS, Agency CMBS have underlying collateral that is guaranteed or insured by one of three government or government-sponsored agencies:

Government National Mortgage Association or "Ginnie Mae" (GNMA)

GNMA Project Loan REMICs (GNRs) are multiple-pool deals collateralized by loans fully insured by FHA and wrapped by GNMA.

GNR REMICs were structured into sections based on time and sequential-pay classes. Recent deal structures have evolved to include more bespoke classes with targeted average lives. These include additional front-pay classes, typically named Class AB, AC and so on, with varying payment windows and average lives. These classes receive principal payments, along with Class A, based on a prescribed percentage formula until retired. Earlier vintage GNR deals would generally include a four-class structure (Classes A, B, C, and D) with average lives of 3-, 5-, 8- and 12-years, respectively, a 20-year Z class, which accrues interest that goes to pay down those four classes first while adding to the principal balance of the Z class, and an IO class, which gets the excess interest. In addition, the IO class receives all the prepayment penalties collected by the trustee.

GNMA Project loans have an explicit US government guarantee in the form of FHA insurance, which guarantees eventual payment of principal, less an assignment fee (1%) and one month of interest, and an additional Ginnie Mae guarantee, which ensures the full recovery and timely payment of principal and interest. By virtue of this dual insurance on the underlying project loans, a GNR REMIC deal inherits the explicit government guarantee for the full recovery and timeliness of all cash flows when any of the project loans default.

Federal National Mortgage Association or “Fannie Mae” (FNMA)

DUS MBS pools are Fannie Mae-guaranteed pass-through MBS backed by one or more multifamily loans. The loans are originated by the Fannie Mae licensed lenders under the DUS (Delegated Underwriting and Servicing) program according to the origination and servicing guidelines set by Fannie Mae.

DUS REMICs, also called Fannie Mae ACES® (Alternative Credit Enhancement Securities) enable investors to invest in multiple-pool DUS MBS to gain the benefits of diversification and improved liquidity. A DUS REMIC typically consists of sequential-pay classes (often with par coupon pricing) and an IO class. For example, the structure may consist of an A1 and A2 class, with corresponding AB1 and AB2 classes to absorb any excess principal payments, based on a predetermined formula, designed to provide stable cash flows and targeted weighted average

lives for classes A1 and A2. Any unscheduled principal payments are allocated to Classes AB1, AB2, A1 and A2, in that order, until retired.

There is no explicit US government guarantee for Fannie Mae DUS MBS pools. Fannie Mae bears the full responsibility for making payments under its guarantee, which is for the timely payment of principal and interest for DUS MBS, and the full payment of principal in the event of a default.

Federal Home Loan Mortgage Corporation or “Freddie Mac” (FHLMC)

FHLMC K-Deals are differentiated from other Agency CMBS products by blending several features and best practices from the private-label CMBS market with the guarantee offered by Freddie Mac for the senior classes.

FHLMC K-Deals have two senior classes, guaranteed by Freddie Mac and rated AAA, at the top of capital structure (Class A1 and A2), which are sliced by time frame to different weighted average lives. The subordinate classes, Class B (rated Single-A), Class C (rated BBB) and Class D (unrated first loss tranche), are not guaranteed by Freddie Mac. Class D is a principal-only class and does not receive, or accrue, any interest payments. In addition, multiple IO classes, with notional amounts tied to various rated and/or unrated classes, are present in a K-deal. Principal payments follow a waterfall and are first paid to Class A1, followed, in order of priority, to Class A2, Class B, Class C and then finally to Class D. Any losses are allocated in reverse sequential order starting from the unrated Class D, then Class C and then Class B. If all subordinate classes are wiped out due to losses, any further principal is paid pro-rata between Class A1 and A2.

Freddie Mac provides a guarantee for the top of the capital structure, namely for senior Classes A1, A2 and the related IO classes. The guarantee typically covers the timely payment of interest to Classes A1, A2, and the IO classes X1 and X2-A, the timely payment of principal to the Classes A1 and A2 upon maturity of any loan, the reimbursement of any realized losses and expenses allocated to guaranteed certificates upon ‘resolution’ of defaulted loans (not on the date the loan default occurs), the ultimate payment of principal by the final distribution date for Classes A1 and A2. This ensures that the total principal is paid in full to these classes by the end of year 10 (i.e., the final distribution date) regardless if defaulted loans are resolved, or not, by that time.

Risk profile

The Agency CMBS market includes various mortgage-backed securities (MBS), where the underlying assets are commercial real estate, predominantly multifamily properties. They have either an explicit US government guarantee or are guaranteed by one of the Government Sponsored Enterprises (GSEs); Agency CMBS – have a strong call protection provisions for the underlying loans, which curb voluntary prepayments and provide a cushion to the undesirable negative convexity that is generally present in Non-Agency RMBS.

Segmentation

ALM-IRR segmented Agency CMBS positions by issuing agency (FNMA, FHLMC, & GNMA). From within each issuing agency, ALM-IRR analyzed each tranche class. Each position within the deal waterfall was then evaluated separately. ALM-IRR then applied the following methodology.

GNMA Segmentation

GNMA's were structured as sequential pay bonds. As such, cash flows followed a specified sequence. Tranche sequence was based on WAL, not credit quality. Therefore the segmentation was broken out by the most senior tranche ""A"". Exposure to subsequent tranches was combined into "AD" which represents a 10 to 12 WAL. Tranche data obtained from Bloomberg was fully analyzed and vetted for accuracy

FNMA Segmentation

Underlying collateral for a DUS MBS pool is often a single multifamily loan underwritten by DUS lenders. DUS deals typically consist of sequential-pay classes. Mega deals consist of a single tranche and are considered an A1 level, senior tranche. Tranche data obtained from Bloomberg was fully analyzed and vetted for accuracy.

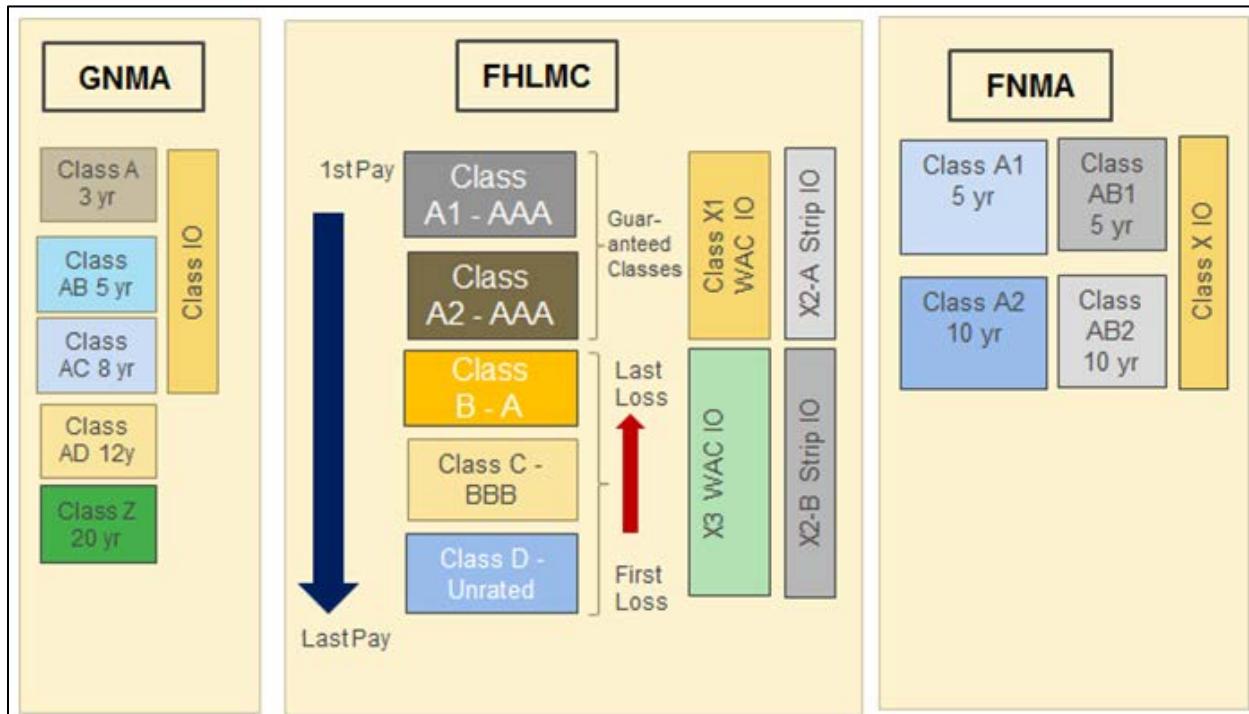
FHLMC Segmentation

In most deals, there are two senior classes, guaranteed by Freddie Mac and rated AAA, at the top of capital structure (Class A1 and A2), which are sliced by time frame into different WAL's. The BNYM portfolio only has positions in either A1 or A2 tranches. Tranche data obtained from Bloomberg was fully analyzed and vetted for accuracy

Data availability for Agency CMBS was adequate based on the criteria set forth for evaluating data quality. Data constraints were generally not applicable for this asset class. Vendor sourced

data was initially segmented by issuing agency. A comprehensive deep dive analysis was then performed based on the each agency's unique structure. Based on these criteria, and the materiality threshold, final segmentation for Agency CMBS was done by issuing agency (FNMA, FHLMC, and GNMA). Positions were further bucketed by tranche within the generic capital structure framework for each issuing agency.

Agency Capital Structure (Generic)



The figures below describe the four step process for segmentation for this asset class during development.

Phase 1: Initial data set was analyzed and sorted by Agency.

Security Description	Agency	Issuer
FHLC MULTI FAMI A	FHLMC	FHLMC MULTIFAMILY STRUCTURED P
FNA 2013-M13 FA	FNMA	FNANNIEMAE-ACES
GNMA 2014-93 AC	GNMA	GOVERNMENT NATIONAL MORTGAGE A

Conclusion: Issuing Agency was identified material for segmentation.

Phase 2: Within each agency, each position was analyzed and bucketed by Tranche Type.

Security Description	Tranche Type
FHLC MULTI FAMI A	SENIOR
FNA 2013-M13 FA	SENIOR
GNMA 2014-93 AC	SENIOR

Conclusion: All BNYM positions are senior tranche (class A1 and A2) and no further segmentation is required.

Phase 3: Segmentation analysis for Agency CMBS based on Issuing Agency, Tranche Class, Market Value, DV01, and Spread DV01.

FHLMC			
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)
A1	789,012,735	78,190	364,858
A2	884,986,589	612,566	619,347
Total FHLMC	1,673,999,323	690,756	984,206
FNMA			
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)
A1	1,030,918,800	172,829	463,568
A2	951,180,707	633,327	652,570
Total FNMA	1,982,049,506	806,156	1,116,137
GNMA			
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)
A	69,941,634	19,857	20,018
AB	32,448,227	7,328	7,372
AC	52,407,319	16,076	18,088
AD	11,848,117	4,392	4,636
Total GNMA	166,645,488	47,853	50,114
Total Agency CMBS	3,802,694,318	1,544,765	2,150,457
	MV	DV01	Spread DV01
	1.00%	0.35%	1.87%
	1.15%	2.70%	3.17%
	2.34%	3.05%	5.04%
	MV	DV01	Spread DV01
	1.34%	0.76%	2.97%
	1.23%	2.00%	3.34%
	2.57%	3.58%	5.71%
	MV	DV01	Spread DV01
	0.09%	0.09%	0.10%
	0.04%	0.03%	0.04%
	0.07%	0.07%	0.08%
	0.02%	0.02%	0.02%
	0.22%	0.21%	0.28%

Conclusion: Segmentation for Agency CMBS is primarily based on the issuing agency. Tranches at the top of capital structure (A1 and A2) are mostly rated AAA and show similar spread behavior. Majority of FNMA deals are mega deals that are considered as senior tranche. The agency CMBS deals are time tranched to WAL and not necessarily the credit quality.

Phase 4: Final Segmentation for Agency CMBS based on 4 Step Process.

Tranche Class	Market Value (m)	DV01 (m)	Spread DV01(m)	MV	DV01	Spread DV01
Total FHLMC	1,653,999,323	690,756	584,206	2.14%	3.05%	5.04%
Total FNMA	1,982,049,506	806,156	1,116,137	2.57%	3.58%	5.71%
Total GNMA	166,645,488	47,853	50,114	0.22%	0.21%	0.26%
Total Agency CMBS	3,802,644,318	1,544,765	2,150,457	4.93%	6.32%	11.01%

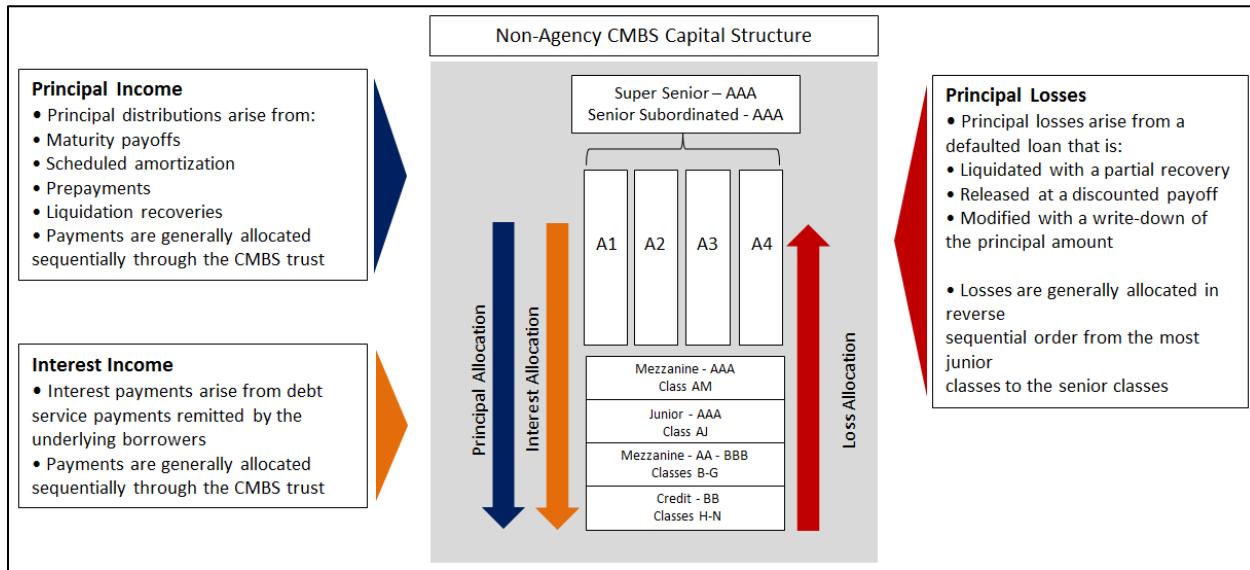
4.1.3 Non-Agency CMBS

Description

Non-Agency CMBS are securitizations of mortgages backed by commercial real estate which are structured without the support of the GSEs. Loans are typically secured by apartment buildings, shopping malls, warehouse facilities, hotels, office buildings, and other commercial properties. Investors usually depend on the collateral for ultimate repayment. Issuers can issue CMBS with ratings across the entire credit spectrum, classes range from triple-A to unrated. Recently, 75% or more of each fixed rate deal was typically rated AAA. Compared to residential mortgages, commercial mortgages usually have larger loan amounts (\$2 million to over \$100 million) and have payment schedules with seven to ten year terms, with 25 to 30 year amortization schedules (like balloon payments). Prepayments are often limited by lockouts and/or penalties. The main risk in these bonds is that of default, and not of prepayment. The collateral (property) determines the credit of the loan, not an individual's consumer credit.

In CMBS, the senior/subordinate credit enhancement structure is most common. Subordinate classes provide credit support for senior classes. Often, the cash flow from the underlying collateral pool supports the senior classes until retirement. The principal is allocated in a top down waterfall structure (sequential pay). Each class has specified priority for when it receives cash flows. Senior securities usually receive scheduled principal and interest first. Remaining classes are then generally paid with remaining cash, in the stated order of priority. Losses are first applied to the principal balance of all junior securities, hence helping to insulate senior classes from initial losses. The amount of junior bonds required (subordination levels) is determined in conjunction with the rating agencies and the security issuers. Higher quality and more diverse collateral typically require lower credit support levels. Usually two or more rating agencies evaluate each transaction.

Non-Agency Capital Structure



Risk profile

Non-Agency CMBS are securitizations of mortgages backed by commercial real estate. Loans are typically secured by apartment buildings, shopping malls, warehouse facilities, hotels, office buildings, and other commercial properties. Investors usually depend on the collateral for ultimate repayment. Prepayments are usually limited by lockouts and/or penalties. The main risk in these bonds is typically default, and not prepayment. Credit of the loan is typically influenced by the collateral (property), not by an individual's consumer credit.

Segmentation

Segmentation for Non-Agency CMBS (CMBS) positions within the BNY Mellon portfolio was initiated with a comprehensive analysis of each position whereby tranche type and tranche class were analyzed against position within the deal waterfall and evaluated separately. Based on the senior/subordinate credit enhancement structure, each security was evaluated based on its position within the deal waterfall and subsequently bucketed accordingly into Senior, Mezzanine, or Subordinated.

Further segmentation was done based on current rating. Data availability for Non-Agency CMBS was adequate based on the criteria set forth for evaluating data quality. Data constraints were minimal for this asset class.

Phase 1: Initial data set was analyzed and sorted by **Tranche Type**.

Security Description	Security Type	Tranche Type	Tranche Class	ORIGINAL COMPOSITE RATING
CSMC_08-C1 A2	SENIOR	MEZZ	AM	AAA
JPMCC_04-LN2 A2	SENIOR	SUB	C	AA
JPMCC_10-C2 A1 144A	SENIOR	SENIOR	A1	AAA
BACM_07-2 AAB	SENIOR	SUB	C	AAA
WBCMT_06-C23 AM	SENIOR	SUB	C	AA

Conclusion: CMBS positions would be segmented by the tranche type- Senior, Subordinate and Mezzanine.

Phase 2: Data within each Tranche Type was further analyzed by **Tranche Class**.

Security Description	Security Type	Tranche Type	Tranche Class	ORIGINAL COMPOSITE RATING
CSMC_08-C1 A2	SENIOR	MEZZ	AM	AAA
JPMCC_04-LN2 A2	SENIOR	SUB	C	AA
JPMCC_10-C2 A1 144A	SENIOR	SENIOR	A1	AAA
BACM_07-2 AAB	SENIOR	SUB	C	AAA
WBCMT_06-C23 AM	SENIOR	SUB	C	AA

Conclusion: At the level of tranche class, exposure was immaterial and limited historical data is available. Tranche type was not considered further for segmentation.

Phase 3: Data within each Tranche Class was analyzed and sorted by **Origination Rating and Vintage**.

Security Description	Tranche Type	Tranche Class	ORIGINAL COMPOSITE RATING	Vintage
CSMC_08-C1 A2	MEZZ	AM	AAA	2008
JPMCC_04-LN2 A2	SUB	C	AA	2004
JPMCC_10-C2 A1 144A	SENIOR	A1	AAA	2010
BACM_07-2 AAB	SUB	C	AAA	2007
WBCMT_06-C23 AM	SUB	C	AA	2006
COMM_13-CCRE12 C	SUB	C	A	2013

Phase 4: Initial Segmentation for Non-Agency CMBS based on Tranche Type, Tranche Class, Market Value, DV01, and Spread DV01.

Non-Agency CMBS			
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	1,483,849,465	331,095	348,228
AA	31,662,233	20,727	20,952
A	39,089,948	24,887	25,154
SENIOR	1,554,551,646	376,709	389,335
AAA	33,047,725	6,347	6,376
AA	3,148,025	1,844	1,863
A	10,358,219	6,687	6,759
MEZZ	46,553,970	14,878	14,998
AAA	63,929,776	33,343	33,706
AA	39,610,565	24,357	24,625
A	34,173,295	21,658	21,889
SUB	137,713,641	79,368	80,220
Total	1,736,819,256	470,955	484,553

Conclusion: origination credit rating is immaterial for segmentation.

Phase 5: Segmentation for Non-Agency CMBS based on Tranche Class, Vintage (Pre 2008 & Post 2008) and the 4 Step Process.

Pre - 2008				Post - 2008		
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)	MV	DV01	Spread DV01
SENIOR	989,373,891	76,293	85,839	1.28%	0.34%	0.44%
MEZZ	22,652,597	3,990	4,006	0.03%	0.02%	0.02%
SUB	13,642,425	1,594	1,599	0.02%	0.01%	0.01%
Total Pre 2008	1,025,666,913	81,877	91,444	1.33%	0.36%	0.47%
Post - 2008				MV	DV01	Spread DV01
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)	0.73%	1.33%	1.55%
SENIOR	565,177,755	300,416	308,496	0.03%	0.05%	0.06%
MEZZ	23,901,372	10,889	10,992	0.16%	0.34%	0.40%
SUB	134,071,216	77,774	78,621			
Total Post 2008	713,150,343	389,078	395,109	0.92%	1.72%	2.01%
Total CMBS	1,738,819,256	470,955	484,553	2.25%	2.08%	2.48%

Conclusion: Based on materiality, CMBS segmentation for risk exposure is based on Tranche class and vintage. The post-crisis origination has historical data with limited volatility and does not capture any stress periods. The model forecasts will determine the use of post-crisis vintage.

4.1.4 Non-Agency RMBS

Description

Non-agency RMBS are not guaranteed or insured by the federal government. In order to achieve AAA rating, the bonds must have sufficient levels of credit enhancement. Credit protection is in the form of subordination, third-party protection, cash reserves, or over-collateralization. Senior/subordinate structures create “levels” of bonds such that the lowest rated tranches absorb credit losses first. The most senior tranches only experience credit losses if all the subordinate bonds are completely written down. Over-collateralization, where extra collateral is placed in the deal (e.g. \$110 million of mortgages backs \$100 million in bonds), is another form of credit protection. Any extra collateral that remains at maturity is usually returned to the originator. Credit of the loan is typically influenced by an individual’s consumer credit, not by the collateral (property). Cash reserves exist when underwriting profits or a servicing spread are set aside to cover default losses. If this is not used, then the underwriter receives the fees at the maturity of the security. At the time of origination, credit rating is typically Aaa/AAA for senior class; Aa/AA or lower for subordinate class.

Segmentation

ALM-IRR first segmented the Non-Agency RMBS (RMBS) portfolio by collateral level. The main types of non-agency collateral are jumbo, Alternative A and Subprime. Jumbo Loans do not qualify for agency guarantee / insurance because of loan size. Alternative A (Alt-A) loans fall in the middle-of-the-credit spectrum (missing documentation on prime borrowers and other characteristics that exclude these loans from being prime). Subprime loans fall further down the credit spectrum. Borrowers in these pools typically have credit problems, prior late payments on their mortgages, prior bankruptcies, or general problems with their bill paying histories.

ALM-IRR further segmented this portfolio based on original rating. The Non-Agency RMBS sector has seen significant downgrades as a result of the 2008 -2009 housing market collapse. As such, data availability for current ratings was not available. The following figures illustrate the four step process for segmentation development for this asset class.

Phase 1: Initial data set was analyzed and bucketed by **Collateral Type**.

Security Description	Collateral Type	Security Type
SASI_93-7 TA8	PRIME	WHOLE
PHMS_93-63 A18	PRIME	WHOLE
WAMU_01-AR5 1A	Sub-Prime	WHOLE
BOAMS_02-K 1A6	Alt-A	WHOLE
SASC_02-5A 2A1	Alt-A	WHOLE
SASC_02-5A 1A1	PRIME	WHOLE

Conclusion: Collateral type was determined to be the most important classification for risk segmentation.

Phase 2: Within each **Collateral Type**, positions were analyzed by **CMO Group (Vintage)**, **Series**, and **Class and tranche number**.

Security Description	Collateral Type	MTG CMO GROUP	MTG CMO SERIES	MTG CMO CLASS
SASI_93-7 TA8	PRIME	1993	7	TA8
PHMS_93-63 A18	PRIME	1993	63	A18
WAMU_01-AR5 1A	PRIME	2001	AR5	1A
BOAMS_02-K 1A6	PRIME	2002	K	1A6
SASC_02-5A 2A1	PRIME	2002	5A	2A1

SECURITY DES	MTG CMO GROUP	MTG CMO SERIES	MTG CMO CLASS	TRANCHE NUM	MTG NUM BONDS DEAL
SASI 1993-7 TA8	1993	7	TA8	8	10
PHMS 1993-63 A18	1993	63	A18	18	23
WAMU 2001-AR5 1A	2001	AR5	1A	1	8
BOAMS 2002-K 1A6	2002	K	1A6	10	11
SASC 2002-5A 2A1	2002	5A	2A1	6	3

Conclusion: Vintage, series, class and tranche number introduced complexity and were dropped from segmentation drivers due to limited data available for pre-crisis non-agency RMBS issuance.

Phase 3: Original Rating was analyzed in relation to **Collateral Type**, **Tranche Class**, and **Tranche Number**. Original Rating is directly correlated to Collateral Type and position within the capital structure.

Security Description	Collateral Type	ORIGINAL COMPOSITE RATING	MTG CMO GROUP	MTG CMO SERIES	MTG CMO CLASS
SASI_93-7 TA8	PRIME	AAA	1993	7	TA8
PHMS_93-63 A18	PRIME	AAA	1993	63	A18
WAMU_01-AR5 1A	PRIME	AAA	2001	AR5	1A
BOAMS_02-K 1A6	PRIME	AAA	2002	K	1A6
SASC_02-5A 2A1	PRIME	AAA	2002	5A	2A1

Conclusion: Majority of BNYM positions were rated AAA at issuance and therefore, credit rating was not material for segmentation.

Phase 4: Initial Segmentation for Non-Agency RMBS based on Collateral Type, Original Rating, Market Value, DV01, and Spread DV01.

PRIME			
Original Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	947,702,089	33,389	352,662
Total PRIME	947,702,089	33,389	352,662
Alt - A			
Original Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	1,540,429,976	23,230	626,580
AA	34,108,910	20	18,495
Total Alt - A	1,574,538,886	23,249	645,075
SUBPRIME			
Original Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	112,749,284	5,823	38,198
AA	292,811,669	490	109,224
Total SUBPRIME	405,560,953	6,313	147,423
Total Non Agency RMBS	2,927,801,927	62,951	1,145,159

pink cells less than .5%

MV	DV01	Spread DV01
1.23%	0.13%	1.81%
1.23%	0.13%	1.81%

Exceeds materiality threshold

MV	DV01	Spread DV01
2.00%	0.10%	3.21%
0.04%	0.00%	0.09%

Exceeds materiality threshold

MV	DV01	Spread DV01
0.15%	0.03%	0.20%
0.38%	0.00%	0.56%

Exceeds materiality threshold

MV	DV01	Spread DV01
0.53%	0.03%	0.75%
3.79%	0.28%	5.86%

Phase 5: Final Segmentation for Non-Agency RMBS based on 4 Step Process

PRIME			
Original Rating	Market Value (m)	DV01(m)	Spread DV01(m)
AAA	947,702,089	33,389	352,662
Total PRIME	947,702,089	33,389	352,662
Alt - A			
Original Rating	Market Value (m)	DV01(m)	Spread DV01(m)
AAA	1,574,538,886	23,249	645,075
Total Alt - A	1,574,538,886	23,249	645,075
SUBPRIME			
Original Rating	Market Value (m)	DV01(m)	Spread DV01(m)
AAA	112,749,284	5,823	38,198
AA	292,811,669	490	109,224
Total SUBPRIME	405,560,953	6,313	147,423
Total Non Agency RMBS	2,927,801,927	62,951	1,145,159

pink cells less than .5%

MV	DV01	Spread DV01
1.23%	0.13%	1.81%
1.23%	0.13%	1.81%

Segmented based on materiality threshold

MV	DV01	Spread DV01
2.04%	0.10%	3.30%
2.04%	0.10%	3.30%

Segmented based on materiality threshold

MV	DV01	Spread DV01
0.15%	0.03%	0.20%
0.38%	0.00%	0.56%

Segmented based on materiality threshold

MV	DV01	Spread DV01
0.53%	0.03%	0.75%
3.79%	0.28%	5.86%

4.1.5 International RMBS

Description

International RMBS are non-USD denominated bonds collateralized by residential mortgages abroad. International RMBS comprise 1.5% or \$1.1B of the investment portfolio. The International RMBS portfolio consists of RMBS securities from the UK (67.1%), Netherlands (20.5%), Ireland (10.7%) and Australia (1.7%)²¹.

Risk profile

Please see the risk profile for Non-Agency RMBS in the previous section.

Segmentation

Data availability for International RMBS was adequate based on the criteria set forth for evaluating data quality. When possible, immaterial positions (such as the Italian MBS) were consolidated with material ones (such as the Irish MBS). All positions are 6 month LIBOR floating rate instruments in corresponding currency. Data constraints were minimal for this asset class. ALM-IRR segmented the vendor sourced data by underlying currency, country of risk and credit rating.

Phase 1: Initial data set was analyzed and sorted by **Currency**.

Security Description	Currency	CURRENT COMPOSITE RATING	COUNTRY FULL NAME
RMAC_05-NS3X A2C RegS	EUR	AA	BRITAIN
ARMF_11-1 A2A 144A	GBP	AAA	BRITAIN
STORM 2012-2 A1	EUR	AAA	NETHERLANDS
RMAC_05-NS2X A2A RegS	GBP	AA	BRITAIN
DARWBY_1 A2	GBP	AAA	BRITAIN

Phase 2: Data within each Currency was analyzed and segmented by **Current Composite Rating**.

Security Description	Currency	CURRENT COMPOSITE RATING	COUNTRY FULL NAME
RMAC_05-NS3X A2C RegS	EUR	AA	BRITAIN
ARMF_11-1 A2A 144A	GBP	AAA	BRITAIN
STORM 2012-2 A1	EUR	AAA	NETHERLANDS
RMAC_05-NS2X A2A RegS	GBP	AA	BRITAIN
DARWBY_1 A2	GBP	AAA	BRITAIN

Phase 3: Data within each Current Composite Rating was analyzed and segmented by **Country of Risk**.

Security Description	Currency	CURRENT COMPOSITE RATING	COUNTRY FULL NAME
RMAC_05-NS3X A2C RegS	EUR	AA	BRITAIN
ARMF_11-1 A2A 144A	GBP	AAA	BRITAIN
STORM 2012-2 A1	EUR	AAA	NETHERLANDS
RMAC_05-NS2X A2A RegS	GBP	AA	BRITAIN
DARWBY_1 A2	GBP	AAA	BRITAIN

Conclusion: Currency, Country of risk and credit rating were considered relevant for the segmentation.

²¹ As of June 30, 2015

Phase 4: Segmentation for International RMBS based on Currency, Current Rating, Country of Risk, Market Value, DV01, Spread DV01, and the 4 Step Process.

Conclusion: Majority of segments were immaterial but were consolidated based on geography and issuing currency for the segmentation.

Phase 5: Final segmentation for International balance after consolidation

4.1.6 Collateralized Loan Obligations

Description

The collateral for a Collateralized Loan Obligation (CLO) consists primarily of leveraged loans. Leveraged loans are generally syndicated bank loans made to borrowers with non-investment grade credit ratings. The CLO market in the United States (leveraged loan market) has typically high liquidity.

Default rates for leveraged loans have historically tracked significantly lower than default rates for high yield bonds, while recovery rates have historically tracked significantly higher than recovery rates for high yield bonds. Subordination determines the credit quality and therefore credit rating. In order to achieve high ratings on its liabilities and thereby create an efficient

financing structure, among other things, a CLO usually creates sufficient structural subordination for more senior tranches, prioritizes the application of cash flows generated by the collateral portfolio so that senior tranches are served before subordinate tranches, corrects failures of par value coverage and interest coverage test levels by diverting the application of cash flows and invests in collateral that meets credit quality, diversification, and other criteria.

Segmentation

Based on materiality thresholds, and given that greater than 94% of BNY Mellon's CLO positions are rated AAA, ALM-IRR based final segmentation entirely on credit rating. The figures below describe the segmentation development process for this asset class.

Phase 1: Initial data was analyzed and sorted by **Tranche Type**:

Security Description	Tranche Type	Current Rating Composite	Vintage	Pre or Post
BD CLO_05-1 A1	Senior	AAA	2005	Pre-Crisis
GALL 2014-1A X	Senior	AAA	2014	Post-Crisis
ALM2015-12A X	Senior	AAA	2015	Post-Crisis
CGMS 2015-1A X	Senior	AAA	2015	Post-Crisis
LATI_06-2 A2 144A	Senior	AAA	2006	Pre-Crisis
GLG ORE HILL X2	Senior	AAA	2013	Post-Crisis

Conclusion: All BNYM exposure was senior tranche, and no further segmentation using tranche type is required

Phase 2: Data within each Tranche Type was analyzed and sorted by **Current Composite Rating**:

Security Description	Tranche Type	Current Rating Composite	Vintage	Pre or Post
BD CLO_05-1 A1	Senior	AAA	2005	Pre-Crisis
GALL 2014-1A X	Senior	AAA	2014	Post-Crisis
ALM2015-12A X	Senior	AAA	2015	Post-Crisis
CGMS 2015-1A X	Senior	AAA	2015	Post-Crisis
LATI_06-2 A2 144A	Senior	AAA	2006	Pre-Crisis
GLG ORE HILL X2	Senior	AAA	2013	Post-Crisis

Conclusion: Majority of BNYM exposure was AAA rated, and no further segmentation using rating is required

Phase 3: Final Segmentation for CLO's based on **Current Composite Rating**, DV01, Spread DV01, and the 4 Step Process.

CLO's - Current Rating			
Tranche Class	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	2,124,436,063	23,204	662,805
AA	125,777,485	919	53,547
Grand Total	2,250,213,568	24,122	716,352

MV	DV01	Spread DV01
2.75%	0.16%	3.38%
0.16%	0.01%	0.27%

Segmented based on materiality threshold

2.91%	0.17%	3.66%
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Segmented based on materiality threshold

4.1.7 Asset-Backed Securities (ABS)

Description

Credit card, auto loans, equipment, and student loans have been used as collateral in ABS transactions in the BNY Mellon investment portfolio. The ABS market is primarily comprised of AAA securities. A and BBB bonds account for about 10-15% of issuance, and approximately 75% of the market is floating rate. ABS securities are structured as securitizations in similar ways.

Similar structures of subordinations of tranches allow a variety of credit, liquidity and prepayment risk profiles, and the spread curves (with respect to average life) that are generally upward-sloping. ABS generally trade at different spreads (to different indexes) depending on the type of asset. Student loans typically trade with the tightest spread.

Risk profile

An ABS, partially derives its creditworthiness from this pool of underlying collateral. Similar to Non-Agency MBS, ABS are not generally guaranteed by a government agency. As such, they typically require credit enhancement to achieve a triple-A rating. The type of credit enhancement used in a security is generally selected by the issuer. The size of enhancement is usually determined by the rating agencies. In addition, ABS generally have low prepayment risk relative to MBS and typically have high liquidity, especially in benchmark issuers.

Segmentation

ALM-IRR first segmented this asset class by collateral level. The main collateral types in the BNY Mellon portfolio are ABS Auto Loans (including floor plan loans), ABS Credit Cards, and ABS Student Loans. ABS Auto Loans are typically three to seven years in length with fixed rates. ABS Credit Cards are revolving pools of individual credit card accounts. ABS Student Loans fund higher education. There are two types of these student loans: FFELP (Federal Family Education Loan Program) and private loans underwritten by DOE.

Over 95% of BNY Mellon ABS holdings are AAA rated. Data availability for ABS was adequate based on the criteria set forth for evaluating data quality. Vendor sourced data was available based on collateral type and rating. The figure below illustrates the development process of segmentation for this asset class.

Phase 1: Initial data was analyzed and sorted by Collateral/Deal Type:

Security Description	Security Type	Deal Type	Tranche Type	COMPOSITE Rating
SLMA_08-6_A2	ABS	STUDENTS	Agency (FFELP)	AAA
AETT 2013-2_A	ABS	CARDS	Senior	AAA
AMCAR 2013-4_A3	ABS	AUTOS	Senior	AAA
TAOT 13-A_A3	ABS	AUTOS	Senior	AAA
SLMP_11-C_A1 144A	ABS	STUDENTS	Private Label	AAA
SLMA_06-9_A4	ABS	STUDENTS	Agency (FFELP)	AAA

Conclusion: Collateral type would be used for segmentation.

Phase 2: Data within each Deal Type was analyzed and sorted by compiled by Tranche Type:

Security Description	Security Type	Deal Type	Tranche Type	COMPOSITE Rating
SLMA_08-6_A2	ABS	STUDENTS	Agency (FFELP)	AAA
AETT 2013-2_A	ABS	CARDS	Senior	AAA
AMCAR 2013-4_A3	ABS	AUTOS	Senior	AAA
TAOT 13-A_A3	ABS	AUTOS	Senior	AAA
SLMP_11-C_A1 144A	ABS	STUDENTS	Private Label	AAA
SLMA_06-9_A4	ABS	STUDENTS	Agency (FFELP)	AAA

Phase 3: Data within each Tranche Type was analyzed and compiled by Current Composite Rating:

Security Description	Security Type	Deal Type	Tranche Type	COMPOSITE Rating
SLMA_08-6_A2	ABS	STUDENTS	Agency (FFELP)	AAA
AETT 2013-2_A	ABS	CARDS	Senior	AAA
AMCAR 2013-4_A3	ABS	AUTOS	Senior	AAA
TAOT 13-A_A3	ABS	AUTOS	Senior	AAA
SLMP_11-C_A1 144A	ABS	STUDENTS	Private Label	AAA
SLMA_06-9_A4	ABS	STUDENTS	Agency (FFELP)	AAA

Conclusion: Majority of BNYM exposure was AAA rated, and no further segmentation using rating is required

Phase 4: For Auto ABS, additional segmentation was based on Credit Quality.

Security Description	Security Type	MTG DEAL TYP	Quality
AMCAR 2013-4_A3	ABS	AUTOS	Subprime
TAOT_13-A_A3	ABS	AUTOS	Prime
AMCAR 2013-5_A3	ABS	AUTOS	Subprime
FORDL 2013-B_A4	ABS	AUTOS	Prime

Phase 5: Initial Segmentation for ABS based on Deal Type, Tranche Type, Credit Rating, (Credit Quality for Auto ABS), Market Value, DV01, and Spread DV01.

ABS AUTOS				
Prime				
Tranche Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
Senior	AAA	1,361,632,646	95,341	138,725
Sub	AA	12,119,997	1,330	1,334
Total		1,373,762,643	96,671	134,558
Subprime				
Tranche Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
Senior	AAA	28,972,389	2,165	2,171
Sub	AA	645,409	1	1
	A	33,342,260	1,824	1,828
Total		62,960,058	3,991	4,001
ABS CARDS				
Tranche Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
Senior	AAA	1,108,328,946	70,209	244,726
	A	19,972,654	77	2,318
Total		1,128,251,601	70,286	247,044
ABS Student Loans				
Tranche Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
Agency (FFELP) Total		683,768,207	6,447	156,253
	AAA	603,319,909	5,978	126,770
	AA	78,438,298	469	29,483
Private Label Total		74,494,420	390	7,496
	AAA	74,494,420	390	7,496
Total		758,262,627	6,777	163,749
ABS Other				
Security Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
EQUIPMENT	AAA	24,509,472	134	1,437
Total		24,509,472	134	1,457
MANUFACTHM	AAA	1,169,326	0	55
Total		1,169,326	0	55
Grand Total		3,348,915,728	177,860	550,864

pink cells less than .5%

Exceeds materiality threshold

Conclusion: Most of the segments were below materiality threshold when segmented for Deal Type, Tranche Type, Current Composite Rating, (Credit Quality for Auto ABS). It was concluded to only use deal type for segmentation of ABS.

Phase 6: Final Segmentation for ABS based on Deal Type, DV01, Spread DV01, and the 4 Step Process.

pink cells less than 5%				
Tranche Type	Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
Auto ABS	143 6722,702	100,662	138,559	
Credit Card ABS	112 8251,601	70,286	247,044	
Student Loan ABS	75 8262,627	6,777	163,748	
Other ABS	25,678,799	134	1,512	
GrandTotal	334 8915,728	177,860	550,864	
			4.34%	0.79%
			2.82%	

4.1.8 Asset Backed Commercial Paper

Description

Asset Backed Commercial Paper (ABCP) is a form of commercial paper collateralized by other financial assets. ABCP is generally a short term instrument, with maturities between 1 and 270 days and an average of 30 days. The security is typically issued by an asset-backed commercial paper program or conduit. The conduit purchases and holds financial assets such as trade receivables, and finances the assets by selling ABCP to investors. The conduit is typically a structured investment vehicle (SIV) established to earn a spread between the financial assets in the SIV and the ABCP.

Barclay's Commercial Paper portfolio consists of 3 month LIBOR floaters with a weighted average maturity of approximately 6 months.

Risk profile

Companies may need to issue commercial paper with credit enhancements; Asset-backed commercial paper is backed by high quality collateral. Credit-supported commercial paper is often guaranteed by an organization with excellent credit, such as a bank. The main credit risk of commercial paper is rollover risk, when the issuer may not be able to sell new paper to pay for maturing paper, either because the market has changed, or the credit rating of the issuer has been downgraded.

Segmentation

No further segmentation is required for the ABCP currently in the BNY Mellon portfolio.

BARCLAYS BANK PLC MTN 144A				MV	DV01	Spread DV01
Currency	Market Value (m)	DV01 (m)	Spread DV01 (m)			
USD	1,650,805,703	24,587	51,283	2.14%	0.11%	0.26%
Grand Total	1,650,805,703	24,587	51,283	2.14%	0.11%	0.26%

4.1.9 Agency Bonds and Debentures

Description

Agency Debentures are debt issued by a federal agency or a Government Sponsored Enterprise (GSE). These types of debentures are backed by the integrity and credit worthiness of the issuer, and are not collateralized. FHLMC, FNMA and FHLB are all GSEs. Therefore, debt issued by these agencies has a similar credit risk profile. ALM-IRR used a single agency credit curve for FHLMC, FNMA and FHLB debentures valuation.

Risk profile

Bonds issued by GSEs such as the Federal National Mortgage Association (Fannie Mae, the Federal Home Loan Mortgage (Freddie Mac) and The Federal Agricultural Mortgage Corporation (Farmer Mac) are not backed by the same guarantee as federal government agencies. Bonds issued by GSEs carry credit risk. In general, Agency Debentures are subject three types of risk:

- Credit and default risk; for GSE-issued agencies, the federal government is under no legal obligation to save a GSE from default.
 - Call risk: Many agency securities carry call provisions that allow the issuer to pay you prior to the bond's maturity date, typically when interest rates drop, leaving you to reinvest at lower prevailing rates.
 - Interest rate risk: If interest rates rise, the value of an agency bond on the secondary market will likely fall

Segmentation

For segmentation development for Agency Debentures see the figure below.

Phase 1: Initial data was analyzed and sorted by Issuing Agency:

Security Description	Agency	Duration
FANNIE MAE	FN MA	5 Yr.
FNMA	FN MA	7 Yr.
FNMA	FN MA	7 Yr.
FNMA BENCHMARK NOTES	FN MA	10 Yr.
FHLMC	FHLMC	5 Yr.

Phase 2: Data within each Agency was analyzed and segmented by Duration.

Security Description	Agency	Duration
FANNIE MAE	FNMA	5 Yr.
FNMA	FNMA	7 Yr.
FNMA	FNMA	7 Yr.
FNMA BENCHMARK NOTES	FNMA	10 Yr.
FHLMC	FHLMC	5 Yr.

Phase 3: Initial Segmentation for Agency Debentures based on Issuing Agency, Duration, Market Value, DV01, and Spread DV01.

Agency Debentures			
Tenor/Agency	Market Value (m)	DV01	Spread DV01
FHLMC	50,582,989	388	388
FNMA	60,670,844	16,534	16,863
5Yr.	111,253,833	16,921	17,251
FHLMC	9,738,702	3,643	3,670
6Yr.	9,738,702	3,643	3,670
FHLB	50,892,407	40,579	41,056
FHLMC	51,084,483	4,599	4,630
FNMA	105,891,335	10,839	10,988
7Yr.	207,868,226	56,018	56,653
FGLMC	20,082,474	6,152	6,030
FHLB	32,742,196	7,717	7,559
FNMA	50,434,925	40,542	41,019
10Yr.	103,259,596	54,410	54,607
Total	432,120,356	130,992	132,181

pink cells less than .5%

MV	DV01	Spread DV01
0.08%	0.00%	0.00%
0.08%	0.11%	0.09%
0.14%	0.12%	0.09%
0.01%	0.08%	0.02%
0.08%	0.08%	0.02%
0.13%	0.08%	0.06%
0.26%	0.38%	0.29%
0.08%	0.04%	0.03%
0.04%	0.05%	0.04%
0.08%	0.28%	0.21%
0.13%	0.38%	0.28%

Exceeds materiality threshold

Conclusion: During phase 3 analysis, it was concluded that no segment based on issuing agency and life was above materiality threshold. Duration was considered as the segmentation driver as all issuing agencies are GSE's.

Phase 4: Final Segmentation for Agency Debentures based on Duration, Market Value, DV01, Spread DV01, and the 4 Step Process.

Agency Debentures			
Tenor	Market Value (m)	DV01	Spread DV01
5Yr.	111,253,833	16,921	17,251
6Yr.	9,738,702	3,643	3,670
7Yr.	207,868,226	56,018	56,653
10Yr.	103,259,596	54,410	54,607
Total	432,120,356	130,992	132,181

pink cells less than .5%

MV	DV01	Spread DV01
0.14%	0.07%	0.09%
0.01%	0.02%	0.02%
0.27%	0.25%	0.29%
0.13%	0.24%	0.28%

Segmented based on materiality threshold

4.1.10 Municipal Bonds

Description

A municipal bond is a debt security issued by a state, municipality or county to finance its capital expenditures. Municipal bonds may be general obligations of the issuer or secured by specified revenues. They are generally structured as two types: General Obligation bonds and Revenue bonds. General Obligation Bonds (GO) promise to repay based on the full faith and credit of the issuer, and can be repaid with a variety of tax sources. Revenue bonds are municipal bonds that finance income-producing projects and are secured by a specified revenue source. Over 99% of revenue bonds are rated "A" or higher.

Risk profile

Municipal securities, or "Munis" are bonds issued by states, cities, counties and other governmental entities to raise money to build roads, schools and other projects for public improvement. Risks for Munis include credit and default risk and can vary greatly from bond to bond. Insured bonds help offset this risk. Interest rate risk also must be considered; if interest rates rise, the value of a municipal bond on the secondary market will likely fall. Lastly, Liquidity risk; some municipal bonds are more liquid than others. This will be influenced by credit quality.

Segmentation

ALM-IRR segmented municipal bond positions based on issue type- revenue or general obligation. General Obligation bonds were further segmented by credit rating. Revenue Bonds were further segmented by project type (see the figure below).

Phase 1: Initial data set was analyzed and bucketed by Collateral Type.

Name	MUNI ISSUE TYP	MUNI LONG INDUSTRY TYP
ALLEN PARK	GENERAL OBLIGATION LTD	General Obligation
ALLEN PK-DOWNTOWN DEV	GENERAL OBLIGATION LTD	General Obligation
AL PUB SCH & CLG AUTH	REVENUE BONDS	Education
AL PUB SCH & CLG AUTH	REVENUE BONDS	Education
AL PUB SCH & CLG AUTH	REVENUE BONDS	Education

Conclusion: Collateral Type was identified as primary driver for segmentation.

Phase 2: Within each Issue Type, positions were segmented by Issuer Type

COUNTY LOCATION ISSUER	STATE_CODE	ISSUER TYPE
King, WA	WA	COUNTY
Klickitat, WA	WA	COUNTY
Brazoria, TX	TX	CITY
Fairfield, OH	OH	CITY
Worcester, MA	MA	CITY
Suffolk, MA	MA	STATE
Suffolk, MA	MA	STATE

Conclusion: Issuer type was not used for segmentation due to limited historical data available.

Phase 3: Within each collateral type, positions were further segmented by Industry Type.

MUNI PURPOSE	MUNI LONG INDUSTRY TYP	ISSUER INDUSTRY	COMPOSITE RATING
REFUNDING BONDS	Education	EDU	AA
PRT, AIRPRT & MARINA IMPS	Airport	APT	A
CURRENT REFUNDING	Medical	MED	A+
WATER UTILITY IMPS.	Development	DEV	AAA
WATER UTILITY IMPS.	Development	DEV	AAA
REFUNDING BONDS	Transportation	TRN	AA
PRT, AIRPRT & MARINA IMPS	Airport	APT	A+

Phase 4: Further analysis and segmentation was performed based on current Composite Rating.

MUNI PURPOSE	MUNI LONG INDUSTRY TYP	ISSUER INDUSTRY	COMPOSITE RATING
REFUNDING BONDS	Education	EDU	AA
PRT, AIRPRT & MARINA IMPS	Airport	APT	A
CURRENT REFUNDING	Medical	MED	A+
WATER UTILITY IMPS.	Development	DEV	AAA
WATER UTILITY IMPS.	Development	DEV	AAA
REFUNDING BONDS	Transportation	TRN	AA
PRT, AIRPRT & MARINA IMPS	Airport	APT	A+

Conclusion: Credit rating and industry types were identified relevant for segmentation.

Phase 7: Final Segmentation for Municipal Bonds based on 4 Step Process.

General Obligation				pink cells less than .5%			Segmented based on materiality threshold
Composite Rating	Market Value (m)	DVO1 (m)	Spread DVO1 (m)	MV	DVO1	Spread DVO1	
AAA	248,988,151	56,038	56,434	0.92%	0.25%	0.25%	
AA	1,265,049,927	374,118	376,954	1.64%	1.65%	1.95%	
A	328,345,489	143,400	144,719	0.48%	0.68%	0.74%	
B	184,023	119	120	0.00%	0.00%	0.00%	
BBB	1,029,351	33	32	0.00%	0.00%	0.00%	
CCC	1,297,659	839	848	0.00%	0.00%	0.00%	
NR	10,705,816	657	659	0.01%	0.00%	0.00%	
Total	1,856,601,425	575,204	579,766	2.40%	2.54%	2.97%	

REVENUE BONDS				pink cells less than .5%			Segmented based on materiality threshold
MUNI PURPOSE	Market Value (m)	DVO1 (m)	Spread DVO1 (m)	MV	DVO1	Spread DVO1	
Transportation	618,652,620	229,157	227,209	0.80%	1.01%	1.18%	
Water	592,004,584	272,089	151,177	0.77%	1.20%	0.77%	
Higher Education	447,358,869	281,997	127,235	0.58%	1.24%	0.65%	
Power	242,085,555	70,974	70,398	0.31%	0.31%	0.36%	
Utilities	158,163,024	72,682	72,011	0.20%	0.32%	0.37%	
School District	147,797,251	48,415	48,111	0.19%	0.19%	0.22%	
Education	147,514,588	28,854	28,669	0.19%	0.13%	0.15%	
Medical	142,619,069	45,267	44,892	0.18%	0.20%	0.23%	
Airport	77,251,971	40,012	39,616	0.10%	0.18%	0.20%	
Facilities	51,489,813	8,942	8,879	0.07%	0.04%	0.05%	
Development	27,560,553	7,462	7,501	0.04%	0.03%	0.04%	
Multifamily Hsg	20,570,819	4,187	4,161	0.03%	0.02%	0.02%	
Bond Bank	14,674,756	6,367	6,314	0.02%	0.03%	0.03%	
Pollution	9,418,302	3,279	3,251	0.01%	0.01%	0.02%	
Total	2,697,111,775	1,114,692	834,423	3.49%	4.92%	4.27%	
Total Municipal Bonds	4,553,713,200	1,689,896	1,414,189	5.90%	7.46%	7.24%	

Conclusion: Final segmentation for Municipal Bonds is based on collateral type, industry type for revenue collateral and credit rating. Industry types below materiality threshold were consolidated into a generic revenue municipal bond segment.

4.1.11 Corporate Bonds

Description

A corporate bond is a debt instrument issued by a corporation in order to gather finances to sustain ongoing operations, fund capital improvements, expand business and fund expansion through mergers and acquisitions. Corporate bonds are generally rated by one or more of the three primary ratings agencies: Standard & Poor's, Moody's, and Fitch. These firms base their ratings on the bond issuer's financial health and likely ability to make interest payments and return the bondholders' principal. Rated bonds fall into one of two categories: investment grade or non-investment grade (also known as high yield).

Risk profile

Companies issue corporate bonds (or corporates) to raise money for capital expenditures, operations and acquisitions. Corporates are issued by all types of businesses, and are segmented into major industry groups. The risk profile for corporate bonds fall into the following categories; Credit and default risk: Varies significantly from bond to bond and is sometimes hard to determine; Liquidity risk: Many corporate bonds are illiquid, making some bonds difficult to sell; Interest rate risk: If interest rates rise, the value of a corporate bond on the secondary market will likely fall; Event risk: Mergers, acquisitions and other events can have a negative effect on a bond issuer's ability to pay its creditors.

Segmentation

The segmentation rationale for this class first took into account that BNY Mellon corporate bond holdings are all investment grade (BBB or higher). 88% of the exposure is A or higher. Corporate bond exposure is diversified across various industrial sectors. The non-financial sector represents 90% of our total corporate bond exposure. ALM-IRR sourced data for Corporates using composite indices for USD and EUR with corresponding composite ratings composed of senior unsecured debt across nine major industry sectors excluding the financial sector. For GBP risk positions, a financial sector composite curve was applied. The UK Financials Composite Index is composed of GBP denominated senior unsecured debt issued by UK financial companies. The below figures illustrate the segmentation development process.

Phase 1: Initial data set was analyzed and bucketed by Currency.

Security Description	Currency	INDUSTRY SECTOR
GENERAL DYNAMICS CORP	USD	Industrial
FRANCE TELECOM SA MTN RegS	EUR	Communications
COMCAST CORPORATION	USD	Communications
PFIZER INC.	USD	Consumer, Non-cyclical

Phase 2: Within each Currency bucket, positions were segmented by Industry Sector.

Security Description	Currency	INDUSTRY SECTOR
GENERAL DYNAMICS CORP	USD	Industrial
FRANCE TELECOM SA MTN RegS	EUR	Communications
COMCAST CORPORATION	USD	Communications
PFIZER INC.	USD	Consumer, Non-cyclical

Phase 3: Each Industry Sector was segmented by current Composite Rating.

Security Description	Currency	INDUSTRY SECTOR	CURRENT COMPOSITE RATING
GENERAL DYNAMICS CORP	USD	Industrial	A
FRANCE TELECOM SA MTN RegS	EUR	Communications	BBB
COMCAST CORPORATION	USD	Communications	A
PFIZER INC.	USD	Consumer, Non-cyclical	A

Phase 4: Initial Segmentation for Corporate Bonds based on Currency, Industry Sector, current Composite Rating, Market Value, DV01, and Spread DV01.

USD Corporate Bonds			
Sector / Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
A	54,350,627	13,265	13,367
BBB	12,637,565	1,795	1,803
Basic Materials	67,188,191	15,060	15,170
AA	22,807,212	1,534	1,537
A	47,596,699	27,049	27,327
BBB	20,706,996	6,420	6,461
Communications	91,112,908	35,003	35,326
AA	21,470,458	5,790	5,841
A	58,485,632	16,457	16,580
BBB	25,441,563	12,739	12,350
Consumer, Cyclical	105,397,653	34,486	34,771
AAA	15,243,298	1,328	1,331
AA	76,948,522	12,056	12,124
A	259,912,890	94,267	95,090
BBB	4,988,465	1,359	1,367
Consumer, Non-cyclical	357,093,170	109,010	109,912
AAA	22,303,564	6,047	6,083
AA	88,017,580	47,427	47,896
A	49,012,112	10,331	10,388
BBB	28,533,074	17,087	17,211
Energy	187,866,329	80,841	81,578
AAA	85,243,527	35,890	36,196
Financial		35,890	36,196
AAA	164,379,850	72,154	72,794
AA	10,104,275	1,580	1,586
Government		73,734	74,380
AA	23,448,568	11,164	11,281
A	180,115,218	79,778	80,510
BBB	40,533,586	10,648	10,738
Industrial	244,097,371	101,989	102,529
AA	46,725,701	31,934	32,298
A	142,042,530	45,207	45,584
Technology	188,768,021	77,142	77,882
AA	15,051,685	12,647	12,789
A	181,671,245	76,888	79,581
Utilities	196,722,980	91,535	92,369
Total USD Corporates	1,439,246,575	654,289	660,112
MV	DV01	Spread DV01	
0.07%	0.06%	0.07%	
0.02%	0.01%	0.01%	
0.08%	0.07%	0.08%	
0.08%	0.01%	0.01%	
0.08%	0.12%	0.14%	
0.08%	0.03%	0.08%	
0.12%	0.15%	0.18%	
0.08%	0.03%	0.08%	
0.08%	0.07%	0.08%	
0.08%	0.05%	0.06%	
0.14%	0.15%	0.18%	
0.02%	0.01%	0.01%	
0.10%	0.05%	0.06%	
0.34%	0.42%	0.48%	
0.01%	0.01%	0.01%	
0.48%	0.48%	0.56%	
0.08%	0.03%	0.08%	
0.11%	0.21%	0.25%	
0.08%	0.05%	0.06%	
0.04%	0.08%	0.09%	
0.24%	0.38%	0.42%	
0.11%	0.16%	0.19%	
0.00%	0.16%	0.19%	
0.21%	0.32%	0.37%	
0.01%	0.01%	0.01%	
0.00%	0.33%	0.36%	
0.08%	0.05%	0.06%	
0.23%	0.35%	0.42%	
0.05%	0.05%	0.05%	
0.32%	0.45%	0.52%	
0.08%	0.14%	0.17%	
0.18%	0.20%	0.23%	
0.24%	0.34%	0.40%	
0.02%	0.06%	0.07%	
0.24%	0.35%	0.41%	
0.25%	0.40%	0.47%	
Exceeds materiality threshold			
Exceeds materiality threshold			

EUR Corporate Bonds

Sector / Rating	Market Value (m)	DVO1 (m)	Spread DVO1 (m)	IVV	DVO1	Spread DVO1
A	12,829,980	4,149	4,158	0.02%	0.02%	0.02%
BBB	7,581,396	3,588	3,586	0.01%	0.01%	0.02%
Basic Materials	20,481,376	7,736	7,754	0.03%	0.03%	0.04%
A	6,723,791	3,579	3,580	0.01%	0.01%	0.02%
BBB	45,395,056	28,251	28,365	0.08%	0.12%	0.13%
Communications	52,118,857	31,830	31,965	0.07%	0.14%	0.18%
AA	6,937,486	2,478	2,482	0.01%	0.01%	0.01%
A	16,925,856	8,386	8,416	0.02%	0.04%	0.04%
BBB	13,625,278	8,679	8,717	0.02%	0.04%	0.04%
Consumer, Cyclical	37,468,683	19,555	19,626	0.05%	0.09%	0.10%
AA	16,329,606	5,709	5,718	0.02%	0.03%	0.03%
A	35,482,322	19,244	19,273	0.05%	0.08%	0.10%
BBB	20,942,204	10,605	10,629	0.08%	0.09%	0.09%
Consumer, Non-cyclical	72,704,132	35,539	35,621	0.08%	0.16%	0.18%
A	2,081,167	1,517	1,524	0.00%	0.01%	0.01%
Diversified	2,081,167	1,517	1,524	0.00%	0.01%	0.01%
AA	7,553,081	4,591	4,607	0.01%	0.02%	0.02%
A	13,801,421	7,011	7,034	0.02%	0.03%	0.04%
BBB	2,213,331	1,416	1,422	0.00%	0.01%	0.01%
Energy	23,567,934	13,018	13,062	0.08%	0.09%	0.09%
AA	61,230,798	15,757	15,776	0.08%	0.07%	0.08%
Financial	61,230,798	15,757	15,776	0.08%	0.07%	0.08%
AA	23,119,886	8,873	8,888	0.08%	0.04%	0.05%
Government	23,119,886	8,873	8,888	0.08%	0.04%	0.05%
AA	2,970,538	1,780	1,785	0.00%	0.01%	0.01%
A	17,748,156	9,236	9,258	0.02%	0.04%	0.05%
BBB	20,950,671	10,211	10,238	0.08%	0.05%	0.05%
Industrial	41,664,365	21,226	21,282	0.08%	0.09%	0.11%
AA	2,027,181	1,480	1,486	0.00%	0.01%	0.01%
A	10,128,908	6,484	6,504	0.01%	0.03%	0.03%
BBB	6,081,625	2,628	2,648	0.01%	0.01%	0.01%
Technology	18,258,656	10,552	10,589	0.02%	0.03%	0.03%
A	19,325,341	12,953	13,012	0.08%	0.06%	0.07%
BBB	39,476,150	17,950	18,000	0.08%	0.05%	0.05%
Utilities	58,801,481	30,908	31,013	0.08%	0.14%	0.16%
Total EUR Corporates	411,388,195	196,508	197,081	0.55%	0.87%	1.01%

GBP Financials

Sector / Rating	Market Value (m)	DVO1 (m)	Spread DVO1 (m)	IVV	DVO1	Spread DVO1
AAA	68,702,861	8,013	8,048	0.08%	0.04%	0.04%
Financial	68,702,861	8,013	8,048	0.08%	0.04%	0.04%
Total GBP Financials	68,702,861	8,013	8,048	0.08%	0.04%	0.04%
Total Corporates	1,920,347,621	95,830	96,252	2.48%	3.79%	4.42%

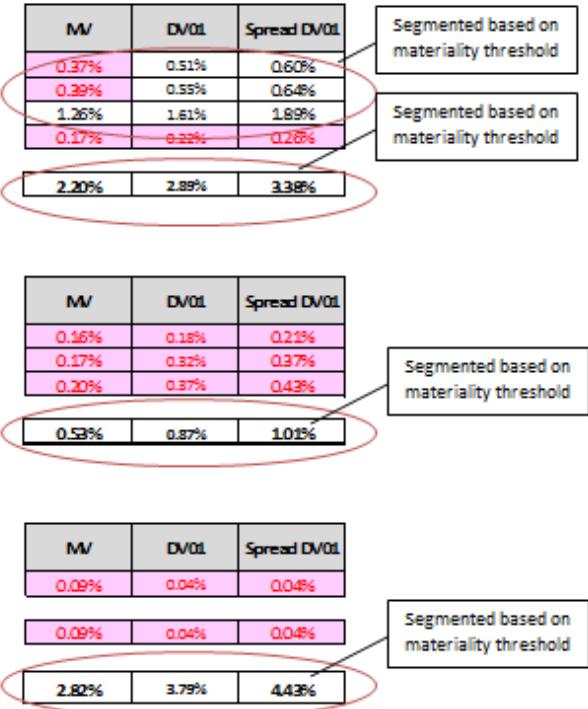
Conclusion: Currency and credit rating were identified as material for risk profile segmentation. Majority of the industry sectors were below materiality threshold and therefore, industry was not considered for final segmentation.

Phase 5: Final Segmentation for Corporate Bonds based on 4 Step Process.

USD Corporate Bonds			
Currency / Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	299,170,234	115,408	116,408
AA	304,574,001	124,131	125,352
A	973,186,743	365,242	368,427
BBB	134,043,249	49,487	49,990
USD	1,699,974,228	654,289	660,112

EUR Corporate Bonds			
Currency / Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AA	120,148,539	40,617	40,704
A	134,962,943	72,551	72,770
BBB	156,285,713	83,329	83,617
EUR	411,398,195	196,508	197,091

GBP Financials			
Currency / Rating	Market Value (m)	DV01 (m)	Spread DV01 (m)
AAA	69,702,861	8,013	8,049
GBP	69,702,861	8,013	8,049
Total Corporates	2,181,075,284	858,810	865,252



4.1.12 Covered Bonds

Description

Covered bonds are debt instruments issued by regulated financial institutions and secured by a priority claim on collateral of high quality on-balance sheet assets. The assets are typically a pool of prime residential mortgages or public sector debt that remains on the issuer's balance sheet but acts as collateral to cover the bonds. Covered Bonds are considered Bankruptcy remote since investors have full recourse to the issuer as well as recourse to the cover pool in the event of issuer insolvency.

Segmentation

BNY Mellon's Covered bonds positions are all AAA. Positions are held in various currencies, predominately USD, EUR, and GBP. ALM-IRR based segmentation on issuer country risk and currency. Data availability for Covered Bonds was sourced using composite iBoxx indices for corresponding domicile of risk and currency. Final segmentation for covered bonds was based on the issuers' country of risk and currency. The figures below illustrate the development process of segmentation for covered bonds.



Phase 1: Initial data set was analyzed and sorted by **Country of Risk**.

Security Description	Country Full Name	Currency
ROYAL BANK OF CANADA RegS	CANADA	EUR
CREDIT SUISSE (GUERNSEY) LTD 144A	SWITZERLAND	USD
STADSHYPOTEKAB 144A	SWEDEN	USD
BARCLAYS BANK PLC MTN RegS	BRITAIN	GBP
SWEDBANK HYPOTEK AB 144A	SWEDEN	USD

Phase 2: Data within each Country of Risk was analyzed and segmented by **Currency**.

Security Description		COUNTRY_FULL_NAME	Currency
ROYAL BANK OF CANADA	RegS	CANADA	EUR
CREDIT SUISSE (GUERNSEY) LTD	144A	SWITZERLAND	USD
STADSHYPOTEKAB	144A	SWEDEN	USD
BARCLAYS BANK PLC MTN	RegS	BRITAIN	GBP
SWEDBANK HYPOTEK AB	144A	SWEDEN	USD

Conclusion: Currency and Country of Risk were considered the primary segment.

Phase 3: Segmentation for Covered Bonds based on country of risk and currency, Market Value, DV01, Spread DV01, and the 4 Step Process.

Conclusion: Based on currency and country, many segments are immaterial and can be consolidated.

Phase 4: Final segmentation based on consolidation of segments

Covered Bonds			
Issuer	Currency	Market Value (m)	DV01(m)
EUR BRITAIN	512,427,937	95,328	95,519
EUR	239,234,037	47,456	75,311
USD	1,176,113,058	203,648	204,996
CANADA	1,415,347,094	251,104	280,308
SCANDINIVIA	570,857,717	152,640	152,868
NETHERLANDS	250,524,325	77,722	77,858
Grand Total	2,749,157,072	576,794	606,552
		MV	DV01
		0.66%	0.42%
		0.31%	0.21%
		1.52%	0.90%
		1.83%	1.11%
		0.74%	0.67%
		0.32%	0.34%
		0.40%	
		3.56%	2.55%
		3.10%	

4.1.13 Sovereign Bonds

Description

A Sovereign Bond is a debt security issued by a national government of a given country and denominated in a foreign currency. Over 35% of the Investment Portfolio consists of Sovereign Bonds (including US Treasuries). ALM-IRR sourced data for Sovereign Bonds using composite indices for corresponding currency, domicile of risk and curve point. Sovereign Bonds fall into two main categories: bonds issued by large, developed economies with high credit ratings and relatively low yields and Emerging Market (EM) bonds issued by developing countries (lower credit ratings and typically higher yields).

Risk profile

The financial risks inherent in sovereign bonds are a function of a country's economy, debt burden, currency stability, demographics and political system.

Segmentation

For US Treasuries, Bunds and Gilts, the respective domestic bond curve is used with no credit spread added. All Sovereign Bonds issued in Euros use the Bund Curve as the risk free yield curve. Country-specific spreads were be added to the Bund Curve. For funding structures in global currencies (Finland in USD), the country specific spread was be applied to the global currency benchmark rate. ALM-IRR based final segmentation for Sovereign Bonds on domicile of risk, and currency (see below). The below figures illustrate the development process of segmentation.

Phase 1: Initial data set was analyzed and bucketed by currency and country of issuance.

Security Description	COUNTRY_FULL_NAME	Currency
FMS WERTMANAGEMENT AOR - (LT) GTD	GERMANY	USD
FINLAND (REPUBLIC OF) MTN 144A	FINLAND	USD
THE TURKS AND CAICOS ISLANDS (GOVE 144A	TURKS & CAICOS	USD
IRELAND (REPUBLIC OF)	IRELAND	EUR
FRANCE (REPUBLIC OF)	FRANCE	EUR

Phase 2: Within each Country of Issue and Currency bucket, positions were segmented by Tenor.

Security Description	COUNTRY_FULL_NAME	Currency	Tenor
FMS WERTMANAGEMENT AOR - (LT) GTD	GERMANY	USD	5 Yr.
FINLAND (REPUBLIC OF) MTN 144A	FINLAND	USD	5 Yr.
THE TURKS AND CAICOS ISLANDS (GOVE 144A	TURKS & CAICOS	USD	5 Yr.
IRELAND (REPUBLIC OF)	IRELAND	EUR	10 Yr.
FRANCE (REPUBLIC OF)	FRANCE	EUR	10 Yr.

Phase 3: Initial Segmentation for Sovereign Bonds based on Country of Issue, Currency, Tenor, and Market Value.

COUNTRY FULL NAME	Tenor	Currency					Total
		USD	EUR	GBP	SGD		
UNITED STATES	2 Yr.	1,838					1,838
	3 Yr.	6,521					6,521
	5 Yr.	7,171					7,171
	7 Yr.	2,664					2,664
	10 Yr.	2,777					2,777
	30 Yr.	3,351					3,351
United States Total		24,322	-	-	-		24,322
Belgium	1 Yr.	-	223	-	-		223
	3 Yr.	-	117	-	-		117
	5 Yr.	-	451	-	-		451
	6 Yr.	-	354	-	-		354
	7 Yr.	-	190	-	-		190
	10 Yr.	-	60	-	-		60
Belgium Total		-	1,278	117	-		1,395
UK	5 Yr.	21	-	959	-		979
	6 Yr.	-	-	2,772	-		2,772
	10 Yr.	-	-	1,343	-		1,343
UK Total		21	-	5,074	-		5,094
Finland	5 Yr.	14	-	-	-		14
France	3mo	-	897	-	-		1,281
	6mo	384					
	1 Yr.	-	178	-	-		178
	5 Yr.	-	2,112	-	-		2,112
	10 Yr.	-	485	-	-		485
	11 Yr.	-	210	-	-		210
France Total		-	4,266	-	-		4,266
Germany	5 Yr.	50	1,817	-	-		1,867
	10 Yr.	-	224	-	-		224
	11 Yr.	-	129	-	-		129
Germany Total		50	2,171	-	-		2,221

Exceeds materiality threshold

Exceeds materiality threshold

Exceeds materiality threshold

***Please note, above segmentation is a snapshot of the full data sample. Full data sample was deemed too large for this document.

Conclusion: Final segmentation was based on currency, country of risk and term structure (short, long and intermediate term points)

Phase 4: Final Segmentation for Sovereign Bonds based on 4 Step Process.

USD Sovereign Bonds				
Country	Currency	Market Value (m)	DV01 (m)	Spread DV01 (m)
UNITED STATES	USD	12,576,986,064	8,128,980	0
FINLAND	USD	14,279,285	1,010	0
GERMANY	USD	50,065,817	11,803	11,864
SWEDEN	USD	70,374,023	10,615	10,634
TURKS & CAICOS	USD	20,348,336	1,315	1,318
USD		12,732,253,528	8,153,725	23,836
USD		155,267,462	24,745	23,836

MV	DV01	Spread DV01
16.29%	35.29%	0.00%
0.02%	0.00%	0.00%
0.06%	0.05%	0.05%
0.03%	0.01%	0.01%
16.48%	36.00%	0.12%
0.20%	0.11%	0.12%

Segmented based on materiality threshold

Country	Currency	Market Value (m)	DV01 (m)	Spread DV01 (m)
BELGIUM	EUR	1,278,438,389	284,351	0
FRANCE	EUR	3,473,913,340	673,477	0
GERMANY	EUR	1,399,308,967	321,805	0
IRELAND	EUR	893,334,184	339,525	0
ITALY	EUR	1,322,380,389	219,422	0
NETHERLANDS	EUR	1,000,414,981	383,977	0
SWITZERLAND	EUR	33,452,139	4,443	4,447
SPAIN	EUR	1,867,830,983	697,643	0
SWEDEN	EUR	71,236,708	18,193	12,997
EUR		11,442,712,048	2,966,840	17,444

MV	DV01	Spread DV01
1.66%	1.26%	0.00%
4.30%	2.98%	0.00%
1.81%	1.42%	0.00%
1.16%	1.39%	0.00%
1.71%	0.97%	0.00%
1.30%	1.70%	0.00%
0.04%	0.02%	0.02%
2.55%	3.08%	0.00%
0.09%	0.08%	0.07%
14.82%	13.10%	0.08%

Segmented based on materiality threshold

Country	Currency	Market Value (m)	DV01 (m)	Spread DV01 (m)
BELGIUM	GBP	117,493,308	39,863	0
BRITAIN	GBP	3,034,021,160	915,588	0
GBP		3,151,514,666	955,452	0
SINGAPORE	SGD	37,295,447	2,793	0

MV	DV01	Spread DV01
0.15%	0.11%	0.00%
3.93%	4.04%	0.00%
4.08%	4.22%	0.00%
0.05%	0.01%	0.00%

Segmented based on materiality threshold

4.1.14 Supranational

Description

A supranational entity is formed by two or more central governments to promote economic development for the member countries. Supranational Institutions finance their activities by issuing bond debt. These are usually considered part of the sub-sovereign debt market. Examples include the World Bank, European Investment Bank and the International American Development Bank.

Risk profile

Supranational borrowers are considered to have a relatively low risk due to support from multiple government guarantees.

Segmentation

Based on materiality thresholds (see below), and based on the fact that Supranational bonds are considered part of the sub-sovereign debt market, ALM-IRR evaluated these positions under the same parameters as Sovereign Bonds using the same data series. For funding

structures in global currencies (Finland in USD), the country specific spread were applied to the global currency benchmark rate.

Supranational Bonds			
Currency	Market Value (m)	DV01 (m)	Spread DV01 (m)
USD	199,378,703	43,646	43,892
EUR	22,846,595	983	983
GBP	16,146,586	705	708
Total	238,371,884	45,333	45,583

MV	DV01	Spread DV01
0.26%	0.19%	0.22%
0.03%	0.00%	0.01%
0.02%	0.00%	0.00%
0.31%	0.20%	0.23%

4.1.15 Equities and Private Placements

BNY Mellon has an immaterial position in common equity and private placements.

4.1.16 Money Market Mutual Funds and Short term Investment Funds

Description

A Money Market Fund is an open ended mutual fund that invests in short term securities such as US Treasury Bills and Commercial Paper. These investments limit any exposure to credit, market, and liquidity risks. Money Market Funds provide liquidity to financial intermediaries, and are regulated under the US Investment Company Act (1940). The Market Risk Group analyzes the BNY Mellon's mutual funds held in the Investment portfolio and ALM-IRR incorporates the results in OCI modeling. Underlying the data for equities and funds is a composition pulled from the Investment Manager's website/publications. BNY Mellon's Market Risk group gathers the underlying data, evaluates the funds in each stress scenario and determines if the fund breaks the buck. Bank sponsored funds include money market mutual funds, STIFs (Short Term Investment Funds) and commingled funds and all are transacted at a constant \$1 NAV. When the funds' NAV falls below \$0.95 the fund is said to have broken the buck. ALM-IRR will incorporate the mark-to-market forecast on these funds provided by Market Risk group

4.2 Moody's Analytics Credit Spread Forecasting Model

Moody's Analytics provided the 'Primary Model' specifications and estimates for the credit spread forecasts as part of the CCAR OCI process. BNY Mellon sourced and provided Moody's Analytics with historical spreads data with longest history available. Linear regression models were developed by Moody's Analytics for each defined material segmentation asset class type. These models utilized two types of methodologies: Two-stage linear regression and Single-stage linear regression.

As mentioned in section 2.5.3, Two-stage linear regression models were developed for asset classes of Agency RMBS, CMOs and US Corporate Bond, since these asset classes have multiple segments and different spread series share a similar overall market trend; and single stage linear regression was directly applied for the rest asset classes. The Two-stage linear regression model here is referring to a modeling scheme that: In the first stage model, a representative index of market credit spreads trend was created through principle component analysis. Then a linear regression model was built by regressing market spread level on macroeconomic and market drivers, which captures the overall market spread trend; In the second stage, another linear regression model was built by regressing each individual time series on predicted market spread level, macroeconomic and market variables, to capture individual time series' idiosyncratic variation.

Model development starts from an appropriate and resourceful candidacy pool. Brown 1999 mentioned that the expected return on MBS based on OAS pricing models is determined by both general market conditions and contract-specific factors. Xu and Fung 2005 introduced several important drivers to predict credit spreads, such as industrial production, new home sales, mortgage rate, general stock market index and world bond market index and etc.. Boyarchenko, Fuster and Lucca 2015 referenced that the MBS spreads dramatically spiked during the Financial Crisis in 2008, reflecting the risk that the explicit and implicit government guarantees would not cover all potential losses. Based on these previous investigations, a number of macroeconomic variables including general economy, market volatility, interest rate and real estate market variables are considered as independent candidacy drivers. In Moody's core macro system, the global impact instead of just regional or local effect was also considered. International drivers belonging to the same economic category are combined into global factor drivers using principle component decomposition. Examples include global growth factor, global equity factor and global equity volatility factor.

Given corresponding candidacy driver pool, correlation analysis of independent variables against dependent variable was conducted, in order to filter out non-critical drivers through quantitative visualization. Ten highest correlated variables were selected and analyzed by senior economists. Based on economic intuition and market subject expertise, these ten candidacy drivers were then shortlisted to a condensed list in preparation for next step of driver selection. This driver narrowing down process includes the bivariate graphs, investigation of macroeconomic relationship under different time windows. Take the Euro 10-Yr Corporate A-Rated spread projection model as an illustration, the identified key candidates include: *Global Equity Factor, Global Equity Volatility Factor, Euro Zone GDP, Euro Zone Equity Index, Euro Zone Equity Volatility, S&P 500 Volatility, US 10y A Corporate Spread, US 10y AA Corporate Spread and US 10y BBB Corporate Spread.*

This well-chosen shortlist was then put into the Best Subset Selection procedure in Stata, to explore all kinds of different combinations with lags up to three periods. The candidacy models with up to three drivers were reviewed to ensure the sign and magnitude of coefficients are consistent with economic intuition; coefficient estimations are statistically significant at 5% level; absolute correlation between explanatory variables are lower than 0.75. Below graph shows examples of candidate models for Euro 10-Yr Corporate A-Rated spread projection model:

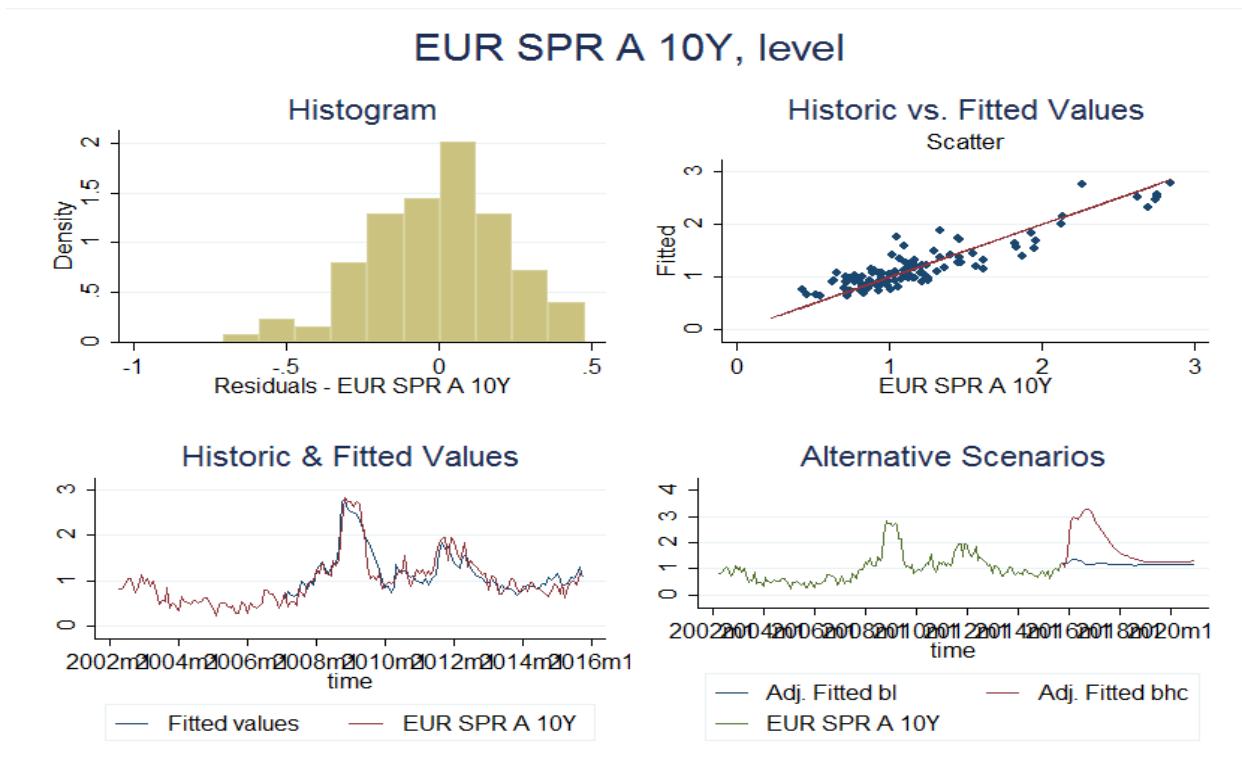
num_rhs_var	econvar1	coefficient1	econvar2	coefficient2	econvar3	coefficient3	r2 adj	rmse	r2rmse_ratio
3	10_r12_eur_gdp	-4.99	10_ff_gef	-0.10	10_ff_vstoxx	0.03	0.82	0.23	3.61
3	10_r12_eur_gdp	-4.40	10_r12_ff_eur_stoxx	-1.42	10_ff_gevf	0.08	0.78	0.25	3.17
3	10_r12_ff_eur_stoxx	-0.45	10_r12_eur_gdp	-4.76	10_ff_us_spr_a_10y	0.47	0.78	0.25	3.12
2	10_ff_vstoxx	0.03	10_ff_vstoxx	0.03	10_ff_gef	-0.12	0.78	0.25	3.09
3	10_ff_gef	-0.04	10_r12_eur_gdp	-5.01	10_ff_us_spr_a_10y	0.48	0.78	0.25	3.04
2	10_r12_eur_gdp	-4.87	10_r12_eur_gdp	-4.87	10_ff_us_spr_a_10y	0.55	0.77	0.26	2.98
3	10_ff_gef	-0.12	10_r12_eur_gdp	-4.85	10_ff_gevf	0.10	0.75	0.26	2.90
2	10_ff_vstoxx	0.04	10_r12_eur_gdp	-6.32	10_r12_eur_gdp	-6.32	0.76	0.26	2.89
2	10_ff_gevf	0.09	10_r12_ff_eur_stoxx	-1.63	10_r12_ff_eur_stoxx	-1.63	0.75	0.26	2.87
2	10_r12_ff_eur_stoxx	-0.47	10_ff_us_spr_a_10y	0.56	10_r12_ff_eur_stoxx	-0.47	0.76	0.26	2.86
1	10_ff_us_spr_a_10y	0.65	10_ff_us_spr_a_10y	0.65	10_ff_us_spr_a_10y	0.65	0.74	0.27	2.72
2	10_ff_gef	-0.15	10_ff_gef	-0.15	10_ff_gevf	0.11	0.72	0.28	2.59
3	10_r12_eur_gdp	-8.61	10_r12_ff_eur_stoxx	-0.65	10_ff_us_spr_a_10y	0.35	0.72	0.28	2.53
2	10_spvol	0.46	10_r12_eur_gdp	-10.33	10_r12_eur_gdp	-10.33	0.71	0.28	2.50
3	10_ff_us_spr_aa_10y	0.36	10_r12_eur_gdp	-9.15	10_ff_gef	-0.06	0.71	0.29	2.43
1	10_ff_us_spr_bbb_10y	0.48	10_ff_us_spr_bbb_10y	0.48	10_ff_us_spr_bbb_10y	0.48	0.70	0.29	2.37
2	10_r12_eur_gdp	-9.69	10_r12_eur_gdp	-9.69	10_ff_us_spr_aa_10y	0.47	0.69	0.30	2.31
1	10_ff_vstoxx	0.05	10_ff_vstoxx	0.05	10_ff_vstoxx	0.05	0.69	0.30	2.31
2	10_ff_gevf	0.18	10_ff_gevf	0.18	10_r12_eur_gdp	-7.02	0.66	0.30	2.17
2	10_r12_eur_gdp	-10.77	10_r12_ff_eur_stoxx	-1.22	10_r12_eur_gdp	-10.77	0.62	0.33	1.90
2	10_ff_gef	-0.13	10_r12_eur_gdp	-11.27	10_r12_eur_gdp	-11.27	0.62	0.33	1.87
2	10_r12_ff_eur_stoxx	-0.94	10_r12_ff_eur_stoxx	-0.94	10_ff_us_spr_aa_10y	0.43	0.61	0.33	1.84
1	10_ff_gevf	0.21	10_ff_gevf	0.21	10_ff_gevf	0.21	0.58	0.34	1.70
2	10_r12_ff_eur_stoxx	-0.76	10_spvol	0.43	10_r12_ff_eur_stoxx	-0.76	0.58	0.34	1.69
2	10_ff_gef	-0.08	10_ff_us_spr_aa_10y	0.46	10_ff_gef	-0.08	0.58	0.35	1.68
1	10_spvol	0.59	10_spvol	0.59	10_spvol	0.59	0.54	0.36	1.50
1	10_r12_ff_eur_stoxx	-1.72	10_r12_ff_eur_stoxx	-1.72	10_r12_ff_eur_stoxx	-1.72	0.44	0.40	1.10
1	10_r12_eur_gdp	-15.22	10_r12_eur_gdp	-15.22	10_r12_eur_gdp	-15.22	0.44	0.40	1.10
1	10_ff_gef	-0.18	10_ff_gef	-0.18	10_ff_gef	-0.18	0.41	0.41	1.01

From the reviewed candidate models, the one with maximum adjusted R² /RMSE was selected as final model. Below table shows the final model for Euro 10-Yr Corporate A-Rated spread. Euro GDP growth rate is a critical indicator of general economic health. The negative coefficients on Euro GDP and Global Equity Factor is because that when the economy and

market is performing well, borrowers' financial performance and credit quality improve, and Banks lend at lower rates, so that the spreads become narrower. Like Euro 10-Yr Corporate A-Rated spread, for each credit spread forecasting models in the OCI families, drivers' economic intuition were investigated and the market macroeconomic dynamic image derived from the final model was thoroughly discussed and validated.

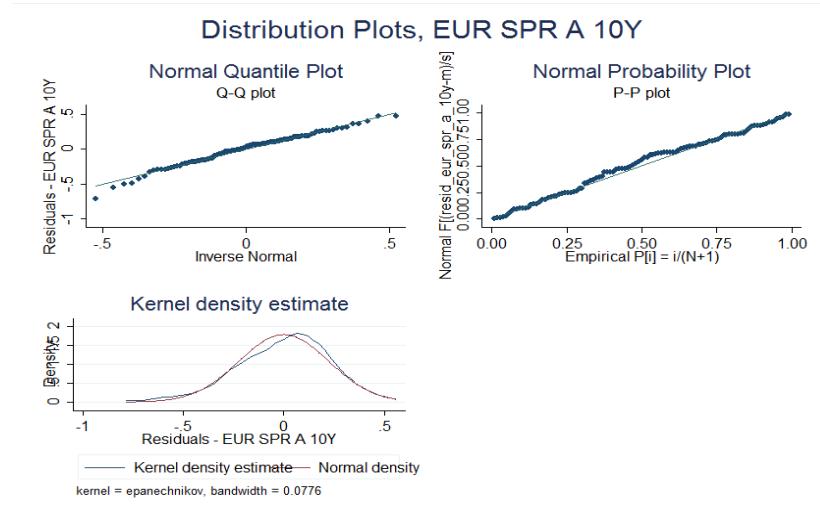
Driver	Coef	P> t
Intercept	0.57	0.000
Annualized Growth Rate of Euro GDP	-4.99	0.010
Global Equity Factor	-0.10	0.000
Euro Stock Volatility	0.03	0.000

Diagnostics statistics of final model was produced and evaluated through different angles. The in-sample fitting performance was measured through statistics such as in the graph and table below. The histogram in the top left of the chart shows the distribution of Residual differences between Forecasted and Actual Euro 10-Year A-Rated spread. Results were closely distributed around 0. The graph in the top right corner plots the historic vs fitted values; results were closely distributed around y=x. The graph in lower left plots the actual vs fitted values as a time series. Predicted and actual values appear aligned throughout the range of dates, and the graph in lower right shows forecasting results for baseline and BHC idiosyncratic stress scenarios.

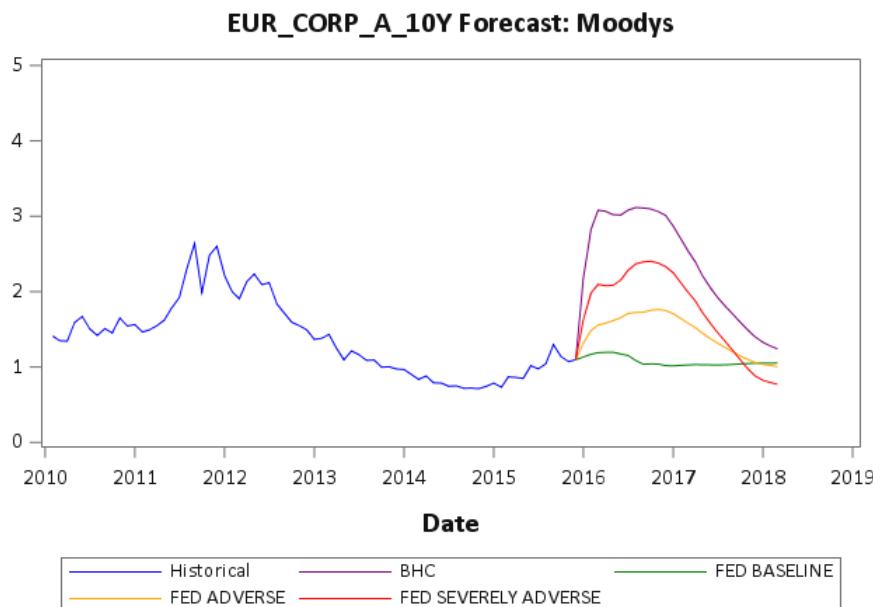


R Square	R Square	0.82
Adjusted R Square	Adj. R Square	0.82
Akaike Information Criterion	AIC	-0.1
Bayesian Information Criterion	BIC	-464.87
Root Mean Squared Error	RMSE	0.23
Mean Squared Error	MSE	0.05
Mean Absolute Error	MAE	0.18
Mean Absolute Percentage Error	MAPE	16.48
Maximal Variance Inflation Factor	Max VIF	2.07

The model performance was also assessed on different hold out samples through varied time windows. A resourceful list of statistical testing was implemented for Autocorrelation, Heteroskedasticity, Stationarity, Coefficient Stability, Sensitivity and Residual diagnostics. All of these detailed model diagnostic results for Euro 10-Yr Corporate A-Rated spread could be seen in the segment-level model documentation. Please also refer to section 2.5.3 Model Evaluation for the complete list of statistics provided. The normality plots of residuals for Euro 10-Yr Corporate A-Rated spread are shown below as an example. The quantile plots were closely aligned with $y=x$ and the kernel density estimate shows smooth results.



Besides a set of model diagnostic testing proceeded, the forecasting outlook is also scrutinized for each credit spread forecasting models. Since these spread projection models are targeted to assess the spread forecasting pattern under regulatory stress testing, forecasting outlook is one of the most critical criteria to assess the final model performance. For Euro 10-Yr Corporate A-Rated spread, the projection under different scenarios are plotted as below. The forecasted strikes under stress scenarios are consistent with the expectations under corresponding economic and market assumptions.



Here Euro 10-Yr Corporate A-Rated spread forecasting model is an example of the single-stage linear regression methodology used in BNY Mellon's Primary credit spreads forecasting model.

For the Two-stage regression methodology, please refer to appendix 7.10 US Agency RMBS OAS Projection as illustration. Although the modeling structure is different, variable selection process and model diagnostics are similar to section 4.2 here.

4.3 BNY Mellon Internal Credit Spread Forecasting Model

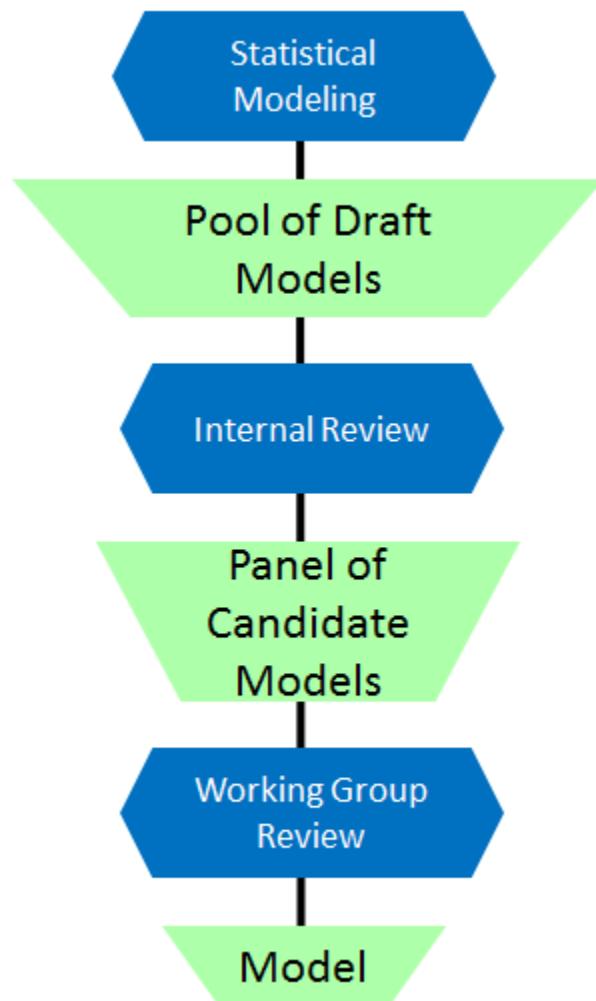
The internal credit spread projection model is the benchmark model to the Moody's Analytics primary credit spread forecasting model.

ALM-IRR developed the model drawing on quantitative expertise while collaborating with subject matter experts (SMEs) across the organization. ALM-IRR confirmed all first principles including product background and assumptions on factors potentially affecting valuations. During the internal model development life cycle, data is scrutinized to identify characteristics such as trend, stationarity, and seasonality while the model development team reviews each data variable for multiple descriptive elements to verify acceptability. These reviews eventually begin to create a pool of candidate variables to be used in preliminary models.

A stepwise regression process was applied based on selected business-intuitive parameters (called drivers) and their transformations. The drivers fall into six possible categories: rate, liquidity, market volatility, general economy, asset class specific and credit.

Once all models were reviewed individually, the team began the selection process to identify satisfactory candidate models with acceptable results that aligned with goodness of fit and statistical significance.

Top models were presented to the working group for discussion and model selection. The working group is comprised of members from the Market Risk Group and the Portfolio Management Group. Based on the feedback from the working group, models could be re assessed and the process recycled as necessary until a final model was agreed upon. The below figures illustrate the process for model development and the review process for each segment.



An example of an Agency RMBS model specification follows. Multiple iterations of the models were created, analyzed and reviewed for goodness of fit and statistical significance until five successful candidate models were identified²². From these five models, a preferred model can be further isolated. This step in the process is illustrated in the figure below with the chosen and preferred model in darker blue.

²² For a detailed description of the model development process, please see the document "Spread Forecasting Model Documentation for Investment Portfolio."

Agency RMBS

CMO_PAC_10WAL (Diff MoM)

Drivers Considered	Candidate models			
	1	2	3	4
Rate	US 10 Year Treasury* Rate (Diff MoM)			US 10 Year Treasury* Rate (Diff MoM)
Liquidity		Spread between 1 Week LIBOR and 1 Week OIS (Diff MoM) *	Spread between 1 Week LIBOR and 1 Week OIS (Diff MoM) *	Spread between 1 Week LIBOR and 1 Week OIS (Diff MoM) *
Market volatility		Volatility Index * (Diff QoQ)	Volatility Index * (Diff QoQ)	Volatility Index * (Diff QoQ)
General Economy				
Asset Class Specific	Mortgage Rate* (Diff QoQ)		Mortgage Rate (Diff QoQ)	
Credit (Spread)	Moody's Baa Corp Spread (Diff MoM)*			
R-squared	0.36	0.22	0.22	0.25
Adjusted R-squared	0.34	0.20	0.20	0.23
Comments	Ranking of the driver buckets from SME responses: Market Volatility, Asset Class Specific, Credit, Rate, General Economy, and Basis.			

* Significant at 10%, 5%, or 1%

- Preferred Model
- Historical fit and forecast balance results presented in following slides
- Negative coefficient

Two drivers have been chosen for the preferred model from among the many drivers and combinations considered: the spread between 1 Week LIBOR and 1 Week OIS (month to month change) and the Volatility Index (VIX) (quarter to quarter change). These two drivers will serve as explanatory variables to forecast the movements of the OAS for the asset class Agency RMBS CMO_PAC_10WAL²³.

Below are the results of running this model. The results predict the degree to which this asset class will be affected by movements in these drivers (indicated by the size of the coefficients).

²³ This is a planned amortization class collateralized mortgage obligation with a 10 year weighted average life

Drivers used in selected model

Driver	Variable	Coefficient	Unit of coefficient	P-value	Std. Coeff.
Liquidity	Spread between 1 Week LIBOR and 1 Week OIS (Diff MoM)	0.08	%	<0.05	0.14
Market volatility	Volatility Index (Diff QoQ)	0.01	%	<0.01	0.44
	Intercept	-0.01	%	>0.10	N/A

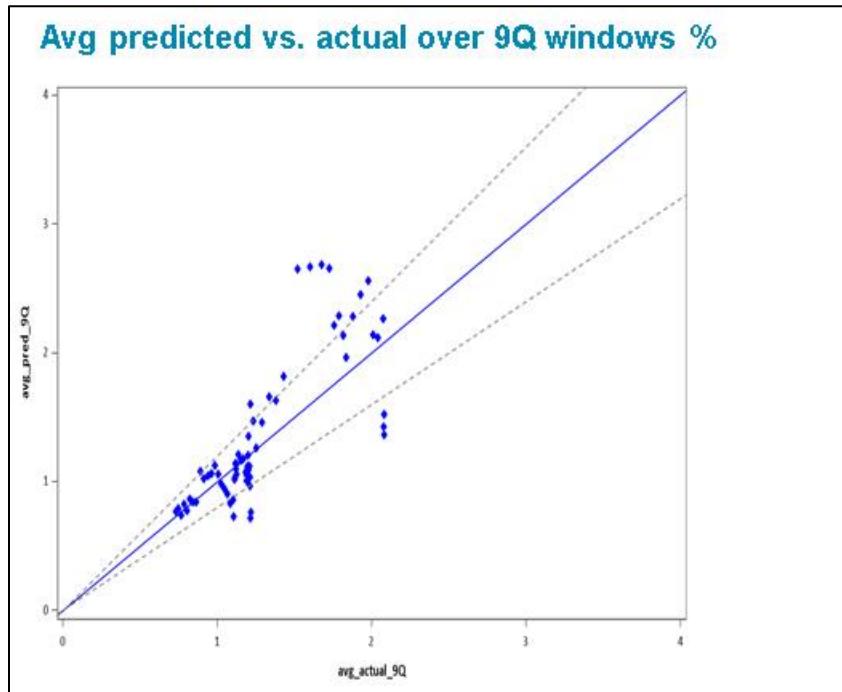
Pr > F: <0.0001

The resulting coefficients suggest that for each indicated change in the model variables (the drivers), the effect on the CMO_PAC_10WAL is:

- 8bps increase for a 100bps increase in the Spread between 1W Libor and 1W OIS from month to month
- 1 bps increase for a 100bps increase in the Volatility Index quarter to quarter

The p-values of <0.10 for all the selected parameters show the statistical significance of these chosen drivers on this specific asset class in the investment portfolio.

The 9-Q graph below compares the actual versus predicted values over the 9-quarter time period. Units for both axes are percentage. The dotted lines on the graph mark the 20% margin of forecast error. The solid diagonal line is the 45 degree line. The dots on the line mean predicted value equals actual value. For the dots above the line, the further away from the line, the more over-estimation. For the dots below the line, the further away from the line, the more under-estimation



4.4 The QRM OCI Valuation Model

QRM is a vendor system used by BNY Mellon's ALM Group for calculating and managing the economic value of equity (EVE), the balance sheet interest rate sensitivities (DV01), and forecasting the net interest income (NII) of the balance sheet under different macro-economic scenarios²⁴. QRM's functionality includes interest rate, yield curve, cash flow, and behavior modeling, and prepayment and run-off models for the relevant portfolios. Projected spreads are input into the QRM OCI Valuation framework along with interest rates and other macroeconomic factors. Credit spread granular segmentation is modeled in QRM using multiple credit spread trees tied to the respective discounting yield curves. The QRM framework adjusts the future portfolio's positions for maturities, amortization, prepayment and planned purchases to produce the projected future portfolio. Full re-valuation of the portfolio is performed at every future instance over the forecast horizon, incorporating the scenarios and the projected spread shocks.

²⁴ Refer to the Appendix for QRM details

For a detailed description of the QRM OCI Valuation model including the inputs, data sources and controls for integrity, please consult the appendix (7.5) and the model validation document *QRM OCI (Model ID number #2122)*.

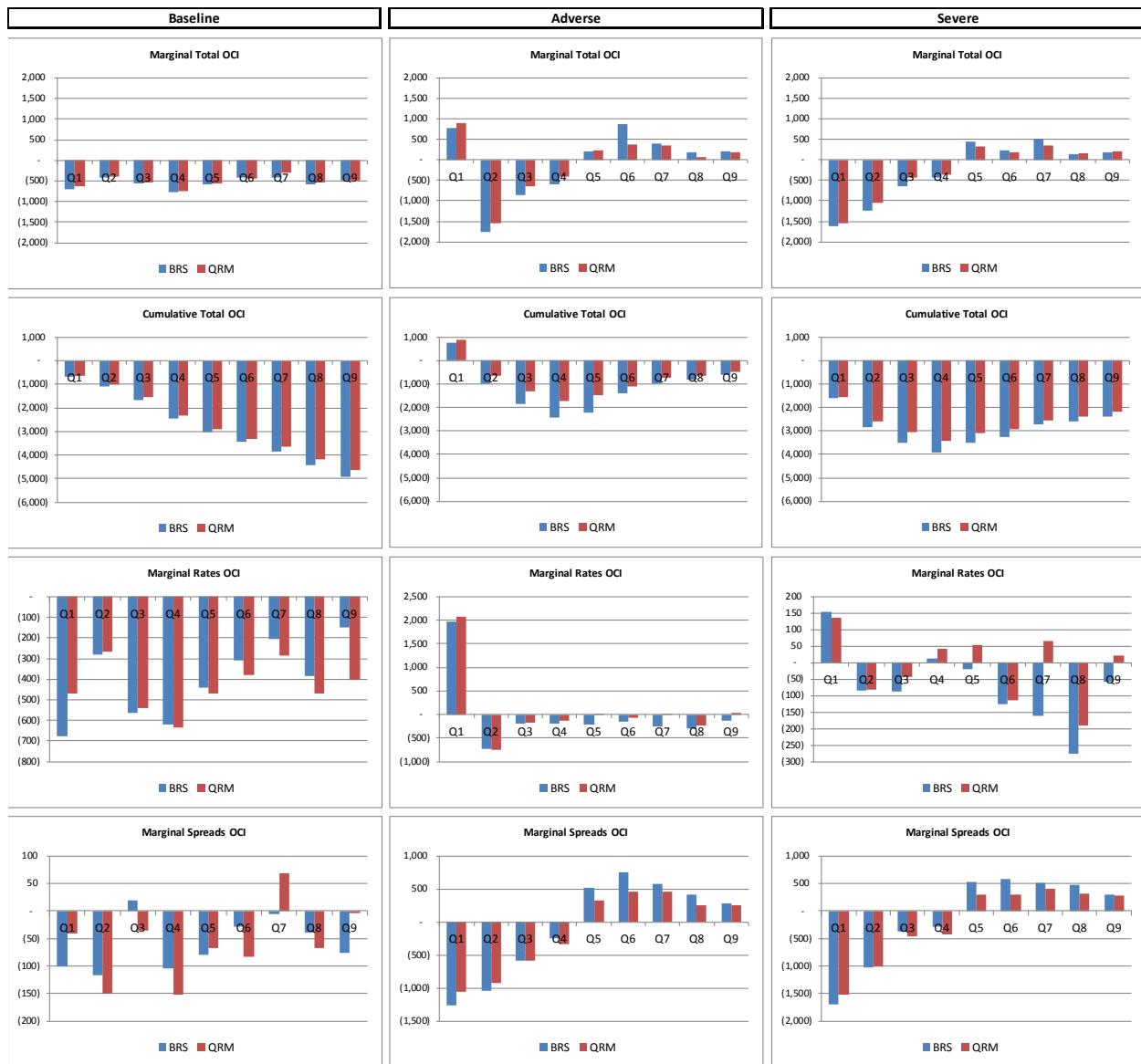
4.5 The Blackrock OCI Valuation Model

Blackrock Advisory Services was engaged to use their AOCI model as a benchmark model for the OCI Valuation calculation, and to provide modeling, scenario analysis and related services to generate CCAR risk assessments and related analytics.

BNY Mellon provides portfolio position data and assumptions related to macro-economic variables rates, credit spreads/OAS and dynamic future portfolio composition, consistent with the QRM OCI Valuation model. Blackrock's deliverables include portfolio valuations, risk metrics, risk factor attribution analysis and model documentation for various simulated scenarios.

Prior to CCAR 2016, Blackrock performed a dry run repeat of DFAST 2015 OCI analysis using the same input assumptions as were used in the QRM OCI Valuation model. ALM-IRR performed attribution analysis using factors such as spreads, rates, net amortization and pay downs and documented the model variances.

The overall results from benchmarking Blackrock and QRM OCI in the DFAST 2015 baseline scenario are presented below:



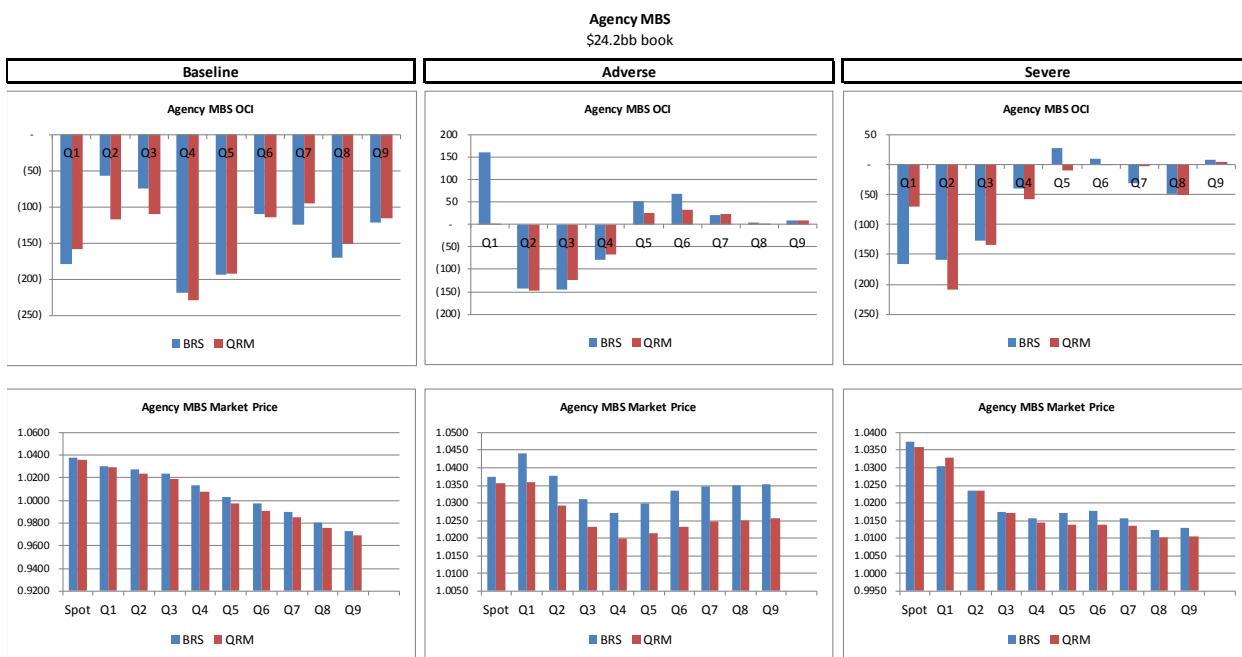
Further testing of the runoff portfolio in Baseline, Adverse, and Severe scenarios showed that Blackrock's OCI modeling tracked close to QRM's modeling, with minor model driven variances.

Primary sources of variation observed during the analysis.

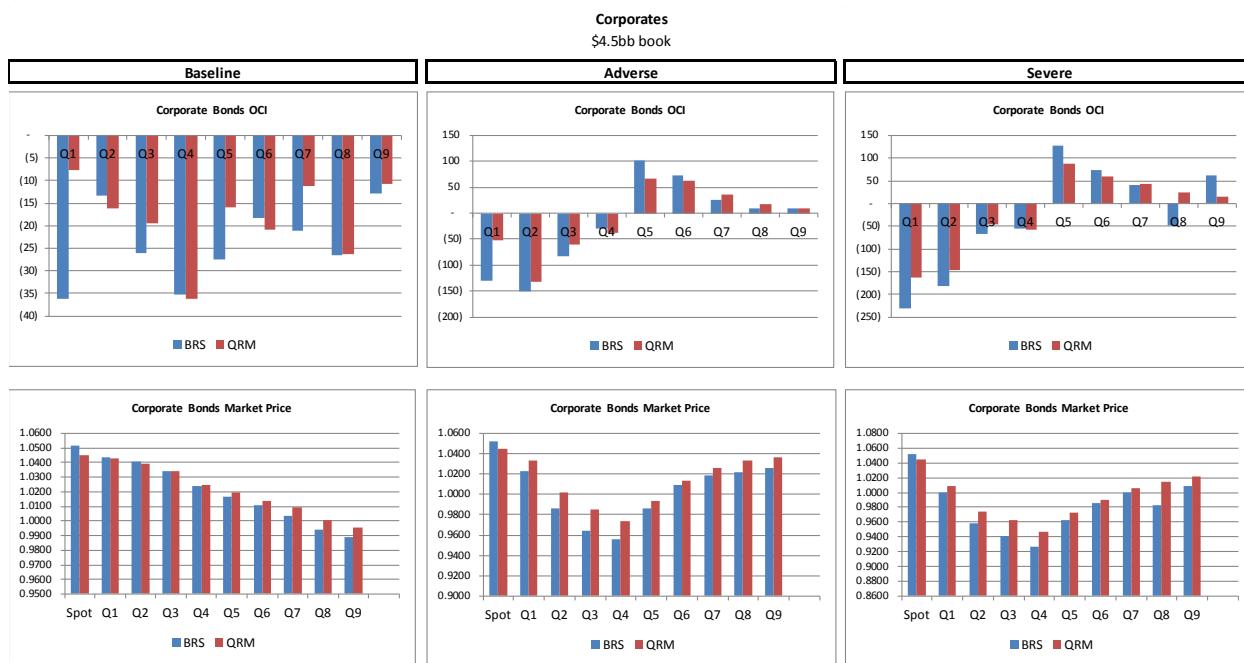
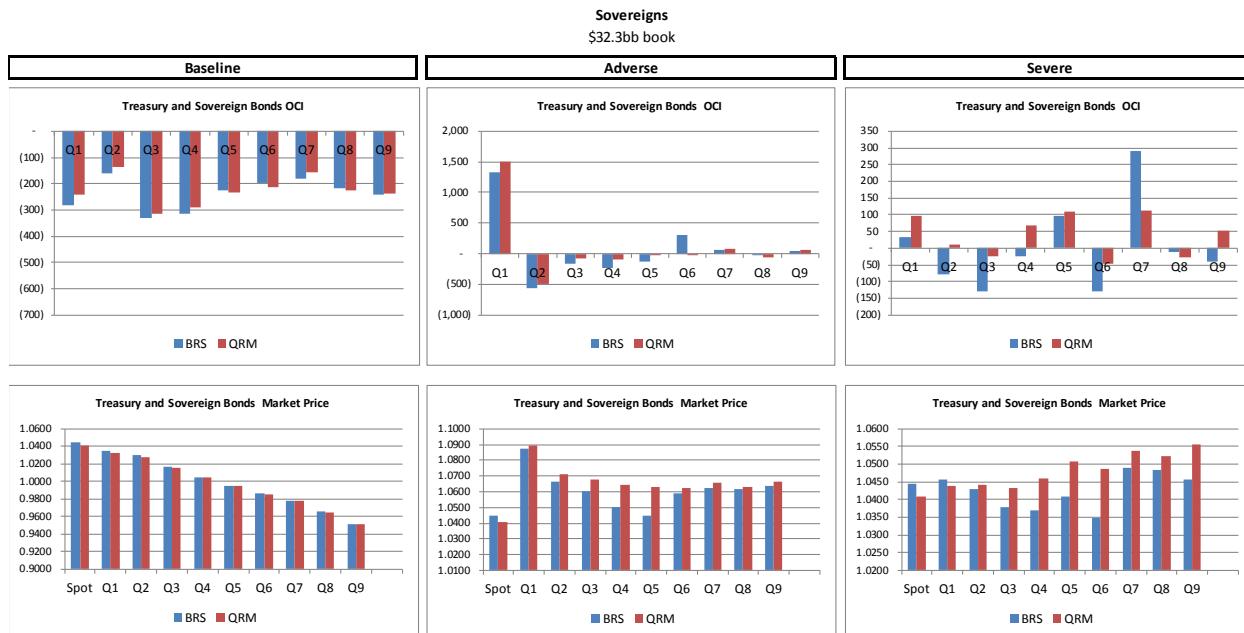
1. Rate inputs in QRM were different from Blackrock for USD tenors greater than 10 years. The differences occurred in the first period and continued for the rest of the periods. This impacts securities with maturities greater than 10 years, such as MBS, Municipal Bonds, and hedges.

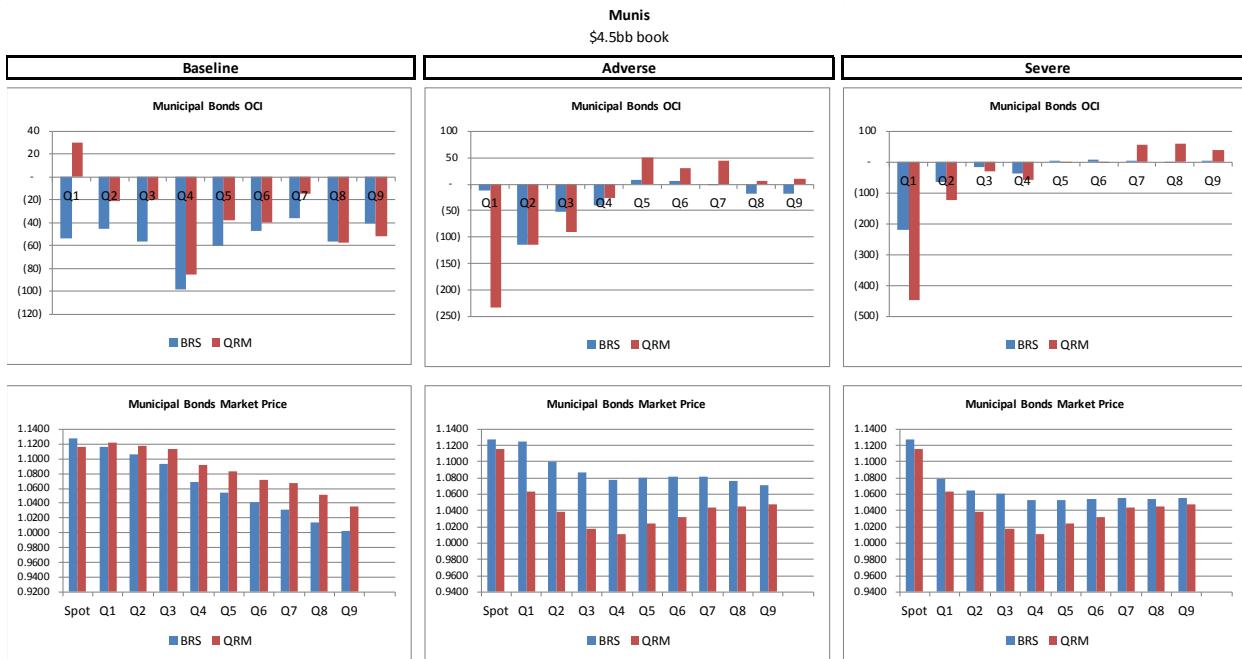
2. Discounting assumptions²⁵ between QRM and Blackrock also differed for certain securities. For example, Corporate Bonds were discounted by the Libor/Swap curve in Blackrock's analysis and by the Treasury curve in QRM's. Municipal Bonds were discounted with at Treasury curve plus spread by Blackrock but using a generic Municipal Bond curve in QRM.
3. For some credit securities, such as CLOs, Blackrock did not compute rate risk. For other credit securities, Blackrock's rate risk seemed understated. For previous experience, Blackrock analytics zeros out rate risk for very credit sensitive securities.
4. Behavioral assumptions for QRM and Blackrock differed (i.e., CPR, CDR, Severities). For example, in the Adverse scenario, the overall face value difference by the 27th period grew to \$5 Billion (BRS greater). Most of that difference was in Agency MBS.

OCI for some selected securities is presented in the following charts.



²⁵ Details on the discounting assumptions provided in the Model #2122 QRM OCI document



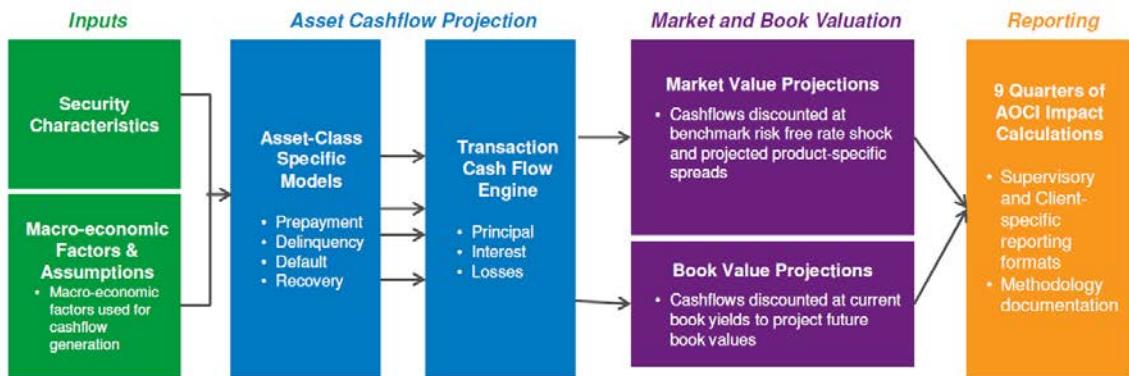


4.6 The Blackrock OCI Valuation Methodology

BlackRock's OCI valuation follows a five step process

- Onboarding portfolio data and translating provided macroeconomic scenarios into BlackRock model vectors;
- Cash flow projections for each security via BlackRock's proprietary asset class credit risk models;
- Market value projections based on discounting security cash flows at the benchmark risk-free rate and projected product-specific spreads;
- Book value projections based on security amortization profiles and the calculated as of date book yield; and finally, Unrealized gain / loss, or AOCI impact, calculations at each horizon date based on the projected quarterly market and book values.

Throughout the unrealized gain / loss (and related credit OTTI) calculation process, BlackRock financial modelers and portfolio managers review outputs, including cash flows, product specific spread projections, future market values, future book values and sub-portfolio level unrealized gain / loss trajectories. The diagram below represents BlackRock's AOCI calculation methodology for fixed income securities.



5. Model Output Analysis

5.1 Attribution Analysis

BNY Mellon performs decomposition and attribution analysis²⁶ on the OCI forecasts to explain the market value change. The primary drivers for the mark-to-market change are interest rates, credit spreads and exchange rate. ALM-IRR analyzes the effect from each of these drivers for every planning quarter end to highlight the drivers of market value change based on the segment level risk profile. This analysis ensures that the forecasted OCI is consistent with the scenario specific macroeconomic assumptions.

5.2 Sensitivity Analysis

ALM-IRR performs parameter sensitivity analysis to assess model behavior to changes in input parameters. The purpose of sensitivity analysis is to ensure model is stable and tractable with variations in inputs, and model performance is not affected by stressed input assumptions. Model sensitivity analysis is performed for parallel shift to the interest rates, credit spreads, HPI and mortgage rates²⁷.

²⁶ Attribution analysis example for implementation test are documented in the Model #2122 QRM OCI document

²⁷ Parameter sensitivity analysis is performed during model implementation and development, documented in the Model #2122 QRM OCI document

6. Review and Challenge

As described earlier, there are two steps to the calculation of OCI. First, there is the credit spread forecasting model and secondly there is the OCI valuation model. For the credit spread forecasting model, a two-step challenge and review process has been employed. The rate setting working group (RSWG) checks each of the credit spreads provided by Moody's for reasonableness and then challenges Moody's on each anomaly identified. Further, BNY Mellon's internal benchmark credit spread model contests the actual forecast provided by Moody's analytics. For the OCI valuation model, Blackrock is the benchmark model to the forecast created by the QRM framework. Further, the senior management, treasury risk committee and the risk oversight group working together provide a second line of challenge and review to the models and resultant forecasts. As with the Moody's (primary) credit spread forecasting model, if any issues are identified, then balance sheet action recommended by the stress testing oversight group (composed of risk and senior management) will immediately be implemented.

7. Appendices

7.1 CCAR 2016 Stress Test

The Dodd-Frank Wall Street Reform and Consumer Protection Act require the Board of Governors of the Federal Reserve System (Board) to conduct an annual supervisory stress test of bank holding companies (BHCs) at least once a year. The Board uses three supervisory scenarios—baseline, adverse, and severely adverse in its supervisory stress test and a BHC's annual company-run stress test. The baseline scenario follows a similar profile to the average projections from surveys of economic forecasters, while the adverse and severely adverse scenarios describe hypothetical sets of conditions designed to assess the strength of banking organizations and their resilience to adverse economic environments.

Scenario Description

All scenarios start in the first quarter of 2016 and extend through the second quarter of 2018.

- The **baseline** scenario for the United States is for a sustained, moderate expansion in economic activity, with real GDP growth at an average rate of 2.5 percent per year, unemployment rate
- The Supervisory Adverse Scenario is characterized by global weakening of economic activity, deflation in U.S., moderate recession in U.S. and widening of credit spreads. Outside the United States, the adverse scenario features moderate recessions in the euro area, the United Kingdom, and Japan, and below-trend growth in developing Asia.
- The Supervisory Severely Adverse Scenario is characterized by severe global recession, a period of heightened corporate financial stress, negative yields on short-term US Treasury, large reduction in asset prices, decline in equity prices, lower yields and widening of credit spreads. Outside the United States, the severely adverse scenario features severe recessions in the euro area, the United Kingdom, and Japan, and moderate recession in developing Asia.
- In the BHC Idiosyncratic stress scenario, BNY Mellon's long-term credit rating is downgraded three notches with a one notch short-term downgrade. The result is severe economic downturn, prolonged global recession, lower yields and significant widening of credit spreads.

The investment portfolio profile as of 12/31/2015 for CCAR 2016 is documented in Appendix 7.2

Credit spread segmentation

The detailed segmentation for modeling credit spreads for the BNY Mellon AFS securities portfolio follows the four-step process as described in section 3. The below exhibits the final segmentation for CCAR 2016 credit spread modeling.

Agency MBS & CMO

Security Type	Issuer	Coupon	Mkt Value (\$ Millions)	Spread Segment
Agency MBS 15Y	FHLMC	2.500	\$ 31	
		3.000	\$ 2,241	FHLMC15_CC
		3.500	\$ 1,128	
		4.000	\$ 512	FHLMC15_4
		4.500	\$ 343	FHLMC15_4p5_2005, FHLMC15_4p5_2009
		5.000	\$ 196	
		5.500	\$ 0	
	FNMA	6.000	\$ 0	FHLMC15_5_2005, FHLMC15_2008
		7.000	\$ 0	
		2.500	\$ 147	
Agency MBS 30Y	FHLMC	3.000	\$ 1,463	FNMA15_CC
		3.500	\$ 1,535	
		4.000	\$ 602	FNMA15_4
		4.500	\$ 383	
		5.000	\$ 201	
		5.500	\$ 0	
		6.000	\$ 0	
		6.500	\$ 0	FNMA15_4p5
		7.000	\$ 0	
		7.500	\$ 0	
		8.000	\$ 0	
	GNMA		\$ 1	GNMA15_CC
	FNMA	4.000	\$ 1	
		4.500	\$ 80	
		5.000	\$ 15	
		5.500	\$ 8	
		6.000	\$ 6	
		6.500	\$ 1	FHLMC30_CC
		7.000	\$ 0	
		7.500	\$ 0	
		8.000	\$ 0	
	GNMA	3.000	\$ 30	
		3.500	\$ 181	FNMA30_CC
		4.000	\$ 97	
		4.500	\$ 57	FNMA30_4p5
		5.000	\$ 182	
		5.500	\$ 40	
		5.750	\$ 1	
		6.000	\$ 23	
		6.500	\$ 4	FNMA30_5p5
		7.000	\$ 0	
		7.500	\$ 0	
		8.000	\$ 0	

Security Type	Issuer	Trait	Mkt Value (\$ Millions)	Spread Segment
Agency Hybrid	FHLMC	1/1	\$ 0	FHLM5_1_3
		3/1	\$ 18	
		5/1	\$ 316	
		7/1	\$ 246	
		10/1	\$ 197	
	FNMA	1/1	\$ 100	FNMA5_1_3
		3/1	\$ 13	
		5/1	\$ 406	
		7/1	\$ 353	
	GNMA	10/1	\$ 389	
		1/1	\$ 0	FNMA5_1_3
		3/1	\$ -	
		5/1	\$ 243	
		7/1	\$ -	
		10/1	\$ -	

Security Type	Type	WAL	Mkt Value (\$ Millions)	Spread Segment
Agency CMO Fixed	Sequential	< 1.0	\$ 1	CMO_SEQ_2WAL, CMO_SEQ_10WAL
		1	\$ 41	
		2	\$ 3	
		3	\$ 104	
		4	\$ 99	
		5	\$ 88	
		6	\$ 114	
	Passthrough	1	\$ 42	CMO_PAC_2WAL, CMO_PAC_10WAL
		3	\$ 13	
		4	\$ 17	
	PAC/TACs	< 1.0	\$ 0	CMO_PAC_2WAL, CMO_PAC_10WAL
		1	\$ 4	
		2	\$ 17	
		3	\$ 3	
		4	\$ 111	
		5	\$ 93	
		6	\$ 97	

In the CCAR 2016 Supervisory Severely Adverse scenario, the U.S. Treasury yields decline and the spread basis between Treasury and USD Swap yields widens. The OAS projections for Agency CMO calculated over Swap curve indicated tightening over first few quarters that was inconsistent with other asset classes. ALM-IRR decided to use the CMO spread over Treasury while continue using the Libor/Swap curve for discounting. MRMG was informed of this approximation and approved for CCAR 2016.

Security Type	Coupon	Mkt Value (\$ Millions)	Spread Segment
Agency CMO Floater	6.50	\$ 1,295	CMO_FLTFLT_6p5
	7.00	\$ 1,113	CMO_FLTFLT_7
	6.50	\$ 5,129	CMO_FLTSTR_6p5
	7.00	\$ 3,084	CMO_FLTSTR_7

Structured Products

Security Type	Tranche Type	Credit Rating	Mkt Value (\$ Millions)	Spread Segment
ABS	Auto ABS	AAA	\$ 1,066	ABS_AT_AAA_1Y, ABS_AT_AAA_3Y
		AA	\$ 31	
	ABS CARDS	AAA	\$ 1,165	ABS_CC_AAA_3Y, ABS_CC_AAA_7Y
		A	\$ 20	
	ABS Student Loans	AAA	\$ 540	ABS_SL_AAA_1Y, ABS_SL_AAA_7Y
		AA	\$ 71	
CLO		AAA	2,234	CLO_AAA_3M
		AA	117	
Non Agency CMBS	Senior		\$ 1,295	CMBS_2005_A
	Subordinate		\$ 97	CMBS_2005_AJ

Security Type	Issuer	Tranche	Mkt Value (\$ Millions)	Spread Segment
Agency CMBS	FHLMC	A	\$ 1,684	FHLMC_CMBS_A2_10Y
	FNMA	A1	\$ 957	FNMA_DUS_5to10Y
		A2	\$ 1,238	
	GNMS	A	\$ 141	GNMA_CMBS_3p5Y & GNMA_CMBS_12Y

Security Type	Type	Rating	Mkt Value (\$ Millions)	Spread Segment
Non Agency RMBS	Prime	AAA	\$ 821	RMBS_Prime_AAA
		Alt-A	\$ 1,332	RMBS_AltA_AAA
		AA	\$ 23	RMBS_AltA_AA
	SubPrime	AAA	\$ 101	RMBS_SubPrime_AAA
		AA	\$ 251	
		A	\$ 10	RMBS_AltA_AA

Security Type	Currency	Country	Rating	Mkt Value (\$ Millions)	Spread Segment
International MBS	EUR	BRITAIN	AA	\$ 147	EUR_DCH_AA
		IRELAND	A	\$ 54	
			BBB	\$ 40	EUR_IR BBB
	GBP	NETHERLANDS	AAA	\$ 215	EUR_DCH_5t10 AAA
		BRITAIN	AAA	\$ 623	GBP_UK_0t3 AAA,G BP_UK_3t5 AAA GBP_UK_5t10 AAA
		IRELAND	BBB	\$ 25	EUR_IR BBB

Municipal Bonds

Security Type	Type	Rating	Mkt Value (\$ Millions)	Spread Segment
Municipal Bonds- Revenue	Education Municipal	AAA	\$ 30	
		AA	\$ 347	BFV_ED_AA_1Y, BFV_ED_AA_5Y
		A	\$ 82	, BFV_ED_AA_10Y
		NONE	\$ 17	
	Transportation Municipal	AAA	\$ 8	BFV_TR_AA_1Y, BFV_TR_AA_5Y,
		AA	\$ 443	BFV_TR_AA_10Y
		A	\$ 219	
	Utility Municipal	AAA	\$ 151	
		AA	\$ 539	BFV_UT_A_1Y, BFV_UT_A_5Y,
		A	\$ 106	BFV_UT_A_10Y, BFV_UT_AA_1Y,
		BBB	\$ 92	BFV_UT_AA_5Y, BFV_UT_AA_10Y
		NONE	\$ 18	
	Other revenue Municipal	AAA	\$ 19	
		AA	\$ 501	BFV_REV_A_1Y, BFV_REV_A_5Y,
		A	\$ 207	BFV_REV_A_10Y
		BBB	\$ 0	
		NONE	\$ 69	
Municipal Bonds- General Obligation	General Obligation	AAA	\$ 286	BFV_GO_AA_1Y, BFV_GO_AA_5Y & BFV_GO_AA_10Y
		AA	\$ 704	
		A	\$ 202	
		B	\$ 0	
		BBB	\$ 0	BFV_GO_A_1Y, BFV_GO_A_5Y &
		CCC	\$ 1	BFV_GO_A_10Y
		NR	\$ 2	

Corporate and Covered Bonds

Security Type	Currency	Rating	Mkt Value (\$ Millions)	Spread Segment
Corporate Bonds	USD	AAA	\$ 38	USD_CORP_AAA_1Y, USD_CORP_AAA_5Y, USD_CORP_AAA_10Y
		AA	\$ 213	USD_CORP_AA_1Y, USD_CORP_AA_5Y, USD_CORP_AA_10Y
		A	\$ 1,040	USD_CORP_A_1Y, USD_CORP_A_5Y, USD_CORP_A_10Y
		BBB	\$ 84	USD_CORP_BBB_1Y, USD_CORP_BBB_5Y, USD_CORP_BBB_10Y
	EUR	AAA	\$ 22	EUR_CORP_AA_1Y, EUR_CORP_AA_5Y, EUR_CORP_AA_10Y
		AA	\$ 67	EUR_CORP_A_1Y, EUR_CORP_A_5Y, EUR_CORP_A_10Y
		A	\$ 179	EUR_CORP_BBB_1Y, EUR_CORP_BBB_5Y, EUR_CORP_BBB_10Y
		BBB	\$ 154	EUR_CORP_BBB_1Y, EUR_CORP_BBB_5Y, EUR_CORP_BBB_10Y

Security Type	Country	Currency	Mkt Value (\$ Millions)	Spread Segment
Covered Bonds	BRITAIN	EUR	\$ 354	iBoxx_EUR_GB
		GBP	\$ 8	
	CANADA	USD	\$ 753	iBoxx_Canada_Cov
		GBP	\$ 144	iBoxx_EUR_Canada
		EUR	\$ 118	
	NETHERLANDS	EUR	\$ 214	iBoxx_EUR_Netherlands
	FRANCE	EUR	\$ 25	
	FINLAND	EUR	\$ 185	iBoxx_EUR_Scandinavia
	NORWAY	EUR	\$ 176	
	SWEDEN	USD	\$ 16	
		EUR	\$ 147	
	SWITZERLAND	USD	\$ 24	
		USD	\$ 6	

Sovereign Bonds and Agency Debentures

Security Type	Issuer	WAL	Mkt Value (\$ Millions)	Spread Segment
Agency Debentures	FHLMC	5Y	\$ 48	AgencyDeb_Short, AgencyDeb_Intermediate, AgencyDeb_Long
		6Y	\$ 9	
		7Y	\$ 31	
		10Y	\$ 15	
	FNMA	5Y	\$ 33	
		6Y	\$ -	
		7Y	\$ 88	
		10Y	\$ 49	
	FHLB	5Y	\$ -	
		6Y	\$ -	
		7Y	\$ 48	
		10Y	\$ 49	

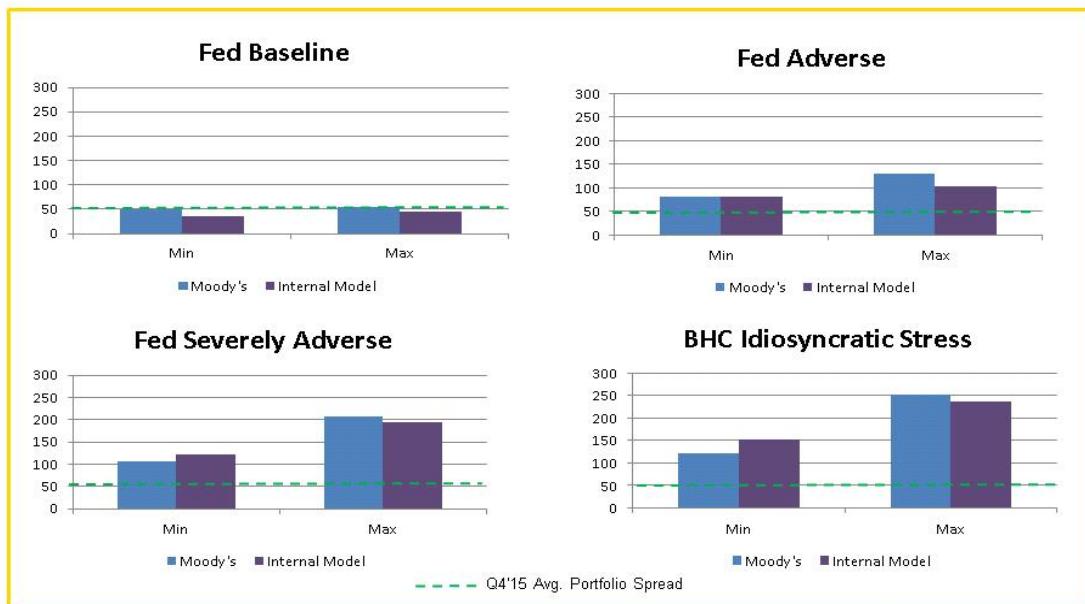
Security Type	Country	Mkt Value (\$ Millions)	Spread Segment
Sovereign and International Bonds	BELGIUM	\$ 1,005	SOV_EUR_BEL 1Y, 10Y
	FRANCE	\$ 1,978	SOV_EUR_FRA 1Y, 10Y
	IRELAND	\$ 761	SOV_EUR_IRL 1Y, 10Y
	ITALY	\$ 1,377	SOV_EUR_ITA 1Y, 10Y
	NETHERLANDS	\$ 1,040	SOV_EUR_NED 1Y, 10Y
	SPAIN	\$ 1,927	SOV_EUR_SPA 1Y, 10Y
	SWEDEN	\$ 138	SOV_EUR_SWE 1Y, 10Y
	BRAZIL	\$ 95	SOV_EUR_SPA 1Y, 10Y

The position in Brazilian sovereign debt is immaterial, and consolidated with the most volatile sovereign curve i.e. Spain

Credit Spread forecasts

Credit Spread spreads for each of the identified risk segments are modeled by Moody's and input to the model as relative shock to the spot position. For mortgage backed securities, shock is applied to the option-adjusted spreads.

Forecasts were also generated using the internal benchmark models to aid in review and challenge of Moody's models. The below exhibit compares the maximum and minimum weighted average portfolio spread for Moody's models and Internal models. The weighted average portfolio spread from Moody's model was modestly more punitive than internal models. However, the trend and rank order of forecasts from both models were consistent with the scenarios.



ASSET TYPE	Q4'15	Baseline						Adverse					
		MOODY'S MODELS			INTERNAL MODELS			MOODY'S MODELS			INTERNAL MODELS		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Agency MBS	45	37	47	40	44	50	46	48	63	58	60	74	66
Agency MBS CMO	35	35	68	50	28	35	31	32	73	60	45	68	51
EUR Sov	58	66	77	69	71	128	97	54	145	105	101	144	125
Muni	66	28	61	44	48	64	55	73	100	87	73	101	86
CLO	110	124	143	138	84	115	97	211	417	316	143	289	247
Non-agency RMBS	269	251	370	315	30	200	115	700	1306	1037	585	761	698
Non-agency CMBS	105	83	128	103	-74	31	-27	200	378	296	134	321	227
Agency CMBS	90	77	96	83	86	122	104	93	120	109	117	161	148
ABS	60	52	74	60	15	34	22	66	136	117	93	194	148
USD Corp	161	117	134	124	69	118	90	222	271	247	146	205	179
EUR Corp	111	98	118	104	53	84	67	97	180	145	163	303	234
Avg Portfolio SPD	49	30	55	33	35	45	40	81	129	105	81	104	92
BBB Corp SPD (from Fed)	267	183	207	193				293	363	332			

ASSET TYPE	15Q4	Severe						BHC Idiosyncratic					
		MOODY'S MODELS			INTERNAL MODELS			MOODY'S MODELS			INTERNAL MODELS		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Agency MBS	45	49	97	76	68	130	95	64	149	108	67	157	114
Agency MBS CMO	35	32	101	69	116	193	135	76	148	111	54	131	84
EUR Sov	58	76	243	164	87	191	148	137	332	230	231	409	325
Muni	66	98	178	142	91	180	121	105	157	134	89	196	138
CLO	110	272	619	456	239	443	357	340	698	512	292	544	480
Non-agency RMBS	269	1118	2247	1761	1242	1555	1362	1220	2246	1730	1344	1732	1573
Non-agency CMBS	105	299	702	516	370	839	590	408	979	756	173	793	538
Agency CMBS	90	91	172	135	159	246	202	113	255	180	220	296	238
ABS	60	75	294	193	171	483	339	127	518	311	201	613	439
USD Corp	161	347	448	396	187	333	270	127	421	289	180	366	324
EUR Corp	111	71	232	176	254	467	370	129	338	233	52	406	334
Avg Portfolio SPD	49	106	207	160	122	194	161	123	233	199	132	236	199
BBB Corp SPD (from Fed)	267	404	572	496				404	572	496			

The tables below summarize the forecasted credit spread and OAS shocks applied to the risk segments across the fours stress scenarios.

Credit Spread shock forecasts for the Baseline Scenario											
Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
Agency MBS 15Y FNMA	FNMA15_CC	3,145,288,581	-0.02	-0.03	-0.06	-0.06	-0.06	-0.07	-0.07	-0.08	-0.09
	FNMA15_4	602,376,199	0.04	-0.01	-0.05	-0.06	-0.06	-0.08	-0.09	-0.11	-0.12
	FNMA15_4p5	585,028,346	0.04	-0.01	-0.06	-0.06	-0.07	-0.09	-0.11	-0.12	-0.13
Agency MBS 15Y FHLMC	FHLMC15_CC	3,400,054,997	-0.01	-0.03	-0.05	-0.06	-0.06	-0.07	-0.07	-0.07	-0.08
	FHLMC15_4	512,209,539	0.05	0.00	-0.07	-0.09	-0.10	-0.12	-0.13	-0.15	-0.16
	FHLMC15_4p5_2005	86,166,708	0.04	-0.01	-0.06	-0.07	-0.08	-0.10	-0.11	-0.13	-0.14
	FHLMC15_4p5_2009	257,257,166	0.04	-0.01	-0.05	-0.06	-0.07	-0.09	-0.11	-0.12	-0.13
	FHLMC15_5_2005	53,480,053	0.06	0.03	-0.04	-0.06	-0.07	-0.09	-0.11	-0.13	-0.15
	FHLMC15_5_2008	142,595,171	-0.02	-0.06	-0.12	-0.15	-0.16	-0.18	-0.20	-0.22	-0.24
Agency MBS 15Y GNMA	GNMA15_CC	926,671	0.02	0.07	0.03	-0.02	-0.01	-0.01	-0.02	-0.03	-0.03
	FNMA30_CC	307,778,093	0.05	0.04	0.02	0.01	0.01	0.00	0.00	-0.01	-0.02
Agency MBS 30Y FNMA	FNMA30_4p5	56,663,874	0.05	0.03	0.00	0.00	-0.01	-0.02	-0.02	-0.03	-0.04
	FNMA30_5p5	249,708,756	0.08	0.07	0.05	0.04	0.04	0.02	0.01	0.00	-0.01
Agency MBS 30Y FHLMC	FHLMC30_CC	110,600,739	-0.03	-0.04	-0.06	-0.07	-0.08	-0.09	-0.10	-0.11	-0.11
Agency MBS 30Y GNMA	GNMA30_CC	254,272,445	0.05	0.04	0.01	0.01	0.01	0.00	-0.01	-0.01	-0.02
Agency Hybrid	FNMA5_1_3	1,504,447,899	0.15	0.11	0.06	0.05	0.03	0.02	0.00	0.00	-0.01
	FHLM5_1_3	777,392,592	0.01	-0.02	-0.07	-0.08	-0.10	-0.11	-0.12	-0.13	-0.13
Agency CMO	CMO_PAC_2WAL	396,701,003	0.04	0.15	0.01	0.03	0.10	0.12	0.16	0.25	0.30
	CMO_PAC_10WAL		0.06	0.16	0.04	0.07	0.14	0.16	0.21	0.30	0.36
	CMO_SEQ_2WAL		-0.10	-0.04	-0.14	-0.17	-0.14	-0.14	-0.14	-0.10	-0.08
	CMO_SEQ_30WAL	449,757,792	0.08	0.20	0.08	0.13	0.22	0.24	0.32	0.43	0.51
	CMO_FLTSTR_6p5	5,129,103,946	-0.01	0.06	0.08	0.12	0.16	0.20	0.27	0.33	0.40
	CMO_FLTSTR_7	3,083,655,324	0.01	0.04	0.06	0.09	0.11	0.15	0.20	0.24	0.29
	CMO_FLTFLT_6p5	1,295,453,859	0.01	0.04	0.06	0.09	0.12	0.13	0.19	0.22	0.28
	CMO_FLTFLT_7	1,113,080,247	0.00	0.03	0.04	0.06	0.07	0.10	0.14	0.17	0.22
Agency CMBS	GNMA_CMBS_3p5Y		0.05	0.02	-0.04	-0.04	-0.07	-0.08	-0.10	-0.12	-0.14
	GNMA_CMBS_12Y		0.04	0.02	-0.03	-0.03	-0.05	-0.06	-0.07	-0.08	-0.09
	FNMA_DUS_5to10Y	2,195,272,360	0.07	0.03	-0.04	-0.04	-0.06	-0.08	-0.11	-0.14	-0.16
Non Agency CMBS	FHLMC_CMBS_A2_10Y	1,683,635,964	0.04	0.02	-0.03	-0.03	-0.05	-0.07	-0.08	-0.09	-0.11
	CMBS_2005_A	1,295,421,981	0.04	0.15	0.05	0.00	-0.14	-0.11	-0.18	-0.22	-0.24
Agency Bonds	CMBS_2005_AJ	96,578,019	0.64	1.36	1.29	1.01	0.40	0.63	0.33	0.09	0.05
	AgencyDeb_Srt		0.07	0.05	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.01
	AgencyDeb_Int		371,000,000	0.03	0.00	-0.03	-0.03	-0.03	-0.04	-0.05	-0.05
CLO	AgencyDeb_Lng		0.02	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.04	-0.04
	CLO AAA_3M	2,351,000,000	0.14	0.24	0.26	0.30	0.27	0.31	0.32	0.33	0.33
ABS	ABS_AT_AAA_1	1,097,056,098	0.11	0.03	-0.03	-0.06	-0.04	-0.09	-0.16	-0.15	-0.15
	ABS_AT_AAA_3		0.48	0.37	0.33	0.33	0.27	0.27	0.20	0.08	0.11
	ABS_CC_AAA_3	1,185,171,903	0.07	0.03	-0.03	-0.04	-0.04	-0.06	-0.06	-0.05	-0.06
	ABS_CC_AAA_7		0.04	0.03	-0.05	-0.06	-0.05	-0.08	-0.08	-0.08	-0.09
	ABS_SL_AAA_1	610,771,999	0.05	0.01	-0.04	-0.07	-0.07	-0.10	-0.16	-0.16	-0.16
	ABS_SL_AAA_7		0.05	-0.02	-0.07	-0.11	-0.14	-0.17	-0.21	-0.21	-0.23
Covered Bonds	iBoxx_Canada_Cov	897,392,867	-0.21	-0.20	-0.25	-0.32	-0.31	-0.31	-0.32	-0.32	-0.31
	iBoxx_EUR_Canada	117,512,503	-0.13	-0.11	-0.14	-0.18	-0.17	-0.17	-0.18	-0.18	-0.18
	iBoxx_EUR_GB	362,873,078	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
	iBoxx_EUR_Ntnds	239,608,102	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
	iBoxx_EUR_Scandi	554,326,635	-0.11	-0.10	-0.14	-0.17	-0.22	-0.22	-0.22	-0.22	-0.22
Non Agency RMBS	RMBS_Prime_AAA	820,556,218	-0.24	-0.26	0.06	-0.20	-0.27	-0.20	-0.55	-0.60	-0.72
	RMBS_AltA_AAA	1,332,122,987	1.01	1.41	1.38	0.74	1.07	0.78	0.28	0.21	-0.08
	RMBS_AltA_AA	284,290,870	1.34	1.88	2.16	1.26	1.67	1.65	1.17	1.11	0.78
	RMBS_SubPrime_AAA	100,548,288	-0.15	0.10	0.77	0.60	0.42	0.61	0.29	0.23	0.12
EUR MBS	EUR_DCH_AA		147,278,146	1.75	1.78	1.50	1.58	1.47	1.51	1.49	1.51
	EUR_DCH_5to10_AA	214,533,408	0.74	0.78	0.70	0.73	0.72	0.73	0.74	0.74	0.74
	EUR_IR BBB	119,329,995	-0.58	3.77	4.87	6.26	6.95	6.75	7.30	7.85	7.83
GBP MBS	GBP_UK_0t3_AAA			0.55	0.69	0.56	0.63	0.52	0.56	0.52	0.50
	GBP_UK_3t5_AAA	623,340,088		0.28	0.35	0.37	0.40	0.36	0.37	0.35	0.32
	GBP_UK_5t10_AAA			0.45	0.71	0.83	0.90	0.83	0.86	0.82	0.74
EUR Sovereigns	SOV_EUR_FRA_1Y			0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
	SOV_EUR_FRA_5Y	1,978,377,538		-0.09	-0.15	-0.20	-0.27	-0.29	-0.33	-0.40	-0.43
	SOV_EUR_FRA_10Y			-0.09	-0.15	-0.20	-0.27	-0.29	-0.33	-0.40	-0.47
	SOV_EUR_NLD_1Y			0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
	SOV_EUR_NLD_5Y	1,039,888,729		0.30	0.19	0.18	0.07	0.06	0.00	-0.05	0.01
	SOV_EUR_NLD_10Y			0.30	0.19	0.18	0.07	0.06	0.00	-0.05	0.01

Credit Spread shock forecasts for the Baseline Scenario											
Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
EUR Sovereigns	SOV_EUR_BEL_1Y	1,004,810,141	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09
	SOV_EUR_BEL_5Y		0.30	0.21	0.21	0.18	0.17	0.16	0.15	0.15	0.14
	SOV_EUR_BEL_10Y		0.30	0.21	0.21	0.18	0.17	0.16	0.15	0.15	0.14
	SOV_EUR_ITA_1Y	1,377,253,640	0.18	0.18	0.18	0.20	0.18	0.22	0.24	0.24	0.27
	SOV_EUR_ITA_5Y		0.01	-0.06	-0.13	-0.20	-0.24	-0.25	-0.26	-0.27	-0.26
	SOV_EUR_ITA_10Y		0.01	-0.06	-0.13	-0.20	-0.24	-0.25	-0.26	-0.27	-0.26
	SOV_EUR_SPA_1Y	1,926,954,727	0.26	0.23	0.25	0.27	0.26	0.29	0.32	0.33	0.36
	SOV_EUR_SPA_5Y		0.38	0.18	0.17	0.09	0.09	0.06	0.05	0.09	0.10
	SOV_EUR_SPA_10Y		0.38	0.18	0.17	0.09	0.09	0.06	0.05	0.09	0.10
	SOV_EUR_IRL_1Y	760,978,042	0.01	-0.01	0.00	0.05	0.05	0.10	0.12	0.12	0.16
	SOV_EUR_IRL_5Y		0.02	-0.02	-0.04	-0.05	-0.06	-0.07	-0.08	-0.08	-0.08
	SOV_EUR_IRL_10Y		0.02	-0.02	-0.04	-0.05	-0.06	-0.07	-0.08	-0.08	-0.08
	SOV_EUR_SWE_1Y	137,820,783	0.20	0.18	0.17	0.19	0.20	0.25	0.27	0.26	0.34
	SOV_EUR_SWE_5Y		-0.13	-0.22	-0.31	-0.38	-0.34	-0.29	-0.34	-0.31	-0.30
	SOV_EUR_SWE_10Y		-0.13	-0.22	-0.31	-0.38	-0.34	-0.29	-0.34	-0.31	-0.30
EUR Corporates	EUR_CORP_A_1Y	179,100,994	0.13	0.09	-0.07	-0.08	-0.07	-0.08	-0.07	-0.06	-0.05
	EUR_CORP_A_5Y		0.11	0.08	-0.06	-0.08	-0.07	-0.07	-0.07	-0.05	-0.05
	EUR_CORP_A_10Y		0.09	0.08	-0.06	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04
	EUR_CORP_AA_1Y	88,778,804	0.10	0.07	-0.05	-0.06	-0.06	-0.06	-0.06	-0.04	-0.04
	EUR_CORP_AA_5Y		-0.01	-0.04	-0.15	-0.17	-0.16	-0.16	-0.16	-0.14	-0.14
	EUR_CORP_AA_10Y		-0.13	-0.15	-0.25	-0.27	-0.26	-0.26	-0.25	-0.24	-0.24
	EUR_CORP BBB_1Y	154,025,687	0.15	0.10	-0.07	-0.09	-0.08	-0.08	-0.08	-0.06	-0.06
	EUR_CORP BBB_5Y		0.14	0.10	-0.08	-0.10	-0.09	-0.09	-0.08	-0.06	-0.06
	EUR_CORP BBB_10Y		0.13	0.11	-0.09	-0.11	-0.10	-0.10	-0.09	-0.07	-0.06
USD corporates	USD_CORP_A_1Y	1,039,884,594	-0.49	-0.37	-0.17	-0.32	-0.23	-0.19	-0.21	-0.16	-0.12
	USD_CORP_A_5Y		-0.40	-0.34	-0.24	-0.37	-0.32	-0.30	-0.36	-0.34	-0.32
	USD_CORP_A_10Y		-0.32	-0.31	-0.29	-0.39	-0.38	-0.38	-0.47	-0.47	-0.46
	USD_CORP_AA_1Y	213,487,413	-0.52	-0.38	-0.14	-0.31	-0.20	-0.16	-0.17	-0.11	-0.07
	USD_CORP_AA_5Y		-0.44	-0.35	-0.20	-0.34	-0.27	-0.25	-0.28	-0.25	-0.22
	USD_CORP_AA_10Y		-0.43	-0.34	-0.21	-0.35	-0.28	-0.26	-0.30	-0.27	-0.25
	USD_CORP AAA_1Y	37,678,400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	USD_CORP AAA_5Y		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	USD_CORP AAA_10Y		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	USD_CORP BBB_1Y	83,949,592	-0.45	-0.35	-0.20	-0.34	-0.27	-0.24	-0.28	-0.24	-0.21
	USD_CORP BBB_5Y		-0.39	-0.33	-0.24	-0.36	-0.32	-0.30	-0.36	-0.34	-0.32
	USD_CORP BBB_10Y		-0.30	-0.30	-0.30	-0.40	-0.40	-0.40	-0.50	-0.50	-0.50
Municipal Bonds - General Obligations	BFV_GO_A_1Y	205,923,179	-0.06	-0.08	-0.15	-0.17	-0.25	-0.30	-0.44	-0.51	-0.53
	BFV_GO_A_5Y		-0.06	-0.15	-0.14	-0.19	-0.21	-0.20	-0.27	-0.31	-0.33
	BFV_GO_A_10Y		0.04	-0.17	-0.18	-0.20	-0.30	-0.27	-0.34	-0.45	-0.46
	BFV_GO_AA_1Y	989,356,949	-0.06	-0.09	-0.15	-0.18	-0.24	-0.32	-0.45	-0.48	-0.51
	BFV_GO_AA_5Y		-0.05	-0.13	-0.12	-0.16	-0.18	-0.17	-0.23	-0.27	-0.28
	BFV_GO_AA_10Y		-0.05	-0.13	-0.12	-0.16	-0.18	-0.17	-0.23	-0.27	-0.28
	BFV_TR_AA_1Y	448,531,337	-0.05	-0.08	-0.13	-0.17	-0.23	-0.30	-0.42	-0.46	-0.48
	BFV_TR_AA_5Y		-0.05	-0.12	-0.11	-0.15	-0.17	-0.16	-0.22	-0.25	-0.27
	BFV_TR_AA_10Y		-0.05	-0.13	-0.11	-0.16	-0.18	-0.17	-0.23	-0.26	-0.28
Municipal Bonds - Revenue	BFV_UT_AA_1Y	105,869,857	-0.07	-0.10	-0.16	-0.20	-0.26	-0.34	-0.47	-0.51	-0.53
	BFV_UT_AA_5Y		-0.10	-0.20	-0.20	-0.26	-0.29	-0.28	-0.35	-0.40	-0.42
	BFV_UT_AA_10Y		-0.06	-0.16	-0.15	-0.20	-0.23	-0.21	-0.29	-0.33	-0.35
	BFV_UT_AA_1Y	686,570,476	-0.06	-0.09	-0.15	-0.18	-0.24	-0.31	-0.43	-0.47	-0.49
	BFV_UT_AA_5Y		-0.04	-0.13	-0.11	-0.15	-0.17	-0.16	-0.22	-0.25	-0.27
	BFV_UT_AA_10Y		-0.05	-0.13	-0.12	-0.16	-0.18	-0.17	-0.23	-0.26	-0.28
	BFV_ED_AA_1Y	375,426,826	-0.06	-0.08	-0.14	-0.17	-0.23	-0.30	-0.42	-0.46	-0.48
	BFV_ED_AA_5Y		-0.04	-0.11	-0.10	-0.13	-0.15	-0.14	-0.20	-0.23	-0.25
	BFV_ED_AA_10Y		-0.05	-0.13	-0.11	-0.16	-0.18	-0.17	-0.23	-0.26	-0.28
	BFV_REV_A_1Y	1,233,321,375	-0.12	-0.15	-0.20	-0.24	-0.29	-0.36	-0.47	-0.50	-0.52
	BFV_REV_A_5Y		-0.11	-0.21	-0.20	-0.27	-0.30	-0.30	-0.37	-0.42	-0.43
	BFV_REV_A_10Y		0.03	-0.14	-0.15	-0.16	-0.24	-0.22	-0.27	-0.36	-0.38
ABCP	ABCP	1,903,605,887	-0.02	-0.03	-0.06	-0.08	-0.04	-0.06	-0.06	-0.06	-0.04
International Bonds	USD INTERNATIONAL FINLAND 1Y	14,083,738	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL FINLAND 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL FINLAND 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	GBP INTERNATIONAL BELGIUM 1Y	88,399,041	2.07	2.26	1.91	1.71	1.36	1.06	0.76	0.48	0.19
	GBP INTERNATIONAL BELGIUM 5Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	GBP INTERNATIONAL BELGIUM 10Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	EUR INTERNATIONAL SWEDEN 1Y	140,187,876	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	EUR INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	EUR INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL SWEDEN 1Y		0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85

Credit Spread shock forecasts for the Adverse Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
Agency MBS 15Y FNMA	FNMA15_CC	3,145,288,581	0.13	0.14	0.20	0.21	0.19	0.16	0.14	0.11	0.08
	FNMA15_4	602,376,199	0.16	0.11	0.12	0.10	0.07	0.03	0.00	-0.02	-0.03
	FNMA15_4p5	585,028,346	0.18	0.13	0.14	0.12	0.08	0.03	0.00	-0.02	-0.04
Agency MBS 15Y FHLMC	FHLMC15_CC	3,400,054,997	0.13	0.13	0.16	0.17	0.15	0.12	0.09	0.06	0.04
	FHLMC15_4	512,209,539	0.24	0.21	0.23	0.21	0.15	0.07	0.01	-0.04	-0.06
	FHLMC15_4p5_2005	86,166,708	0.21	0.18	0.20	0.19	0.14	0.07	0.03	-0.02	-0.04
	FHLMC15_4p5_2009	257,257,166	0.18	0.13	0.14	0.11	0.08	0.03	0.00	-0.02	-0.04
	FHLMC15_5_2005	53,480,053	0.21	0.21	0.20	0.18	0.14	0.08	0.03	0.00	-0.02
	FHLMC15_5_2008	142,595,171	0.12	0.13	0.12	0.10	0.06	-0.01	-0.05	-0.09	-0.11
Agency MBS 15Y GNMA	GNMA15_CC	926,671	0.10	0.33	0.30	0.32	0.28	0.23	0.16	0.11	0.07
Agency MBS 30Y FNMA	FNMA30_CC	307,778,093	0.14	0.14	0.17	0.18	0.17	0.15	0.14	0.12	0.11
	FNMA30_4p5	56,663,874	0.14	0.14	0.16	0.16	0.15	0.12	0.11	0.09	0.07
	FNMA30_5p5	249,708,756	0.20	0.22	0.28	0.30	0.30	0.27	0.25	0.23	0.21
Agency MBS 30Y FHLMC	FHLMC30_CC	110,600,739	0.06	0.06	0.07	0.07	0.05	0.03	0.00	-0.02	-0.03
Agency MBS 30Y GNMA	GNMA30_CC	254,272,445	0.19	0.20	0.25	0.26	0.24	0.21	0.19	0.16	0.14
Agency Hybrid	FNMAS_1_3	1,504,447,899	0.37	0.34	0.35	0.32	0.26	0.18	0.12	0.08	0.05
	FHLMS_1_3	777,392,592	0.23	0.18	0.20	0.18	0.11	0.04	-0.02	-0.06	-0.09
Agency CMO	CMO_PAC_2WAL	396,701,003	0.39	0.39	0.58	0.64	0.58	0.39	0.23	0.18	0.16
	CMO_PAC_10WAL		0.31	0.29	0.45	0.51	0.48	0.32	0.20	0.17	0.17
	CMO_SEQ_2WAL		0.24	0.31	0.39	0.41	0.35	0.21	0.06	0.00	-0.03
	CMO_SEQ_10WAL	449,757,792	0.30	0.29	0.49	0.56	0.55	0.38	0.27	0.25	0.28
	CMO_FLTSTR_6p5	5,129,103,946	-0.06	0.16	0.29	0.41	0.38	0.31	0.29	0.28	0.27
	CMO_FLTSTR_7	3,083,655,324	-0.06	0.19	0.28	0.38	0.34	0.27	0.25	0.22	0.20
	CMO_FLTFLT_6p5	1,295,453,859	-0.09	0.16	0.28	0.39	0.41	0.31	0.28	0.24	0.21
	CMO_FLTFLT_7	1,113,080,247	-0.04	0.21	0.29	0.38	0.33	0.26	0.23	0.18	0.16
Agency CMBS	GNMA_CMBS_3p5Y	141,091,676	0.36	0.30	0.34	0.32	0.27	0.18	0.12	0.07	0.03
	GNMA_CMBS_12Y		0.25	0.21	0.23	0.22	0.19	0.12	0.08	0.05	0.02
	FNMA_DUS_5to10Y	2,195,272,360	0.31	0.26	0.28	0.28	0.24	0.15	0.10	0.05	0.03
	FHLMC_CMBS_A2_10Y	1,683,635,964	0.29	0.24	0.27	0.25	0.22	0.14	0.09	0.05	0.03
Non Agency CMBS	CMBS_2005_A	1,295,421,981	0.84	1.65	2.00	2.16	2.23	1.84	1.42	1.04	0.79
	CMBS_2005_AJ	96,578,019	2.58	6.59	7.97	8.88	9.50	8.35	6.83	5.46	4.50
Agency Bonds	AgencyDeb_Srt		0.24	0.25	0.26	0.24	0.20	0.14	0.08	0.04	0.02
	AgencyDeb_Int	371,000,000	0.19	0.15	0.16	0.15	0.12	0.07	0.03	0.01	-0.01
	AgencyDeb_Lng		0.06	0.08	0.08	0.07	0.08	0.05	0.04	0.02	0.01
CLO	CLO_AAA_3M	2,351,000,000	1.01	1.84	2.52	3.07	2.78	2.35	2.01	1.67	1.34
ABS	ABS_AT_AAA_1	1,097,056,098	0.54	0.33	0.42	0.35	0.29	0.20	0.15	0.10	0.08
	ABS_AT_AAA_3		1.12	1.20	1.48	1.45	1.04	0.77	0.51	0.30	0.16
	ABS_CC_AAA_3	1,185,171,903	0.91	0.93	1.17	1.16	0.86	0.60	0.38	0.18	0.04
	ABS_CC_AAA_7		0.95	1.01	1.27	1.27	0.92	0.62	0.37	0.15	-0.01
	ABS_SL_AAA_1	610,771,999	0.39	0.25	0.31	0.29	0.22	0.16	0.12	0.08	0.06
	ABS_SL_AAA_7		0.82	0.52	0.64	0.51	0.35	0.24	0.15	0.08	0.02
Non Agency RMBS	iBoxx_Canada_Cov	897,392,867	-0.05	0.32	0.43	0.52	0.53	0.29	0.08	-0.09	-0.23
	iBoxx_EUR_Canada	117,512,503	-0.06	0.14	0.17	0.20	0.20	0.09	-0.01	-0.08	-0.14
	iBoxx_EUR_GB	362,873,078	-0.03	0.49	0.48	0.49	0.38	0.18	-0.02	-0.15	-0.15
	iBoxx_EUR_Ntnds	239,608,102	-0.04	0.30	0.30	0.34	0.28	0.21	0.12	0.05	-0.01
	iBoxx_EUR_Scandi	554,326,635	-0.03	0.17	0.16	0.18	0.14	0.08	0.02	-0.03	-0.07
EUR MBS	RMBS_Prime AAA	820,556,218	1.20	2.86	3.66	5.19	5.68	5.06	4.31	3.89	3.32
	RMBS_AltA AAA	1,332,122,987	6.05	8.11	9.85	12.03	11.19	9.97	8.47	7.50	6.42
	RMBS_AltA AA	284,290,870	6.28	11.28	14.55	18.22	18.25	16.54	14.06	11.96	9.95
	RMBS_SubPrime AAA	100,548,288	1.28	4.25	6.16	8.63	9.86	9.14	8.42	7.82	6.87
GBP MBS	EUR_DCH_AA	147,278,146	3.63	4.12	4.72	5.06	4.12	3.29	2.55	1.92	1.51
	EUR_DCH_5t10 AAA	214,533,408	1.34	1.65	1.90	2.08	1.73	1.42	1.15	0.90	0.74
	EUR_IR BBB	119,329,995	4.11	10.83	15.75	18.11	18.84	14.54	12.15	9.96	8.36
EUR Sovereigns	GBP_UK_0t3 AAA		1.51	1.47	2.03	2.30	2.06	1.66	1.27	0.90	0.65
	GBP_UK_3t5 AAA	623,340,088	1.00	0.86	1.25	1.31	1.20	1.01	0.82	0.59	0.42
	GBP_UK_5t10 AAA		0.99	1.21	1.92	2.41	2.41	2.09	1.75	1.31	1.00
	SOV_EUR_FRA_1Y		0.57	0.47	0.46	0.37	0.27	0.18	0.08	0.03	-0.02
	SOV_EUR_FRA_5Y	1,978,377,538	-0.51	-0.57	-0.59	-0.62	-0.63	-0.61	-0.61	-0.65	-0.69
	SOV_EUR_FRA_10Y		-0.62	-0.67	-0.69	-0.73	-0.73	-0.71	-0.71	-0.75	-0.80
	SOV_EUR_NLD_1Y		0.58	0.47	0.46	0.38	0.28	0.19	0.08	0.04	-0.02
	SOV_EUR_NLD_5Y	1,039,888,729	0.57	0.35	0.36	0.17	0.10	-0.04	-0.19	-0.21	-0.31
	SOV_EUR_NLD_10Y		0.66	0.44	0.46	0.26	0.19	0.05	-0.09	-0.12	-0.22

Credit Spread shock forecasts for the Adverse Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
EUR Sovereigns	SOV_EUR_BEL_1Y	1,004,810,141	0.56	0.46	0.45	0.38	0.27	0.18	0.08	0.03	-0.02
	SOV_EUR_BEL_5Y		0.61	0.39	0.43	0.31	0.22	0.12	-0.01	-0.12	-0.20
	SOV_EUR_BEL_10Y		0.71	0.49	0.53	0.43	0.32	0.23	0.09	-0.01	-0.10
	SOV_EUR_ITA_1Y	1,377,253,640	0.73	0.71	0.76	0.68	0.52	0.35	0.18	0.11	0.05
	SOV_EUR_ITA_5Y		0.41	0.40	0.42	0.29	0.10	-0.20	-0.45	-0.52	-0.62
	SOV_EUR_ITA_10Y		0.50	0.49	0.51	0.38	0.19	-0.10	-0.35	-0.42	-0.52
	SOV_EUR_SPA_1Y	1,926,954,727	0.86	0.93	0.93	0.83	0.65	0.46	0.28	0.21	0.14
	SOV_EUR_SPA_5Y		1.01	1.52	1.27	0.88	0.64	0.37	0.16	0.07	-0.06
	SOV_EUR_SPA_10Y		1.01	1.53	1.18	0.89	0.64	0.38	0.17	0.08	-0.05
	SOV_EUR_IRL_1Y	760,978,042	1.02	0.84	0.82	0.73	0.74	0.73	0.54	0.36	0.24
	SOV_EUR_IRL_5Y		0.91	0.85	0.88	0.78	0.67	0.53	0.24	0.01	-0.19
	SOV_EUR_IRL_10Y		1.14	1.08	1.11	1.00	0.89	0.75	0.45	0.23	0.03
	SOV_EUR_SWE_1Y	137,820,783	0.27	0.32	0.37	0.32	0.26	0.24	0.16	0.07	0.00
	SOV_EUR_SWE_5Y		-0.32	-0.40	-0.49	-0.56	-0.55	-0.52	-0.58	-0.56	-0.56
	SOV_EUR_SWE_10Y		-0.37	-0.45	-0.54	-0.61	-0.60	-0.57	-0.63	-0.61	-0.61
EUR Corporates	EUR_CORP_A_1Y	179,100,994	0.63	0.67	0.75	0.75	0.56	0.31	0.12	-0.04	-0.10
	EUR_CORP_A_5Y		0.53	0.60	0.68	0.69	0.51	0.29	0.11	-0.04	-0.09
	EUR_CORP_A_10Y		0.46	0.56	0.63	0.65	0.49	0.28	0.10	-0.04	-0.09
	EUR_CORP_AA_1Y	88,778,804	0.49	0.52	0.58	0.58	0.43	0.24	0.09	-0.03	-0.08
	EUR_CORP_AA_5Y		0.32	0.38	0.44	0.45	0.31	0.13	-0.01	-0.13	-0.18
	EUR_CORP_AA_10Y		0.16	0.24	0.30	0.33	0.18	0.02	-0.12	-0.24	-0.28
	EUR_CORP BBB_1Y	154,025,687	0.68	0.72	0.81	0.80	0.60	0.34	0.13	-0.04	-0.11
	EUR_CORP BBB_5Y		0.66	0.75	0.85	0.87	0.65	0.37	0.14	-0.05	-0.12
	EUR_CORP BBB_10Y		0.64	0.78	0.88	0.93	0.68	0.39	0.15	-0.05	-0.13
USD corporates	USD_CORP_A_1Y	1,039,884,594	0.15	0.35	0.26	0.24	0.38	0.48	0.48	0.64	0.61
	USD_CORP_A_5Y		0.44	0.73	0.74	0.78	0.80	0.75	0.64	0.67	0.60
	USD_CORP_A_10Y		0.65	1.03	1.11	1.19	1.12	0.95	0.77	0.70	0.61
	USD_CORP_AA_1Y	213,487,413	0.14	0.27	0.15	0.09	0.27	0.44	0.48	0.68	0.64
	USD_CORP_AA_5Y		0.34	0.57	0.53	0.52	0.60	0.64	0.59	0.69	0.63
	USD_CORP_AA_10Y		0.40	0.62	0.60	0.59	0.65	0.68	0.63	0.71	0.64
	USD_CORP BBB_1Y	83,949,592	0.33	0.54	0.50	0.49	0.58	0.62	0.59	0.69	0.63
	USD_CORP BBB_5Y		0.44	0.74	0.75	0.80	0.81	0.75	0.65	0.67	0.61
	USD_CORP BBB_10Y		0.70	1.10	1.20	1.30	1.20	1.00	0.80	0.70	0.60
Municipal Bonds - General Obligations	BVF_GO_A_1Y	205,923,179	-0.09	0.04	0.00	0.20	0.20	0.17	0.17	0.19	0.20
	BVF_GO_A_5Y		0.15	0.31	0.23	0.33	0.36	0.29	0.17	0.12	0.10
	BVF_GO_A_10Y		0.04	0.52	0.49	0.49	0.68	0.55	0.41	0.25	0.23
	BVF_GO_AA_1Y	989,356,949	-0.05	0.03	0.06	0.22	0.17	0.16	0.17	0.18	0.20
	BVF_GO_AA_5Y		0.13	0.26	0.20	0.28	0.31	0.25	0.15	0.10	0.08
	BVF_GO_AA_10Y		0.13	0.27	0.20	0.29	0.31	0.25	0.15	0.10	0.08
Municipal Bonds - Revenue	BVF_TR_AA_1Y	448,531,337	-0.03	0.04	0.06	0.22	0.17	0.16	0.17	0.18	0.20
	BVF_TR_AA_5Y		0.12	0.25	0.19	0.27	0.29	0.23	0.14	0.09	0.08
	BVF_TR_AA_10Y		0.12	0.26	0.20	0.28	0.30	0.24	0.14	0.10	0.08
	BVF_UT_AA_1Y	105,869,857	0.02	0.19	0.28	0.50	0.42	0.34	0.30	0.26	0.24
	BVF_UT_AA_5Y		0.08	0.37	0.29	0.39	0.43	0.32	0.18	0.11	0.07
	BVF_UT_AA_10Y		0.16	0.33	0.25	0.35	0.38	0.31	0.18	0.12	0.10
	BVF_UT_AA_1Y	686,570,476	0.01	0.12	0.17	0.35	0.27	0.23	0.22	0.20	0.20
	BVF_UT_AA_5Y		0.14	0.29	0.24	0.33	0.36	0.28	0.17	0.12	0.10
	BVF_UT_AA_10Y		0.12	0.26	0.20	0.28	0.30	0.24	0.14	0.10	0.08
	BVF_ED_AA_1Y	375,426,826	-0.04	0.05	0.07	0.23	0.19	0.17	0.17	0.17	0.18
	BVF_ED_AA_5Y		0.14	0.27	0.21	0.29	0.31	0.26	0.16	0.11	0.10
	BVF_ED_AA_10Y		0.12	0.26	0.20	0.28	0.30	0.24	0.14	0.10	0.08
	BVF_REV_AA_1Y	1,233,321,375	0.02	0.17	0.24	0.43	0.36	0.30	0.26	0.22	0.21
	BVF_REV_AA_5Y		0.09	0.39	0.30	0.41	0.45	0.34	0.19	0.11	0.07
	BVF_REV_AA_10Y		0.03	0.42	0.40	0.40	0.55	0.45	0.33	0.20	0.19
ABCP	ABCP	1,903,605,887	0.08	0.23	0.19	0.19	0.17	0.10	0.06	0.03	0.01
International Bonds	USD INTERNATIONAL FINLAND 1Y	14,083,738	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL FINLAND 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL FINLAND 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	GBP INTERNATIONAL BELGIUM 1Y	88,399,041	2.07	2.26	1.91	1.71	1.36	1.06	0.76	0.48	0.19
	GBP INTERNATIONAL BELGIUM 5Y		2.13	2.38	2.64	2.31	2.10	1.78	1.45	1.27	1.10
	GBP INTERNATIONAL BELGIUM 10Y		2.13	2.38	2.64	2.31	2.10	1.78	1.45	1.27	1.10
	EUR INTERNATIONAL SWEDEN 1Y	140,187,876	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	EUR INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	EUR INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL SWEDEN 1Y		0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85

Credit Spread shock forecasts for the Severely Adverse Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
Agency MBS 15Y FNMA	FNMA15_CC	3,145,288,581	0.39	0.37	0.51	0.48	0.41	0.32	0.26	0.19	0.14
	FNMA15_4	602,376,199	0.41	0.29	0.37	0.28	0.18	0.08	0.03	-0.02	-0.05
	FNMA15_4p5	585,028,346	0.48	0.34	0.43	0.32	0.21	0.10	0.03	-0.03	-0.06
Agency MBS 15Y FHLMC	FHLMC15_CC	3,400,054,997	0.38	0.33	0.45	0.40	0.33	0.24	0.18	0.12	0.07
	FHLMC15_4	512,209,539	0.62	0.50	0.62	0.51	0.35	0.16	0.03	-0.09	-0.13
	FHLMC15_4p5_2005	86,166,708	0.52	0.43	0.54	0.46	0.32	0.17	0.08	-0.01	-0.06
	FHLMC15_4p5_2009	257,257,166	0.47	0.34	0.42	0.32	0.21	0.09	0.03	-0.03	-0.06
	FHLMC15_5_2005	53,480,053	0.50	0.50	0.55	0.47	0.33	0.18	0.08	0.00	-0.04
	FHLMC15_5_2008	142,595,171	0.42	0.44	0.48	0.41	0.26	0.11	0.00	-0.08	-0.13
Agency MBS 15Y GNMA	GNMA15_CC	926,671	0.24	0.79	0.70	0.78	0.61	0.43	0.26	0.15	0.06
Agency MBS 30Y FNMA	FNMA30_CC	307,778,093	0.29	0.28	0.36	0.35	0.30	0.25	0.22	0.18	0.14
	FNMA30_4p5	56,663,874	0.32	0.28	0.36	0.33	0.28	0.21	0.17	0.13	0.10
	FNMA30_5p5	249,708,756	0.43	0.41	0.56	0.56	0.52	0.44	0.39	0.33	0.29
Agency MBS 30Y FHLMC	FHLMC30_CC	110,600,739	0.23	0.21	0.27	0.25	0.18	0.11	0.05	0.01	-0.02
Agency MBS 30Y GNMA	GNMA30_CC	254,272,445	0.43	0.41	0.54	0.51	0.44	0.36	0.30	0.24	0.19
Agency Hybrid	FNMA5_1_3	1,504,447,899	0.83	0.72	0.81	0.70	0.49	0.30	0.15	0.05	-0.01
	FHLMS5_1_3	777,392,592	0.68	0.53	0.63	0.53	0.33	0.15	0.01	-0.08	-0.14
Agency CMO	CMO_PAC_2WAL	396,701,003	0.92	0.79	1.21	1.18	0.95	0.53	0.19	-0.13	-0.21
	CMO_PAC_10WAL		0.78	0.62	0.99	0.93	0.74	0.36	0.06	-0.22	-0.26
	CMO_SEQ_2WAL		0.69	0.81	0.89	0.98	0.78	0.47	0.19	-0.04	-0.12
	CMO_SEQ_10WAL	449,757,792	0.77	0.62	1.05	1.00	0.80	0.41	0.09	-0.19	-0.23
	CMO_FLTSTR_6p5	5,129,103,946	-0.09	0.30	0.47	0.65	0.59	0.44	0.31	0.20	0.10
	CMO_FLTSTR_7	3,083,655,324	-0.10	0.34	0.44	0.61	0.53	0.40	0.28	0.17	0.08
Agency CMBS	CMO_FLTFLT_6p5	1,295,453,859	-0.15	0.30	0.45	0.63	0.64	0.49	0.36	0.23	0.13
	CMO_FLTFLT_7	1,113,080,247	-0.06	0.39	0.48	0.63	0.55	0.41	0.28	0.16	0.06
	GNMA_CMBS_3p5Y	141,091,676	0.89	0.70	0.91	0.78	0.58	0.34	0.19	0.07	0.00
	GNMA_CMBS_12Y		0.62	0.49	0.64	0.54	0.40	0.24	0.13	0.05	0.00
	FNMA_DUS_5to10Y	2,195,272,360	0.81	0.70	0.88	0.75	0.56	0.32	0.19	0.08	0.02
	FHLMC_CMBS_A2_10Y	1,683,635,964	0.71	0.57	0.74	0.63	0.47	0.27	0.15	0.06	0.00
Non Agency CMBS	CMBS_2005_A	1,295,421,981	2.47	3.85	4.73	4.99	4.58	3.66	2.81	2.09	1.49
	CMBS_2005_AI	96,578,019	6.58	13.97	16.96	19.22	18.58	15.81	12.81	10.31	8.01
Agency Bonds	AgencyDeb_Srt		0.58	0.58	0.65	0.58	0.42	0.26	0.14	0.05	-0.01
	AgencyDeb_Int	371,000,000	0.49	0.40	0.48	0.40	0.29	0.17	0.10	0.04	0.01
	AgencyDeb_Lng		0.14	0.20	0.24	0.23	0.20	0.14	0.11	0.07	0.05
CLO	CLO_AAA_3M	2,351,000,000	1.62	2.79	4.12	5.09	4.85	4.23	3.53	2.79	2.16
ABS	ABS_AT_AAA_1	1,097,056,098	1.69	1.30	1.73	1.28	0.93	0.65	0.47	0.36	0.27
	ABS_AT_AAA_3		3.04	2.51	3.21	2.83	2.02	1.43	0.90	0.47	0.17
	ABS_CC_AAA_3	1,185,171,903	2.13	1.84	2.50	2.27	1.74	1.27	0.82	0.43	0.13
	ABS_CC_AAA_7		2.24	2.02	2.71	2.49	1.84	1.29	0.78	0.34	0.03
	ABS_SL_AAA_1		1.27	0.98	1.29	1.05	0.73	0.51	0.37	0.27	0.20
	ABS_SL_AAA_7	610,771,999	2.17	1.49	1.94	1.44	0.98	0.73	0.49	0.31	0.16
Covered Bonds	iBoxx_Canada_Cov	897,392,867	0.28	1.03	1.18	1.34	1.22	0.79	0.38	0.05	-0.23
	iBoxx_EUR_Canada	117,512,503	0.09	0.50	0.53	0.60	0.52	0.31	0.12	-0.03	-0.15
	iBoxx_EUR_G8	362,873,078	0.54	1.76	1.64	1.66	1.20	0.66	0.19	-0.15	-0.15
	iBoxx_EUR_NtInds	239,608,102	0.16	0.84	0.76	0.84	0.67	0.47	0.26	0.09	-0.05
	iBoxx_EUR_Scandi	554,326,635	0.15	0.56	0.52	0.55	0.41	0.25	0.10	-0.02	-0.11
Non Agency RMBS	RMBS_Prime_AAA	820,556,218	3.43	6.24	8.77	10.86	11.32	10.42	9.37	8.12	6.92
	RMBS_AltA_AAA	1,332,122,987	11.49	15.84	20.25	22.82	21.25	19.31	16.86	14.39	11.68
	RMBS_AltA_AA	284,290,870	10.86	19.36	26.58	32.52	32.76	29.97	26.31	21.93	17.66
	RMBS_SubPrime_AAA	100,548,288	3.49	8.16	12.60	16.32	18.11	17.22	15.99	14.29	12.44
EUR MBS	EUR_DCH_AA	147,278,146	6.09	6.42	7.93	8.19	6.47	4.79	3.31	2.08	1.26
	EUR_DCH_St10_AAA	214,533,408	1.90	2.33	2.87	3.14	2.59	2.02	1.49	1.02	0.71
	EUR_IR_BBB	119,329,995	13.65	18.06	27.19	28.43	28.73	22.82	17.78	13.32	9.30
GBP MBS	GBP_UK_0T3_AAA		3.41	2.50	3.73	3.61	2.79	1.97	1.16	0.59	0.23
	GBP_UK_3T5_AAA	623,340,088	2.33	1.54	2.38	2.05	1.68	1.35	0.94	0.64	0.43
	GBP_UK_5t10_AAA		1.73	1.23	2.50	2.84	2.76	2.50	1.91	1.47	1.18
EUR Sovereigns	SOV_EUR_FRA_1Y		1.10	0.76	0.71	0.56	0.45	0.42	0.30	0.14	0.06
	SOV_EUR_FRA_5Y	1,978,377,538	-0.80	-0.72	-0.73	-0.78	-0.82	-0.85	-0.90	-0.93	-1.01
	SOV_EUR_FRA_10Y		-1.00	-0.91	-0.93	-0.97	-1.01	-1.04	-1.09	-1.12	-1.21
	SOV_EUR_NLD_1Y		1.12	0.77	0.72	0.57	0.46	0.42	0.31	0.15	0.07
	SOV_EUR_NLD_5Y	1,039,888,729	0.90	0.60	0.65	0.34	0.18	-0.06	-0.32	-0.42	-0.55
	SOV_EUR_NLD_10Y		1.09	0.79	0.83	0.53	0.37	0.13	-0.13	-0.23	-0.36

Credit Spread shock forecasts for the Severely Adverse Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
EUR Sovereigns	SOV_EUR_BEL_1Y	1,004,810,141	1.08	0.74	0.69	0.55	0.44	0.41	0.29	0.14	0.06
	SOV_EUR_BEL_5Y		0.98	0.68	0.75	0.53	0.33	0.11	-0.16	-0.36	-0.48
	SOV_EUR_BEL_10Y		1.20	0.89	0.96	0.74	0.54	0.32	0.05	-0.15	-0.27
	SOV_EUR_ITA_1Y	1,377,253,640	1.35	1.17	1.21	1.00	0.75	0.60	0.40	0.17	0.02
	SOV_EUR_ITA_5Y		0.82	0.82	0.85	0.55	0.20	-0.10	-0.39	-0.64	-0.86
	SOV_EUR_ITA_10Y		1.03	1.02	1.06	0.75	0.40	0.11	-0.19	-0.44	-0.65
	SOV_EUR_SPA_1Y	1,926,954,727	1.63	1.49	1.51	1.29	1.01	0.83	0.58	0.34	0.17
	SOV_EUR_SPA_5Y		2.01	2.03	1.88	1.58	1.28	0.88	0.49	0.16	-0.10
	SOV_EUR_SPA_10Y		2.37	2.36	2.24	1.93	1.63	1.23	0.84	0.51	0.26
	SOV_EUR_IRL_1Y	760,978,042	3.58	3.34	2.49	2.08	1.86	1.71	1.63	1.49	1.42
	SOV_EUR_IRL_5Y		3.21	3.24	2.40	2.03	1.67	1.32	1.09	0.87	0.70
	SOV_EUR_IRL_10Y		3.89	3.92	3.08	2.72	2.35	2.01	1.77	1.55	1.38
	SOV_EUR_SWE_1Y	137,820,783	0.26	0.34	0.40	0.35	0.29	0.26	0.18	0.09	0.02
	SOV_EUR_SWE_5Y		-0.60	-0.62	-0.74	-0.81	-0.81	-0.82	-0.86	-0.86	-0.86
	SOV_EUR_SWE_10Y		-0.72	-0.74	-0.87	-0.94	-0.93	-0.94	-0.99	-0.98	-0.99
EUR Corporates	EUR_CORP_A_1Y	179,100,994	1.43	1.34	1.64	1.47	1.05	0.54	0.14	-0.23	-0.36
	EUR_CORP_A_5Y		1.17	1.17	1.44	1.33	0.96	0.51	0.13	-0.22	-0.34
	EUR_CORP_A_10Y		1.00	1.06	1.30	1.24	0.90	0.48	0.12	-0.22	-0.33
	EUR_CORP_AA_1Y	88,778,804	1.11	1.04	1.28	1.14	0.81	0.42	0.11	-0.17	-0.28
	EUR_CORP_AA_5Y		0.85	0.84	1.05	0.96	0.66	0.30	0.00	-0.28	-0.37
	EUR_CORP_AA_10Y		0.59	0.64	0.83	0.78	0.51	0.18	-0.11	-0.38	-0.47
	EUR_CORP BBB_1Y	154,025,687	1.54	1.44	1.77	1.59	1.13	0.59	0.15	-0.24	-0.39
	EUR_CORP BBB_5Y		1.45	1.46	1.79	1.67	1.21	0.64	0.16	-0.28	-0.43
	EUR_CORP BBB_10Y		1.39	1.47	1.81	1.72	1.25	0.67	0.17	-0.30	-0.46
USD corporates	USD_CORP_A_1Y	1,039,884,594	0.96	2.09	3.02	2.67	1.71	1.99	2.34	2.69	2.53
	USD_CORP_A_5Y		1.60	2.29	2.79	2.89	2.39	2.31	2.33	2.34	2.10
	USD_CORP_A_10Y		2.08	2.30	2.32	2.90	2.89	2.56	2.32	2.08	1.79
	USD_CORP_AA_1Y	213,487,413	0.81	1.77	2.52	2.39	1.65	2.04	2.45	2.83	2.67
	USD_CORP_AA_5Y		1.31	1.94	2.37	2.55	2.13	2.24	2.40	2.54	2.32
	USD_CORP_AA_10Y		1.40	1.93	2.26	2.56	2.25	2.32	2.43	2.51	2.28
	USD_CORP BBB_1Y	83,949,592	1.27	2.72	3.97	3.33	2.10	2.23	2.41	2.56	2.35
	USD_CORP BBB_5Y		1.61	2.73	3.65	3.32	2.40	2.32	2.32	2.33	2.09
	USD_CORP BBB_10Y		2.20	2.80	3.20	3.40	3.00	2.60	2.30	2.00	1.70
Municipal Bonds - General Obligations	BFV_GO_A_1Y	205,923,179	0.09	0.53	0.69	0.85	0.69	0.53	0.48	0.40	0.35
	BFV_GO_A_5Y		0.48	0.94	1.05	1.22	1.11	0.92	0.79	0.64	0.56
	BFV_GO_A_10Y		0.04	1.50	1.66	1.96	1.97	1.62	1.41	1.17	1.00
	BFV_GO_AA_3Y	989,356,949	0.22	0.58	0.72	0.79	0.59	0.49	0.44	0.37	0.30
	BFV_GO_AA_5Y		0.41	0.81	0.89	1.05	0.95	0.79	0.67	0.55	0.48
	BFV_GO_AA_10Y		0.42	0.81	0.90	1.05	0.95	0.79	0.68	0.55	0.48
Municipal Bonds - Revenue	BFV_TR_AA_1Y	448,531,337	0.25	0.59	0.73	0.78	0.59	0.49	0.43	0.37	0.31
	BFV_TR_AA_5Y		0.39	0.76	0.84	0.99	0.89	0.74	0.64	0.52	0.45
	BFV_TR_AA_10Y		0.41	0.79	0.88	1.03	0.93	0.77	0.66	0.54	0.47
	BFV_UT_A_1Y	105,869,857	0.32	0.84	1.09	1.25	1.04	0.85	0.71	0.54	0.40
	BFV_UT_A_5Y		0.39	1.11	1.23	1.45	1.34	1.09	0.91	0.72	0.59
	BFV_UT_A_10Y		0.52	1.01	1.12	1.31	1.18	0.98	0.84	0.69	0.60
	BFV_UT_AA_1Y	686,570,476	0.28	0.70	0.88	0.99	0.77	0.63	0.53	0.42	0.32
	BFV_UT_AA_5Y		0.45	0.85	0.96	1.13	1.03	0.85	0.73	0.59	0.51
	BFV_UT_AA_10Y		0.41	0.80	0.89	1.04	0.94	0.78	0.67	0.54	0.48
	BFV_ED_AA_1Y	375,426,826	0.21	0.58	0.72	0.78	0.60	0.49	0.42	0.34	0.27
	BFV_ED_AA_5Y		0.44	0.80	0.90	1.05	0.94	0.78	0.67	0.55	0.49
	BFV_ED_AA_10Y		0.41	0.79	0.88	1.03	0.93	0.77	0.66	0.54	0.47
	BFV_REV_A_1Y	1,233,321,375	0.28	0.72	0.94	1.08	0.89	0.73	0.61	0.47	0.34
	BFV_REV_A_5Y		0.40	1.15	1.27	1.51	1.39	1.13	0.94	0.75	0.62
	BFV_REV_A_10Y		0.03	1.22	1.36	1.60	1.61	1.32	1.15	0.95	0.82
ABCP	ABCP	1,903,605,887	0.42	0.93	0.87	0.87	0.66	0.45	0.34	0.27	0.22
International Bonds	USD INTERNATIONAL FINLAND 1Y	14,083,738	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL FINLAND 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL FINLAND 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	GBP INTERNATIONAL BELGIUM 1Y	88,399,041	2.07	2.26	1.91	1.71	1.36	1.06	0.76	0.48	0.19
	GBP INTERNATIONAL BELGIUM 5Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	GBP INTERNATIONAL BELGIUM 10Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	EUR INTERNATIONAL SWEDEN 1Y	140,187,876	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	EUR INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	EUR INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85

Credit Spread shock forecasts for the BHC Stress Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
Agency MBS 15Y FNMA	FNMA15_CC	3,145,288,581	0.91	0.81	0.87	0.84	0.73	0.57	0.45	0.35	0.28
	FNMA15_4	602,376,199	0.91	0.70	0.68	0.56	0.42	0.25	0.16	0.09	0.07
	FNMA15_4p5	585,028,346	1.05	0.81	0.79	0.64	0.48	0.29	0.18	0.10	0.08
Agency MBS 15Y FHLMC	FHLMC15_CC	3,400,054,997	0.89	0.76	0.80	0.74	0.63	0.47	0.36	0.27	0.22
	FHLMC15_4	512,209,539	1.31	1.07	1.06	0.90	0.69	0.42	0.25	0.12	0.07
	FHLMC15_4p5_2005	86,166,708	1.10	0.89	0.89	0.77	0.58	0.36	0.23	0.13	0.09
	FHLMC15_4p5_2009	257,257,166	1.04	0.80	0.78	0.64	0.48	0.29	0.18	0.10	0.07
	FHLMC15_5_2005	53,480,053	1.00	1.06	0.97	0.82	0.62	0.38	0.21	0.10	0.05
	FHLMC15_5_2008	142,595,171	1.00	1.11	1.01	0.86	0.64	0.39	0.22	0.10	0.05
Agency MBS 15Y GNMA	GNMA15_CC	926,671	0.25	1.44	1.19	1.15	0.92	0.65	0.37	0.19	0.06
Agency MBS 30Y FNMA	FNMA30_CC	307,778,093	0.53	0.47	0.51	0.48	0.42	0.33	0.26	0.20	0.16
	FNMA30_4p5	56,663,874	0.62	0.53	0.55	0.50	0.42	0.31	0.24	0.17	0.14
	FNMA30_5p5	249,708,756	0.82	0.73	0.80	0.77	0.70	0.57	0.47	0.38	0.32
Agency MBS 30Y FHLMC	FHLMC30_CC	110,600,739	0.56	0.57	0.54	0.49	0.39	0.28	0.18	0.12	0.08
Agency MBS 30Y GNMA	GNMA30_CC	254,272,445	0.86	0.76	0.82	0.78	0.68	0.52	0.42	0.32	0.26
Agency Hybrid	FNMA5_1_3	1,504,447,899	1.61	1.54	1.43	1.23	0.95	0.63	0.39	0.24	0.17
	FHLM5_1_3	777,392,592	1.48	1.37	1.28	1.10	0.83	0.53	0.31	0.17	0.10
Agency CMO	CMO_PAC_2WAL	396,701,003	1.65	1.95	2.09	2.05	1.71	1.20	0.88	0.57	0.43
	CMO_PAC_10WAL		1.54	1.83	1.89	1.83	1.54	1.07	0.78	0.50	0.39
	CMO_SEQ_2WAL		0.99	1.72	1.65	1.61	1.32	0.94	0.64	0.40	0.26
	CMO_SEQ_10WAL		449,757,792	1.68	2.04	2.11	2.06	1.74	1.25	0.94	0.65
	CMO_FLTSTR_6p5	5,129,103,946	0.36	0.94	1.05	1.16	1.00	0.82	0.67	0.56	0.47
	CMO_FLTSTR_7	3,083,655,324	0.36	0.81	0.90	0.99	0.84	0.69	0.55	0.45	0.36
Agency CMBS	CMO_FLTFLT_6p5	1,295,453,859	0.27	0.79	0.93	1.05	0.97	0.79	0.62	0.51	0.40
	CMO_FLTFLT_7	1,113,080,247	0.34	0.80	0.88	0.96	0.82	0.66	0.51	0.41	0.32
	GNMA_CMBS_3p5Y	141,091,676	1.83	1.63	1.58	1.37	1.08	0.74	0.50	0.34	0.25
	GNMA_CMBS_12Y		1.28	1.13	1.10	0.96	0.75	0.51	0.35	0.24	0.18
Non Agency CMBS	FNMA_DUS_5to10Y	2,195,272,360	1.77	1.45	1.45	1.23	0.97	0.65	0.45	0.30	0.24
	FHLMC_CMBS_A2_10Y	1,683,635,964	1.48	1.31	1.27	1.11	0.87	0.59	0.41	0.27	0.21
	CMBS_2005_A	1,295,421,981	5.65	7.57	7.58	7.44	6.77	5.48	4.11	3.20	2.52
Non Agency CMBS	CMBS_2005_AU	96,578,019	13.47	24.15	24.41	25.27	24.01	20.43	15.62	12.53	9.90
	Agency Deb_Srt		1.22	1.27	1.18	1.04	0.83	0.58	0.38	0.26	0.20
	Agency Deb_Int	371,000,000	0.98	0.79	0.78	0.67	0.53	0.34	0.24	0.16	0.13
CLO	Agency Deb_Lng		0.30	0.34	0.33	0.30	0.26	0.20	0.14	0.11	0.09
	CLO AAA_3M	2,351,000,000	2.69	3.94	5.03	5.88	5.22	4.45	3.70	2.95	2.30
	ABS_AT_AAA_1	1,097,056,098	3.91	2.82	2.80	2.24	1.74	1.20	0.86	0.59	0.47
ABS	ABS_AT_AAA_3		5.93	4.83	5.01	4.61	3.45	2.48	1.74	1.20	0.90
	ABS_CC_AAA_3	1,185,171,903	4.62	3.89	4.10	3.73	2.76	2.00	1.43	0.97	0.72
	ABS_CC_AAA_7	4.77	4.09	4.32	3.97	2.93	2.12	1.51	1.03	0.76	
	ABS_SL_AAA_1	610,771,999	2.79	2.23	2.14	1.79	1.40	0.97	0.71	0.48	0.37
Covered Bonds	ABS_SL_AAA_7	4.75	3.49	3.46	2.80	2.12	1.54	1.16	0.86	0.70	
	iBoxx_Canada_Cov	897,392,867	0.92	2.43	2.35	2.32	2.10	1.42	0.87	0.50	0.24
	iBoxx_EUR_Canada	117,512,503	0.39	1.23	1.13	1.11	0.98	0.66	0.38	0.20	0.08
	iBoxx_EUR_GB	362,873,078	1.41	4.01	3.55	3.29	2.67	1.92	1.24	0.81	0.52
Non Agency RMBS	iBoxx_EUR_Ntlnds	239,608,102	0.25	1.53	1.39	1.38	1.18	0.97	0.73	0.58	0.45
	iBoxx_EUR_Scandi	554,326,635	0.33	1.18	1.05	1.00	0.83	0.63	0.44	0.31	0.22
	RMBS_Prime_AAA	820,556,218	4.67	7.27	9.61	11.15	12.62	11.05	9.90	8.56	7.10
	RMBS_Alta_AAA	1,332,122,987	12.35	15.91	19.64	22.26	21.27	18.06	15.69	12.95	10.33
EUR MBS	RMBS_Alta_AAA	284,290,870	12.32	20.84	27.77	33.12	33.71	28.79	24.42	19.90	15.45
	RMBS_SubPrime_AAA	100,548,288	3.71	8.41	12.68	15.86	18.86	17.21	15.62	13.52	11.11
	EUR_DCH_AA	147,278,146	8.56	9.07	9.65	9.62	7.29	5.16	3.67	2.53	1.95
GBP MBS	EUR_DCH_5t10_AAA	214,533,408	2.04	2.49	2.86	3.07	2.31	1.69	1.26	0.90	0.72
	EUR_IR_BBB	119,329,995	33.24	36.97	42.17	42.60	41.28	30.78	25.47	22.46	20.22
	GBP_UK_0t3_AAA		7.85	7.33	7.25	6.70	5.41	3.88	2.82	2.03	1.63
EUR Sovereigns	GBP_UK_3t5_AAA	623,340,088	4.97	4.05	4.23	3.75	3.03	2.35	1.87	1.48	1.32
	GBP_UK_5t10_AAA	3.08	3.39	3.91	4.10	3.60	3.02	2.53	2.10	1.82	
	SOV_EUR_FRA_1Y		2.13	2.32	1.96	1.76	1.39	1.09	0.78	0.50	0.20
EUR Sovereigns	SOV_EUR_FRA_5Y	1,978,377,538	1.47	1.82	1.49	1.19	0.91	0.67	0.42	0.22	0.04
	SOV_EUR_FRA_10Y		1.47	1.82	1.49	1.19	0.91	0.67	0.42	0.22	0.04
	SOV_EUR_NLD_3Y		2.16	2.36	1.99	1.79	1.42	1.11	0.79	0.51	0.21
	SOV_EUR_NLD_5Y	1,039,888,729	1.41	1.46	1.43	1.14	0.95	0.71	0.48	0.50	0.44
EUR Sovereigns	SOV_EUR_NLD_10Y		1.41	1.46	1.43	1.14	0.95	0.71	0.48	0.50	0.44

Credit Spread shock forecasts for the BHC Stress Scenario

Asset Type	Segment	Market Value (12/31/2015)	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9
EUR Sovereigns	SOV_EUR_BEL_1Y	1,004,810,141	2.07	2.26	1.91	1.71	1.36	1.06	0.76	0.48	0.19
	SOV_EUR_BEL_5Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	SOV_EUR_BEL_10Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	SOV_EUR_ITA_1Y	1,377,253,640	2.42	2.85	2.43	2.20	1.78	1.48	1.23	0.97	0.78
	SOV_EUR_ITA_5Y		1.83	2.34	1.89	1.59	1.23	0.95	0.77	0.61	0.54
	SOV_EUR_ITA_10Y		1.83	2.34	1.89	1.59	1.23	0.95	0.77	0.61	0.54
	SOV_EUR_SPA_1Y	1,926,954,727	2.55	2.97	2.57	2.32	1.91	1.59	1.33	1.08	0.89
	SOV_EUR_SPA_5Y		2.14	2.22	1.99	1.69	1.42	1.05	0.80	0.67	0.53
	SOV_EUR_SPA_10Y		2.14	2.22	1.99	1.69	1.42	1.05	0.80	0.67	0.53
EUR Corporates	SOV_EUR_IRL_1Y	760,978,042	2.80	3.83	2.95	2.40	2.14	2.02	1.81	1.59	1.44
	SOV_EUR_IRL_5Y		2.72	4.01	3.21	2.70	2.26	2.04	1.83	1.66	1.47
	SOV_EUR_IRL_10Y		2.72	4.01	3.21	2.70	2.26	2.04	1.83	1.66	1.47
	SOV_EUR_SWE_1Y	137,820,783	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	SOV_EUR_SWE_5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	SOV_EUR_SWE_10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
USD corporates	EUR_CORP_A_1Y	179,100,994	2.90	2.59	2.66	2.43	1.82	1.17	0.73	0.37	0.20
	EUR_CORP_A_5Y		2.32	2.16	2.24	2.09	1.57	1.01	0.62	0.30	0.13
	EUR_CORP_A_10Y		1.98	1.92	2.01	1.91	1.45	0.95	0.60	0.30	0.14
	EUR_CORP_AA_1Y	88,778,804	2.23	2.00	2.05	1.86	1.39	0.89	0.55	0.27	0.13
	EUR_CORP_AA_5Y		1.77	1.63	1.69	1.56	1.14	0.69	0.38	0.12	-0.01
	EUR_CORP_AA_10Y		1.37	1.32	1.40	1.32	0.95	0.55	0.27	0.03	-0.09
	EUR_CORP BBB_1Y	154,025,687	3.15	2.82	2.90	2.64	1.99	1.29	0.82	0.43	0.24
	EUR_CORP BBB_5Y		2.85	2.67	2.77	2.59	1.94	1.25	0.76	0.36	0.15
	EUR_CORP BBB_10Y		2.92	2.83	2.96	2.82	2.17	1.48	0.99	0.57	0.35
Municipal Bonds - General Obligations	USD_CORP_A_1Y	1,039,884,594	2.62	2.63	2.84	2.73	1.92	0.98	0.35	-0.20	-0.37
	USD_CORP_A_5Y		2.60	2.62	2.82	2.72	1.91	0.97	0.34	-0.20	-0.38
	USD_CORP_A_10Y		2.37	2.38	2.57	2.48	1.73	0.86	0.28	-0.22	-0.38
	USD_CORP_AA_1Y	213,487,413	2.24	2.25	2.42	2.34	1.66	0.87	0.34	-0.12	-0.27
	USD_CORP_AA_5Y		2.19	2.20	2.37	2.29	1.62	0.85	0.33	-0.12	-0.26
	USD_CORP_AA_10Y		2.24	2.26	2.42	2.34	1.69	0.93	0.42	-0.02	-0.16
	USD_CORP BBB_1Y	83,949,592	3.23	3.25	3.50	3.38	2.40	1.28	0.51	-0.14	-0.35
	USD CORP BBB_5Y		3.21	3.23	3.48	3.36	2.39	1.27	0.51	-0.14	-0.35
	USD CORP BBB_10Y		3.18	3.20	3.44	3.32	2.36	1.25	0.50	-0.14	-0.35
Municipal Bonds - Revenue	BFV_GO_A_1Y	205,923,179	0.38	0.41	0.51	0.53	0.58	0.42	0.36	0.30	0.24
	BFV_GO_A_5Y		0.53	0.90	0.92	0.97	0.99	0.82	0.66	0.57	0.45
	BFV_GO_A_10Y		0.04	1.52	1.48	1.64	1.64	1.54	1.17	1.03	0.84
	BFV_GO_AA_1Y	989,356,949	0.41	0.41	0.50	0.53	0.51	0.37	0.33	0.27	0.21
	BFV_GO_AA_5Y		0.46	0.77	0.79	0.83	0.85	0.71	0.56	0.48	0.38
	BFV_GO_AA_10Y		0.46	0.77	0.80	0.83	0.86	0.71	0.57	0.49	0.38
	BFV_UT_AA_1Y	448,531,337	0.48	0.46	0.55	0.56	0.53	0.38	0.34	0.27	0.21
	BFV_UT_AA_5Y		0.43	0.72	0.75	0.78	0.80	0.67	0.53	0.46	0.35
	BFV_UT_AA_10Y		0.45	0.75	0.77	0.81	0.83	0.69	0.55	0.47	0.37
ABCP	BFV_UT_A_1Y	105,869,857	0.58	0.73	0.93	1.04	0.95	0.69	0.57	0.43	0.31
	BFV_UT_A_5Y		0.47	1.30	1.27	1.34	1.30	1.05	0.80	0.66	0.50
	BFV_UT_A_10Y		0.57	0.96	0.99	1.04	1.06	0.88	0.71	0.61	0.48
	BFV_UT_AA_1Y	686,570,476	0.50	0.57	0.70	0.77	0.68	0.49	0.42	0.32	0.24
	BFV_UT_AA_5Y		0.53	0.84	0.89	0.93	0.94	0.78	0.62	0.52	0.41
	BFV_UT_AA_10Y		0.45	0.76	0.78	0.82	0.84	0.70	0.56	0.48	0.38
	BFV_ED_AA_1Y	375,426,826	0.40	0.43	0.52	0.55	0.54	0.39	0.34	0.26	0.20
	BFV_ED_AA_5Y		0.54	0.81	0.83	0.86	0.87	0.72	0.57	0.49	0.39
	BFV_ED_AA_10Y		0.45	0.75	0.78	0.81	0.83	0.69	0.55	0.48	0.37
International Bonds	BFV_REV_A_1Y	1,233,321,375	0.50	0.63	0.80	0.90	0.82	0.60	0.49	0.37	0.27
	BFV_REV_A_5Y		0.49	1.35	1.32	1.39	1.35	1.09	0.83	0.68	0.52
	BFV_REV_A_10Y		0.03	1.24	1.20	1.33	1.34	1.25	0.95	0.84	0.68
	ABCP	1,903,605,887	1.06	2.12	1.77	1.61	1.30	0.96	0.69	0.50	0.38
	USD INTERNATIONAL FINLAND 1Y	14,083,738	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	USD INTERNATIONAL FINLAND 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	USD INTERNATIONAL FINLAND 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	GBP INTERNATIONAL BELGIUM 1Y	88,399,041	2.07	2.26	1.91	1.71	1.36	1.06	0.76	0.48	0.19
	GBP INTERNATIONAL BELGIUM 5Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	GBP INTERNATIONAL BELGIUM 10Y		2.13	2.38	2.64	2.31	2.10	1.78	1.46	1.27	1.10
	EUR INTERNATIONAL SWEDEN 1Y	140,187,876	0.52	0.60	0.70	0.75	0.65	0.63	0.54	0.45	0.37
	EUR INTERNATIONAL SWEDEN 5Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85
	EUR INTERNATIONAL SWEDEN 10Y		1.56	1.80	1.60	1.49	1.37	1.21	1.07	0.97	0.85

Results

The primary QRM model and benchmark BlackRock model were executed with the same set of input assumptions for macroeconomic data (interest rates, credit spreads, foreign exchange rate, mortgage rates, HPI and unemployment rate) and investment strategy. The portfolio segmentation was consistent with the description above.

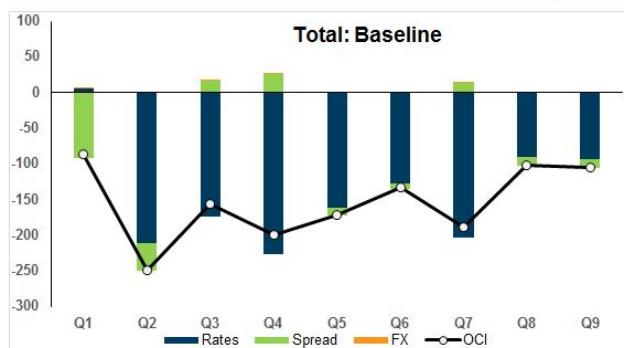
The below tables and charts summarize the forecasted pre-tax and pre-FAS133 hedge adjustment OCI comparison results between primary and the benchmark models:

- Supervisory Baseline Scenario

The primary driver for change in market value in the supervisory baseline scenario was the rising interest rates during the forecast horizon. The total AOCI during the nine quarters of forecast horizon is loss of \$1.4 Billion.

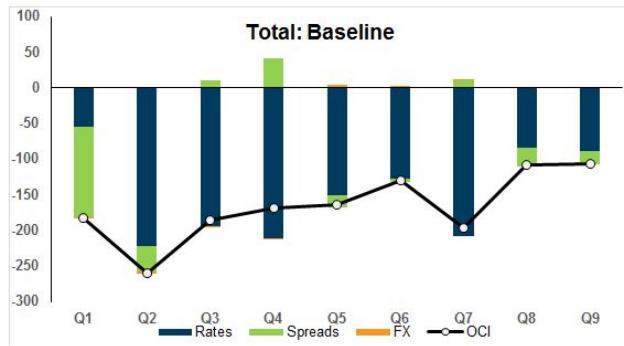
CCAR 2016 OCI forecast - Supervisory Baseline

Primary Model: QRM



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
Baseline OCI	-89	-250	-157	-200	-169	-132	-188	-103	-105	-1,394
Rates	5	-212	-174	-226	-162	-128	-204	-91	-93	-1,285
Spread	-95	-39	16	26	-8	-5	15	-13	-12	-116
FX	0	1	1	1	1	1	1	1	0	7

Benchmark Model: BlackRock



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
Baseline OCI	-183	-261	-186	-169	-163	-130	-196	-109	-107	-1,505
Rates	-55	-223	-194	-211	-151	-127	-208	-84	-89	-1,341
Spread	-127	-35	11	42	-17	-5	10	-26	-19	-167
FX	-1	-2	-3	0	4	2	2	1	0	3

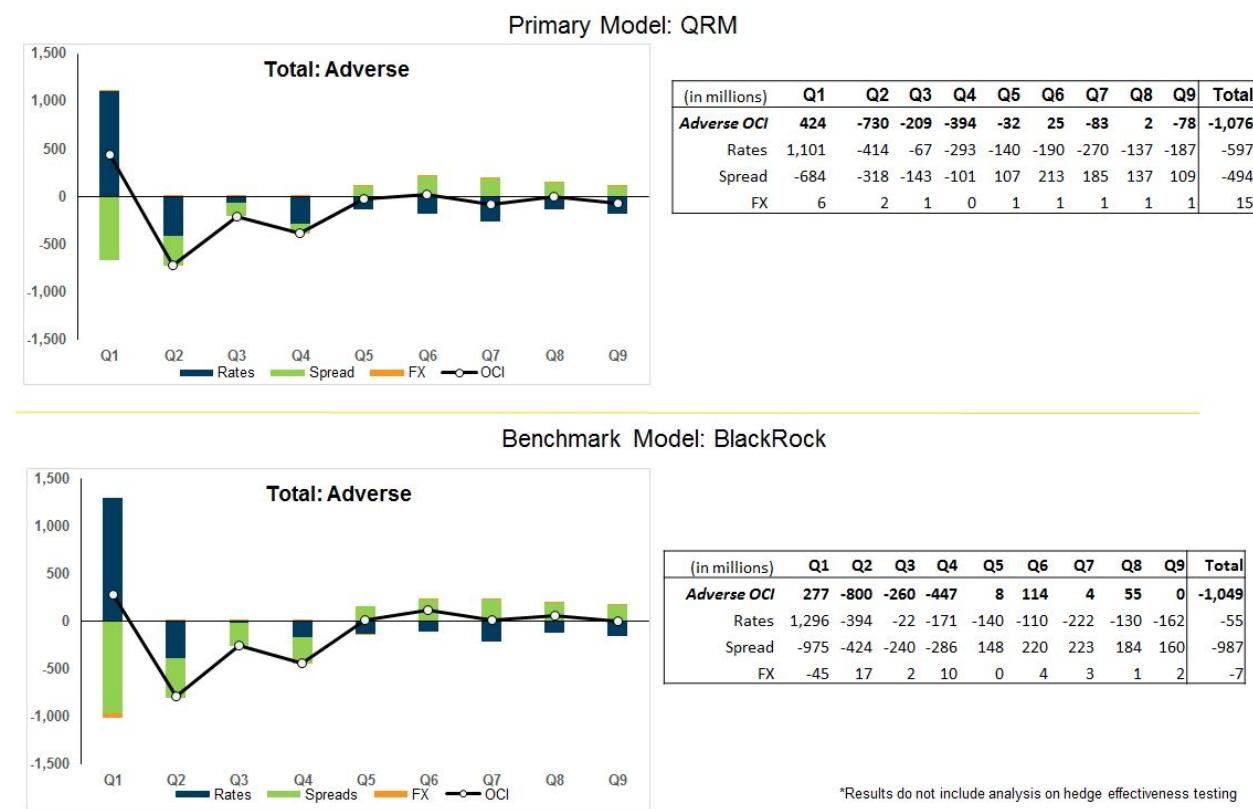
*Results do not include analysis on hedge effectiveness testing

- Supervisory Adverse Scenario

The supervisory adverse scenario is characterized by moderate recession and widening of credit spreads. In 1Q16 the losses driven by credit spreads are offset by gain due to lower interest rates. OCI in subsequent quarters is driven by losses due to widening of credit spreads and rising rates from the low point in 1Q16. Credit spreads indicate tightening starting 1Q17.

The total AOCI during the nine quarters of forecast horizon is loss of \$1.1 Billion.

CCAR 2016 OCI forecast - Supervisory Adverse



- Supervisory Severely Adverse Scenario

The Supervisory Severely Adverse Scenario is characterized by severe global recession, negative yields on short-term US Treasury, large reduction in asset prices, lower yields and significant widening of credit spreads. The gains from sharp decline in interest rates in 1Q16 are partially offset by the losses from the spread widening. In the subsequent quarters, rising interest rates from low of 1Q16 results in loss offset by tightening of credit spreads starting

1Q17. The total projected AOCI during the nine quarters of forecast horizon is loss of \$0.4 Billion.

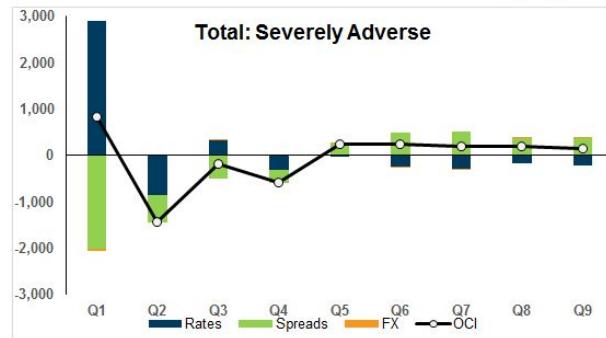
CCAR 2016 OCI forecast - Supervisory Severely Adverse

Primary Model: QRM



	(in millions)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
Sev. Adverse OCI	1,181	-1,435	-124	-572	172	96	71	109	58	-443	
Rates	2,660	-1,043	176	-551	-170	-296	-256	-182	-190	149	
Spread	-1,481	-394	-302	-24	330	389	324	288	245	-624	
FX	2	2	3	3	12	3	3	2	2	32	

Benchmark Model: BlackRock



	(in millions)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
Sev. Adverse OCI	842	-1,445	-178	-585	251	240	200	203	147	-326	
Rates	2,893	-857	323	-315	-3	-237	-300	-167	-220	1,117	
Spread	-2,026	-592	-508	-281	246	485	510	370	365	-1,432	
FX	-26	4	7	11	8	-8	-10	1	1	-12	

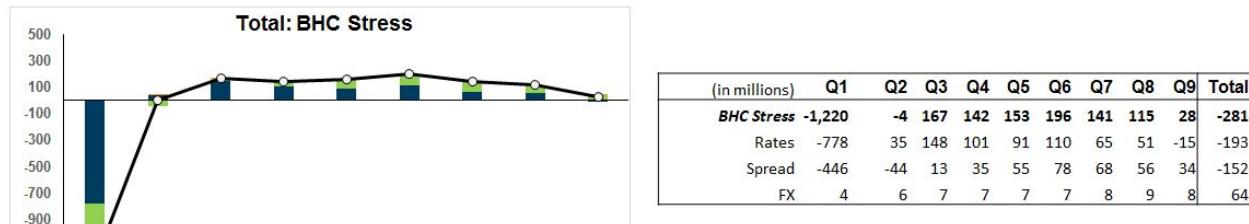
*Results do not include analysis on hedge effectiveness testing

- BHC Stress Scenario

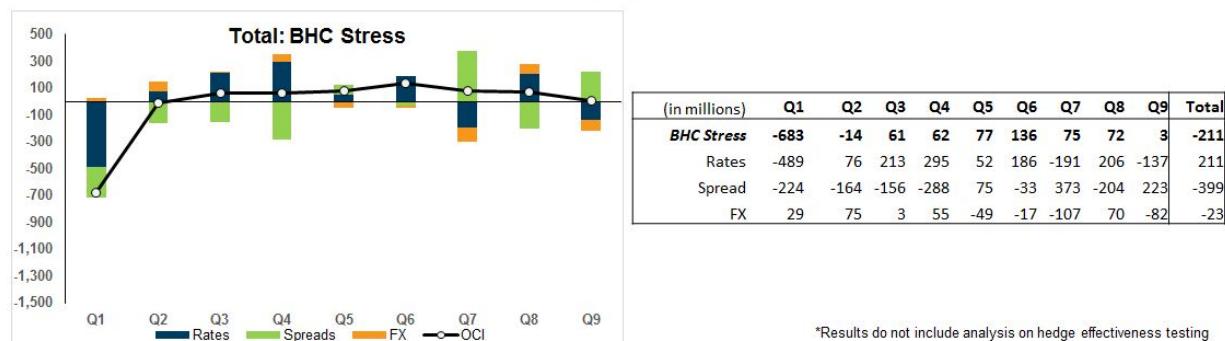
The BHC stress scenario is characterized by prolonged global recession, lower yields and significant widening of credit spreads. While the interest rates decline in U.S, the Euro interest rates are projected for steep rise. Driven by liquidity actions in 1Q16, the USD AFS portfolio is sold. 1Q16 losses are driven primarily by increase in Euro interest rates and widening of credit spreads. Starting 2Q16, run-off from USD HTM securities is 100% reinvested into like AFS securities to rebuild the mark-to-market portfolio. The total AOCI in the BHC stress scenario is reduced due to a significantly smaller AFS portfolio.

CCAR 2016 OCI forecast – BHC Idiosyncratic

Primary Model: QRM



Benchmark Model: BlackRock



*Results do not include analysis on hedge effectiveness testing

The observed unrealized gain/ loss from the two models exhibit the same trend. The benchmark and primary model forecasts were attributed for differences and sources of variation were identified to be driven by model differences.

- Discounting assumptions between QRM and BlackRock differed for certain securities. For example, Corporate Bonds were discounted by the Libor/Swap curve in BlackRock model and by the Treasury curve in QRM. Municipal Bonds were discounted with a Treasury curve plus spread by BlackRock and by a Municipal Bond curve in QRM.
- Behavioral models for QRM and BlackRock differ (i.e., CPR, CDR, Severities).
- For some credit securities, such as CLOs, BlackRock does not report rate risk and all marked-to-market change are attributed to credit. For other credit securities, Blackrock projected rate risk seems understated.
- Application of credit spreads was different between the two models. Certain asset class credit spread segments included term structure. In QRM, the term structure was modeled on the interest rate curve while BlackRock model applied the spread term

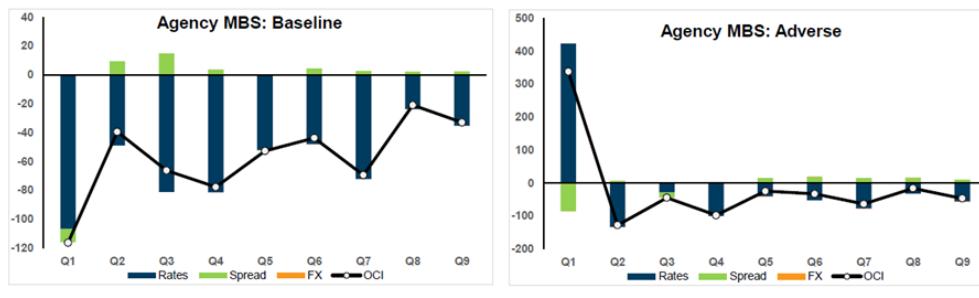
closest to the WAL of the security. Thus, depending on the shape of the credit curve, the credit component contribution to OCI could be different between the two models.

- BlackRock did not provide risk decomposition for new volumes. New volume risk was approximated by existing volume risk. Some risk attribution differences between the two models were a consequence of this approximation.
- QRM forecasted OCI is driven by the Default Assets AFS Gain Loss, where the computation was a function of book value and other factors. BlackRock OCI was modified to be equal to the change in market value minus change in book value (from using face value normalization). The approaches were similar, but not identical.

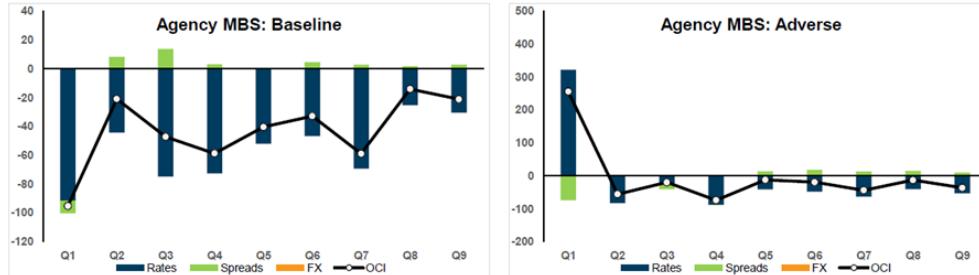
Below exhibits incremental pre-tax OCI projections over nine quarters for few selected securities

Agency MBS

Primary Model: QRM

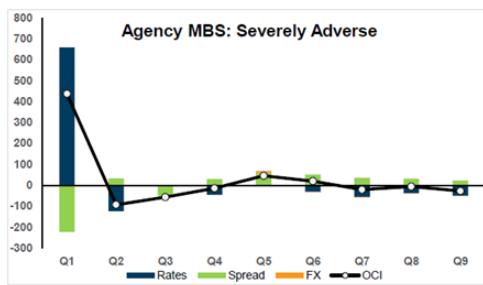


Benchmark Model: BlackRock



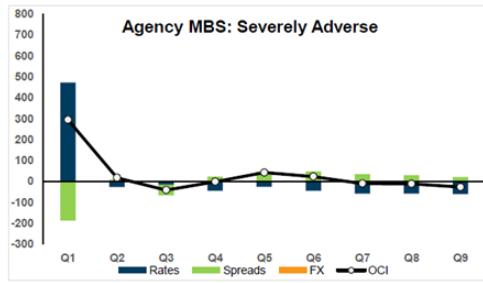
Agency MBS

Primary Model: QRM



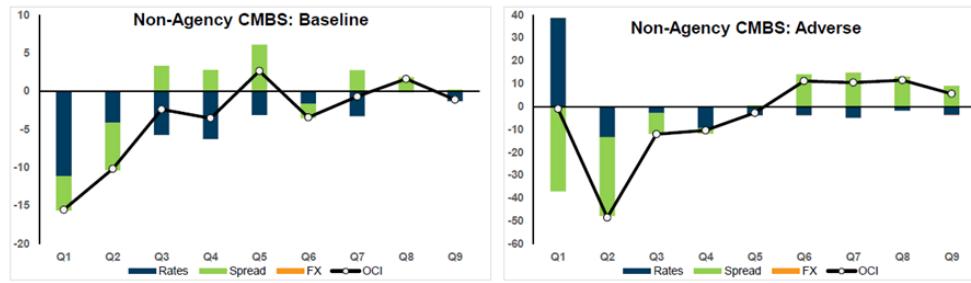
Portfolio Sold in
BHC Stress

Benchmark Model: BlackRock

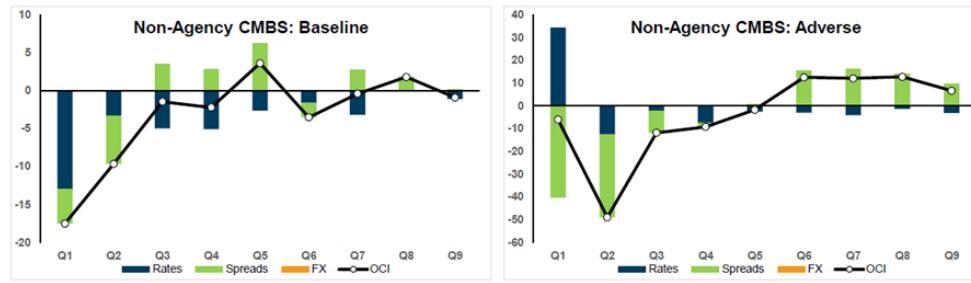


Non-Agency CMBS

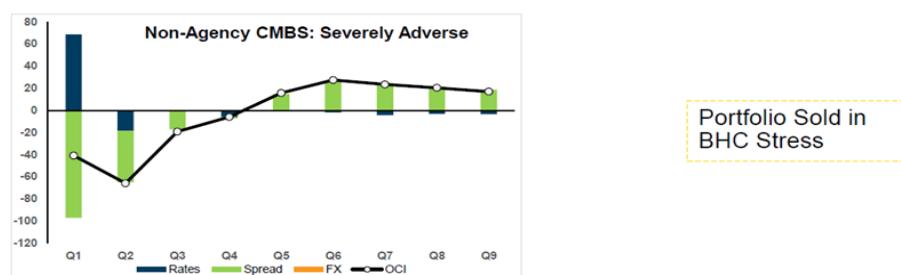
Primary Model: QRM



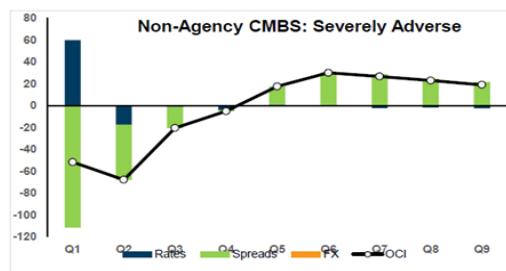
Benchmark Model: BlackRock



Primary Model: QRM



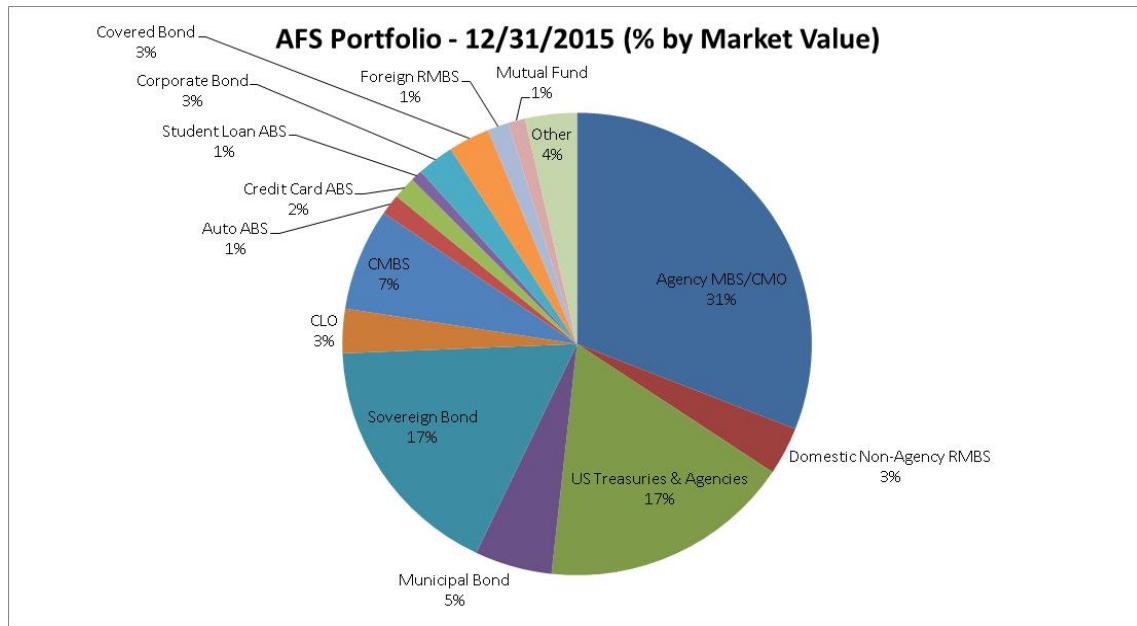
Benchmark Model: BlackRock



7.2 Appendix Investment Portfolio Profile²⁸

Asset Class	Book Value	Market Value	% MV	DV01	CS01
AFS (Net of Hedges)	74,949	75,553	12.7	19.6	
Agency MBS/CMO	23,391	23,514	31%	4.4	8.8
Domestic Non-Agency RMBS	2,217	2,538	3%	0.1	0.8
US Treasuries & Agencies	13,102	13,202	17%	8.5	0.2
Municipal Bond	3,967	4,045	5%	1.4	1.5
Sovereign Bond	12,396	12,585	17%	3.7	2.6
CLO	2,363	2,351	3%	0.0	0.6
CMBS	5,328	5,412	7%	1.7	2.5
Auto ABS	1,099	1,097	1%	0.1	0.1
Credit Card ABS	1,188	1,185	2%	-0.3	0.3
Student Loan ABS	622	611	1%	0.0	0.1
Corporate Bond	1,901	1,930	3%	0.7	0.7
Covered Bond	2,142	2,172	3%	0.5	0.5
Foreign RMBS	1,132	1,104	1%	0.1	0.4
Mutual Fund	873	887	1%	0.0	0.0
Others	3,228	3,235	4%	0.4	0.4
Total AFS Securities	74,949	75,867	100%	21.4	19.6
Hedges	-	-315		-8.7	

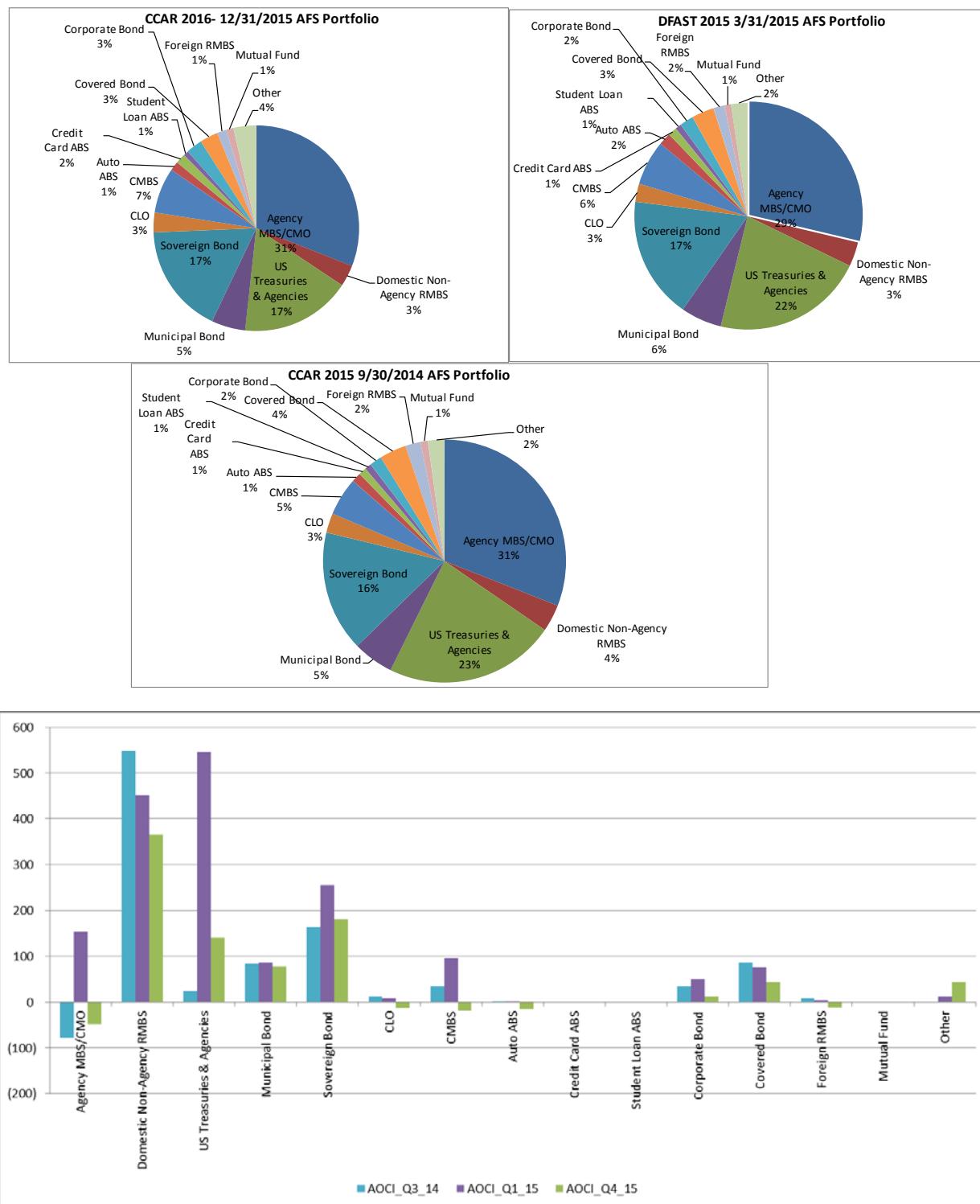
²⁸ As of 12/31/2015



Historical Market Value and AOCI profile for AFS Securities portfolio

AFS Securities	Market Value (in millions \$)			%MV			AOCI*		
	12/31/2015	3/31/2015	9/30/2014	12/31/2015	3/31/2015	9/30/2014	12/31/2015	3/31/2015	9/30/2014
Agency MBS/CMO	23,514	25,184	29,599	31%	29%	31%	(48)	154	(78)
Domestic Non-Agency RMBS	2,538	3,059	3,453	3%	3%	4%	365	451	548
US Treasuries & Agencies	13,202	18,971	21,725	17%	22%	23%	140	546	24
Municipal Bond	4,045	5,139	5,170	5%	6%	5%	78	86	83
Sovereign Bond	13,110	15,243	15,340	17%	17%	16%	181	255	164
CLO	2,351	2,258	2,489	3%	3%	3%	(12)	8	12
CMBS	5,412	5,636	4,831	7%	6%	5%	(19)	96	35
Auto ABS	1,097	1,547	1,211	1%	2%	1%	(16)	2	1
Credit Card ABS	1,185	1,092	967	2%	1%	1%	0	0	0
Student Loan ABS	611	762	851	1%	1%	1%	0	0	0
Corporate Bond	1,930	1,745	1,550	3%	2%	2%	12	50	34
Covered Bond	2,172	2,808	3,400	3%	3%	4%	43	76	86
Foreign RMBS	1,104	1,384	1,928	1%	2%	2%	(11)	4	8
Mutual Fund	887	814	938	1%	1%	1%	0	0	0
Other (ABCP, Supranational)	2,709	2,075	2,106	4%	2%	2%	43	12	0
TOTAL	75,867	87,717	95,558	100%	100%	100%	756	1,740	917

*AOCI as per the 10-Q/10-K financial reporting



*as per the 10-Q/10-K financial reporting

7.3 Appendix Investment Portfolio Segments by Asset Class

The below lists the investment portfolio credit spread forecasting segments identified during the development process based on the four step segmentation approach.

Product	Spread Mnemonic	Tag	Data Source	Ticker / Mnemonic
MBS Agency Passthrough	FNMA 15Yr CC:Liber OAS	Agency MBS 15Y FANNIE_MAE CC	Barclays Live	FNCI 15Yr CC CC:Liber OAS
MBS Agency Passthrough	FNMA 15Yr 4.5 2005:Liber OAS	Agency MBS 15Y FANNIE_MAE 4.5 2005	Barclays Live	FNCI 15Yr 4.5 2005:Liber OAS
MBS Agency Passthrough	FNMA 15Yr 4.0 2011:Liber OAS	Agency MBS 15Y FANNIE_MAE 4.0 2011	Barclays Live	FNCI 15Yr 4.0 2011:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr CC:Liber OAS	Agency MBS 15Y FREDDIE_MAC CC	Barclays Live	FGCI 15Yr CC CC:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr 4.5 2005:Liber OAS	Agency MBS 15Y FREDDIE_MAC 4.5 2005	Barclays Live	FGCI 15Yr 4.5 2005:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr 5.0 2005:Liber OAS	Agency MBS 15Y FREDDIE_MAC 5.0 2005	Barclays Live	FGCI 15Yr 5.0 2005:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr 5.0 2008:Liber OAS	Agency MBS 15Y FREDDIE_MAC 5.0 2008	Barclays Live	FGCI 15Yr 5.0 2008:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr 4.5 2009:Liber OAS	Agency MBS 15Y FREDDIE_MAC 4.5 2009	Barclays Live	FGCI 15Yr 4.5 2009:Liber OAS
MBS Agency Passthrough	FHLMC 15 Yr 4.0 2010:Liber OAS	Agency MBS 15Y FREDDIE_MAC 4.0 2010	Barclays Live	FGCI 15Yr 4.0 2010:Liber OAS
MBS Agency Passthrough	GNMA 15 Yr CC:Liber OAS	Agency MBS 15Y GINNIE_MAE CC	Barclays Live	GNIO 15Yr CC CC:Liber OAS
MBS Agency Passthrough	FNMA 30Yr CC CC:Liber OAS	Agency MBS 30Y FANNIE_MAE CC	Barclays Live	FNL30Yr CC CC:Liber OAS
MBS Agency Passthrough	FNMA 30Yr 4.5 2005:Liber OAS	Agency MBS 30Y FANNIE_MAE 4.5 2005	Barclays Live	FNL30Yr 4.5 2005:Liber OAS
MBS Agency Passthrough	FNMA 30Yr 5.5 2006:Liber OAS	Agency MBS 30Y FANNIE_MAE 5.5 2006	Barclays Live	FNL30Yr 5.5 2006:Liber OAS
MBS Agency Passthrough	FHLMC 30Yr CC:Liber OAS	Agency MBS 30Y FREDDIE_MAC CC	Barclays Live	FGLMC 30Yr CC CC:Liber OAS
MBS Agency Passthrough	GNMA 30 Yr CC:Liber OAS	Agency MBS 30Y GINNIE_MAE CC	Barclays Live	GNSF 30Yr CC CC:Liber OAS
MBS Agency Hybrid ARMS	FNMA, 5/1, 3.0,	Agency MBS ARM HYBRID FANNIE_MAE 35/1	Barclays Live	FNMA, 5/1, 3.0, Liber OAS
MBS Agency Hybrid ARMS	FHLM, 5/1, 3.0,	Agency MBS ARM HYBRID FREDDIE_MAC 35/1	Barclays Live	FHLM, 5/1, 3.0, Liber OAS
MBS Agency CMO	CMO PAC- 2 Yr WAL	Agency CMO PAC	JP Morgan Markets	CMO PAC- 2Yr WAL
MBS Agency CMO	CMO PAC- 10Yr WAL	Agency CMO PAC	JP Morgan Markets	CMO PAC- 10Yr WAL
MBS Agency CMO	CMO SEQ- 2Yr WAL	Agency CMO Sequential	JP Morgan Markets	CMO SEQ- 2Yr WAL
MBS Agency CMO	CMO SEQ- 10Yr WAL	Agency CMO Sequential	JP Morgan Markets	CMO SEQ- 10Yr WAL
MBS Agency CMO	CMO Floaters - Floaters /CAPs 6.5 Cap DM	Agency CMO 6.5 Floaters	JP Morgan Markets	CMO Flt - DM / 6.5 Cap
MBS Agency CMO	CMO Floaters - Floaters /CAPs 7.0 Cap DM	Agency CMO 7.0 Floaters	JP Morgan Markets	CMO Flt - DM / 7.0 Cap
MBS Agency CMO	CMO Floaters Strips - 6.5 Cap DM	Agency CMO 6.5 Cap Passthrough Strips	Barclays Live	Floaters Conventional Strips 6.5 Cap,DM
MBS Agency CMO	CMO Floaters Strips - 7.0 Cap DM	Agency CMO 7.0 Cap Passthrough Strips	Barclays Live	Floaters Conventional Strips 7.0 Cap,DM
Agency CMBS	FHLMC CMBS - A2 10yr	Agency CMBS FREDDIE_MAC A2	JP Morgan Markets	FHLMC A2 10yr Spread
Agency CMBS	FNMA DUS 5-10yr Spread	Agency CMBS FANNIE_MAE	JP Morgan Markets	FNMA DUS 5-10yr Spread
Agency CMBS	GNMA CMBS - 3.5yr	Agency CMBS GINNIE_MAE	JP Morgan Markets	GNMA Project Loans 3.5Yr Spread
Agency CMBS	GNMA CMBS - 12yr	Agency CMBS GINNIE_MAE	JP Morgan Markets	GNMA Project Loans 12Yr Spread
Non-Agency CMBS	CMBS 2005 A	Non Agency CMBS IG Senior AAA	Barclays Live	CMBS 2005 A
Non-Agency CMBS	CMBS 2005 AM	Non Agency CMBS Mezz Mezz AAA	Barclays Live	CMBS 2005 AM
Non-Agency CMBS	CMBS 2005 AJ	Non Agency CMBS Mezz Sub AAA	Barclays Live	CMBS 2005 AJ
Non-Agency CMBS	CMBS 10yr Mezz AA (2011-Current) Spread	Non Agency CMBS Mezz Mezz AA	JP Morgan Markets	CMBS 10yr Mezz AA (2011-Current) Spread
Non-Agency CMBS	CMBS 10yr AJ AA (2011-Current) Spread	Non Agency CMBS Mezz Sub AA	JP Morgan Markets	CMBS AJ AA (2011-Current) Spread
Non-Agency CMBS	CMBS 10yr Mezz A (2011-Current) Spread	Non Agency CMBS Mezz Mezz A	JP Morgan Markets	CMBS 10yr Mezz A (2011-Current) Spread
Non-Agency CMBS	CMBS 10yr BBB+ (2012-Current) Spread (Junior)	Non Agency CMBS Mezz Sub A	JP Morgan Markets	CMBS 10yr BBB+ (2012-Current) Spread
Covered Bonds	iBoxx \$ Canada Covered	USD Covered Bonds Canada	JP Morgan Markets	iBoxx \$ Canada Covered
Covered Bonds	iBoxx EUR Canada	EUR Covered Bonds Canada	JP Morgan Markets	iBoxx EUR Canada
Covered Bonds	iBoxx EUR GB	EUR Covered Bonds United Kingdom	JP Morgan Markets	iBoxx EUR GB
Covered Bonds	iBoxx EUR Netherlands	EUR Covered Bonds Netherlands	JP Morgan Markets	iBoxx EUR Netherlands
Covered Bonds	iBoxx EUR Scandinavia	EUR Covered Bonds Scandinavia	JP Morgan Markets	iBoxx EUR Scandi
Agency Debentures	Agency Debentures Short	Agency Debentures spread	DC	Agency Debentures Short
Agency Debentures	Agency Debentures Intermediate	Agency Debentures spread	DC	Agency Debentures Intermediate
Agency Debentures	Agency Debentures Long	Agency Debentures spread	DC	Agency Debentures Long
CLO	Seasoned USD (04-05 vintage) - CLO AAA Spread to 3M Libor	CLO AAA	JP Morgan Markets	Seasoned USD (04-05 vintage) - CLO AAA Spread to 3M Libor
ABS	Auto Fixed AAA to Swap 1Yr	Auto ABS	JP Morgan Markets	ABS Auto Fixed AAA 1Yr Spread
ABS	Auto Fixed AAA to Swap 3 Yr	Auto ABS	JP Morgan Markets	ABS Auto Fixed AAA 3Yr Spread
ABS	ABS Credit Card Floating AAA 3Yr	Credit Card ABS	JP Morgan Markets	ABS CC Fixed AAA 3Yr Spread
ABS	ABS Credit Card Floating AAA 7Yr	Credit Card ABS	JP Morgan Markets	ABS CC Fixed AAA 7Yr Spread
ABS	Student Floating AAA 1y Libor	Student ABS	JP Morgan Markets	ABS Student Loans AAA 1Yr DM
ABS	Student Floating AAA 5y Libor	Student ABS	JP Morgan Markets	ABS Student Loans AAA 5Yr DM
Non-Agency RMBS	Non Agency RMBS Prime AAA	Non Agency MBS NONAGENCY_PRIME AAA	DC	Non Agency RMBS Prime AAA
Non-Agency RMBS	Non Agency RMBS Alt-A AA	Non Agency MBS NONAGENCY_OTHER AAA	DC	Non Agency RMBS Alt-A AA
Non-Agency RMBS	Non Agency RMBS Alt-A AAA	Non Agency MBS NONAGENCY_OTHER AAA	DC	Non Agency RMBS Alt-A AAA
Non-Agency RMBS	Non Agency RMBS Subprime AAA	Non Agency MBS NONAGENCY_SUBPRIME AAA	DC	Non Agency RMBS Subprime AAA

Product	Spread Mnemonic	Tag	Data Source	Ticker / Mnemonic
Int'l RMBS	EUR Floating Coupon: Dutch RMBS: AA::Spread	EUR MBS AA Netherlands	Barclays Live	EUR Floating Coupon: Dutch RMBS: AA::Spread
Int'l RMBS	EUR Floating Coupon: Dutch RMBS: AAA 5-10::Spread	EUR MBS AAA Netherlands	Barclays Live	EUR Floating Coupon: Dutch RMBS: AAA 5-10::Spread
Int'l RMBS	EUR Floating Coupon: Irish RMBS: BBB::Spread	EUR MBS BBB Ireland	Barclays Live	EUR Floating Coupon: Irish RMBS: BBB::Spread
Int'l RMBS	GBP Floating Coupon: UK Prime RMBS: AAA 0-3::Spread	GBP MBS	Barclays Live	GBP Floating Coupon: UK Prime RMBS: AAA 0-3::Spread
Int'l RMBS	GBP Floating Coupon: UK Prime RMBS: AAA 3-5::Spread	GBP MBS	Barclays Live	GBP Floating Coupon: UK Prime RMBS: AAA 3-5::Spread
Int'l RMBS	GBP Floating Coupon: UK Prime RMBS: AAA 5-10::Spread	GBP MBS	Barclays Live	GBP Floating Coupon: UK Prime RMBS: AAA 5-10::Spread
US Corporates	BFV USD Composite AAA 1 Year	USD Corporate Bonds AAA	Bloomberg	C8801Y Index
US Corporates	BFV USD Composite AAA 5 Year	USD Corporate Bonds AAA	Bloomberg	C8805y Index
US Corporates	BFV USD Composite AAA 10 Year	USD Corporate Bonds AAA	Bloomberg	C88010y Index
US Corporates	BFV USD Composite AA 1 Year	USD Corporate Bonds AA	Bloomberg	C8811Y Index
US Corporates	BFV USD Composite AA 5 Year	USD Corporate Bonds AA	Bloomberg	C8815y Index
US Corporates	BFV USD Composite AA 10 Year	USD Corporate Bonds AA	Bloomberg	C88110y Index
US Corporates	BFV USD Composite A1 1 Year	USD Corporate Bonds A	Bloomberg	C8821Y Index
US Corporates	BFV USD Composite A5 5 Year	USD Corporate Bonds A	Bloomberg	C8825y Index
US Corporates	BFV USD Composite A10 10 Year	USD Corporate Bonds A	Bloomberg	C88210y Index
US Corporates	BFV USD Composite BBB 1 Year	USD Corporate Bonds BBB	Bloomberg	C8831Y Index
US Corporates	BFV USD Composite BBB 5 Year	USD Corporate Bonds BBB	Bloomberg	C8835y Index
US Corporates	BFV USD Composite BBB 10 Year	USD Corporate Bonds BBB	Bloomberg	C88310y Index
EUR Corporates	EUR Europe Corporate AA BFV Yield Curve 1 Year	EUR Corporate bonds AA	Bloomberg	C6671Y Index
EUR Corporates	EUR Europe Corporate AA BFV Yield Curve 5 Year	EUR Corporate bonds AA	Bloomberg	C6675Y Index
EUR Corporates	EUR Europe Corporate AA BFV Yield Curve 10 Year	EUR Corporate bonds AA	Bloomberg	C66710y Index
EUR Corporates	EUR Europe Corporate A BFV Yield Curve 1 Year	EUR Corporate bonds A	Bloomberg	C6701Y Index
EUR Corporates	EUR Europe Corporate A BFV Yield Curve 5 Year	EUR Corporate bonds A	Bloomberg	C6705y Index
EUR Corporates	EUR Europe Corporate A BFV Yield Curve 10 Year	EUR Corporate bonds A	Bloomberg	C67010y Index
EUR Corporates	EUR Europe Corporate BBB BFV Yield Curve 1 Year	EUR Corporate bonds BBB	Bloomberg	C6731Y Index
EUR Corporates	EUR Europe Corporate BBB BFV Yield Curve 5 Year	EUR Corporate bonds BBB	Bloomberg	C6735y Index
EUR Corporates	EUR Europe Corporate BBB BFV Yield Curve 10 Year	EUR Corporate bonds BBB	Bloomberg	C67310y Index
GBP Corporates	GBP Financials BFV Yield Curve 1 Year	GBP Corporate bonds	Bloomberg	C4001Y Index
GBP Corporates	GBP Financials BFV Yield Curve 5 Year	GBP Corporate bonds	Bloomberg	C4005y Index
GBP Corporates	GBP Financials BFV Yield Curve 10 Year	GBP Corporate bonds	Bloomberg	C40010y Index
Sovereign	EUR Belgian Sovereign Curve	EUR Belgian Sovereign Curve 1 Year	Bloomberg	C9001Y Index
Sovereign	EUR Belgian Sovereign Curve	EUR Belgian Sovereign Curve 10 year	Bloomberg	C90010Y Index
Sovereign	EUR France Sovereign Curve	EUR France Sovereign Curve 1 Year	Bloomberg	C9151Y Index
Sovereign	EUR France Sovereign Curve	EUR France Sovereign Curve 10 Year	Bloomberg	C91510Y Index
Sovereign	EUR Ireland Sovereign Curve	EUR Ireland Sovereign Curve 1 Year	Bloomberg	C9181Y Index
Sovereign	EUR Ireland Sovereign Curve	EUR Ireland Sovereign Curve 10 Year	Bloomberg	C91810Y Index
Sovereign	EUR Italy Sovereign Curve	EUR Italy Sovereign Curve 1 Year	Bloomberg	C9051Y Index
Sovereign	EUR Italy Sovereign Curve	EUR Italy Sovereign Curve 10 Year	Bloomberg	C90510Y Index
Sovereign	EUR Netherlands Sovereign Curve	EUR Netherlands Sovereign Curve 1 Year	Bloomberg	C9201Y Index
Sovereign	EUR Netherlands Sovereign Curve	EUR Netherlands Sovereign Curve 10 Year	Bloomberg	C92010Y Index
Sovereign	EUR Spanish Sovereign Curve	EUR Spanish Sovereign Curve 1 Year	Bloomberg	C9021Y Index
Sovereign	EUR Spanish Sovereign Curve	EUR Spanish Sovereign Curve 10 Year	Bloomberg	C90210Y Index
Sovereign	SEK Sweden Sovereign Curve	SEK Sweden Sovereign Curve 1 Year	Bloomberg	GTSEK1Y Govt
Sovereign	SEK Sweden Sovereign Curve	SEK Sweden Sovereign Curve 10 Year	Bloomberg	GTSEK10Y Govt
Municipals	BFV Muni GO AA 1 Year	Municipal Bonds AA G/O	Bloomberg	045M1Y Index
Municipals	BFV Muni GO AA 5 Year	Municipal Bonds AA G/O	Bloomberg	045MSY Index
Municipals	BFV Muni GO AA 10 Year	Municipal Bonds AA G/O	Bloomberg	045M10Y Index
Municipals	BFV Muni Insured A GO 1 Year	Municipal Bonds A G/O	Bloomberg	252M1Y Index
Municipals	BFV Muni Insured A GO 5 Year	Municipal Bonds A G/O	Bloomberg	252MSY Index
Municipals	BFV Muni Insured A GO 10 Year	Municipal Bonds A G/O	Bloomberg	252M10Y Index
Municipals	BFV US Muni Transportation AA- 1 Year	Municipal Bonds AA Rev Transportation	Bloomberg	466M1Y Index
Municipals	BFV US Muni Transportation AA- 5 Year	Municipal Bonds AA Rev Transportation	Bloomberg	466MSY Index
Municipals	BFV US Muni Transportation AA- 10 Year	Municipal Bonds AA Rev Transportation	Bloomberg	466M10Y Index
Municipals	BFV US Muni Utility A- 1 Year	Municipal Bonds A Rev Utility	Bloomberg	522M1Y Index
Municipals	BFV US Muni Utility A- 5 Year	Municipal Bonds A Rev Utility	Bloomberg	522MSY Index
Municipals	BFV US Muni Utility A- 10 Year	Municipal Bonds A Rev Utility	Bloomberg	522M10Y Index
Municipals	BFV US Muni Utility AA 1 Year	Municipal Bonds AA Rev Utility	Bloomberg	520M1Y Index
Municipals	BFV US Muni Utility AA 5 Year	Municipal Bonds AA Rev Utility	Bloomberg	520MSY Index
Municipals	BFV US Muni Utility AA 10 Year	Municipal Bonds AA Rev Utility	Bloomberg	520M10Y Index
Municipals	BFV US Muni Education AA 1 Year	Municipal Bonds AA Rev Education	Bloomberg	448M1Y Index
Municipals	BFV US Muni Education AA 5 Year	Municipal Bonds AA Rev Education	Bloomberg	448MSY Index
Municipals	BFV US Muni Education AA 10 Year	Municipal Bonds AA Rev Education	Bloomberg	448M10Y Index
Municipals	US Revenue A Muni BFV Yield Curve 1 Year	Municipal Bonds A Rev	Bloomberg	332M1Y Index
Municipals	US Revenue A Muni BFV Yield Curve 5 Year	Municipal Bonds A Rev	Bloomberg	332MSY Index
Municipals	US Revenue A Muni BFV Yield Curve 10 Year	Municipal Bonds A Rev	Bloomberg	332M10Y Index
Commercial Paper	BACR/6M SENIOR/SPREAD/NYC CLOSE	Commercial Paper (ABC/P)	Barclays Live	BACR/6M SENIOR/SPREAD/NYC CLOSE

7.4 Appendix QRM details

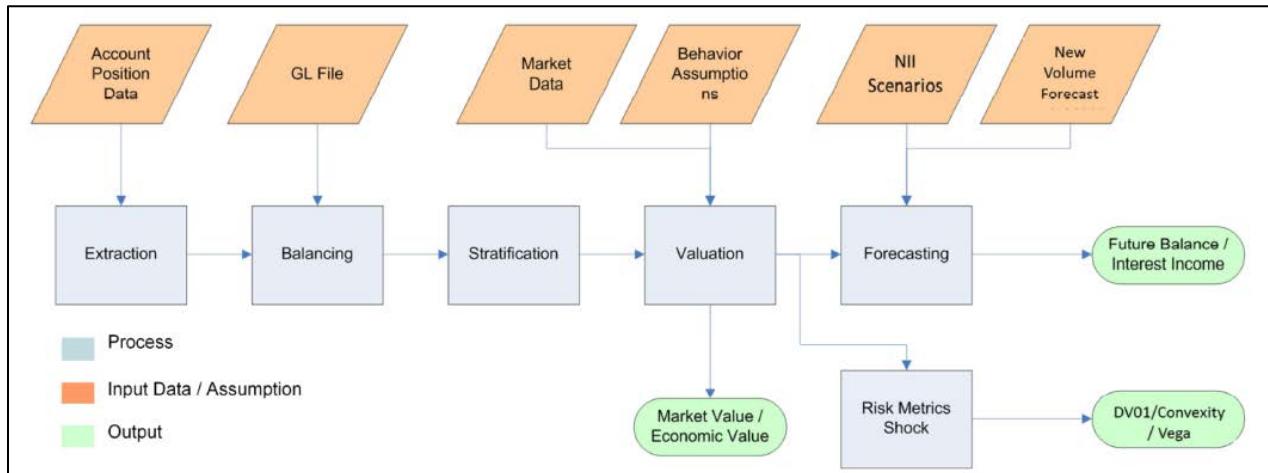
7.4.1 The QRM model

The QRM model is a vendor system developed and supported by Quantitative Risk Management. QRM is used by the ALM-IRR to provide BNY Mellon management with analytics for managing interest rate revenue and market value of capital. The interest rate risk(IRR) tasks performed by QRM include the valuation of asset and liability balance sheet items, off-balance sheet instruments (EVE), the measurement of balance sheet risk (DV01), and forecasting the net interest income (NII) of the balance sheet under different interest rate scenarios. QRM's functionality includes the ability to specify contractual information, and customer behavior assumptions such as prepayment models and runoff models for the relevant portfolios and accounts. The QRM model contains the entire balance sheet of BNY Mellon.

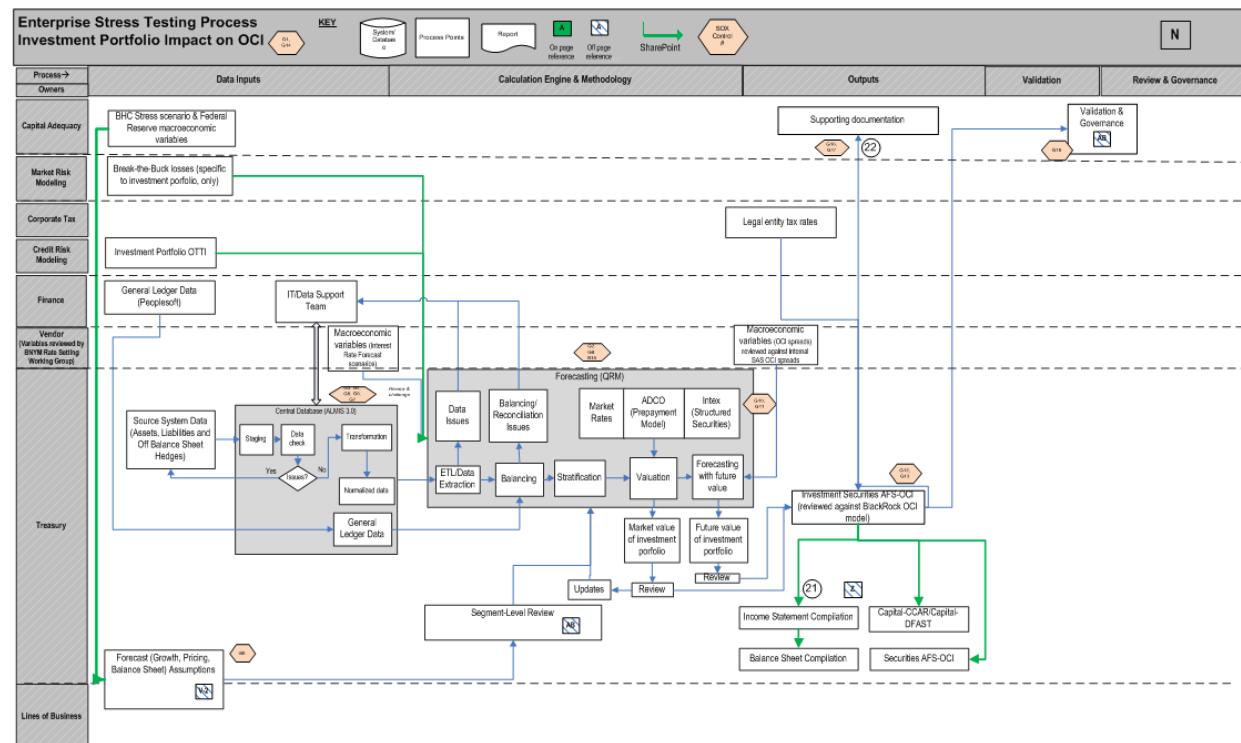
The QRM Interest Rate Risk (IRR) model's process for the balance sheet can be described in size processes:

- Extraction: extract the position level details for corresponding accounts created in QRM.
- Balancing: balance the assets and liabilities sides of the balance sheet based on the GL file.
- Stratification: segment the detailed position into buckets for future calculation.
- Valuation: calculate the market value and/or MTM spread for every account based on the contractual features, behavior assumptions, discount curves and/or market prices.
- Risk Metrics Shock: parallel shock the discount curve up and down 10bps and calculate DV01 and convexity of each account.
- Forecasting: project new volumes based on new volume forecast and forecast the NII accordingly.

The below figure illustrates, for each step, the process, the data and assumption input into the model and the output of the basic QRM Model Process.



And the figure below describes the detailed work process flow for the Investment Portfolio effect on OCI.



7.4.2 Valuation

The QRM model uses the discounting cash flow methodology to calculate the *market value* and *economic value* of each account²⁹. The calculation is done on a bucket level and aggregated at the account level for reporting. The cash flows include principals, interest, prepayment, etc., and

²⁹ For a more detailed description of the calculations within QRM, please consult the document *QRM Model Model ID #2539*

are calculated based on the instrument characters, contractual features and the behavior assumptions. The *economic value* is calculated as:

$$EV = \sum_i (CF_i \times e^{-r_i t_i})$$

Where

- CF_i is the sum of cash flows in period i;
- r_i is the spot rate of period i from the discounting yield curve, in the format of continuous compounding;
- t_i is the time length to period i, in the format of year.
- The market value is calculated in either of the two methods:

The *market value* is calculated first for the current market configuration using the equation:

$$MV = MarketPrice / 100 \times F$$

where

- | | |
|-------------|---|
| MarketPrice | = the market price of a position with a face amount of \$100; and |
| F | = the face amount of the position. |

And then for the project future value of the market using the below equation:

$$MV = \sum_i [CF_i \times e^{-(r_i + MTMspread)t_i}]$$

where

- | | |
|-----------|--|
| MTMspread | = the Mark-to-Market spread defined in the model |
| CF | = the sum of cash flows in period i |
| r | = the spot rate of period I from the discounting yield curve |
| i | = the time period |

7.4.3 Yield Curve Construction

The QRM model uses a monotonic cubic spline method to perform the bootstrapping of the yield curve. Spot interest rate curves include:

- USD Libor/Swap
- USD Treasury

- Euribor/Swap
- EUR German Govt. Curve
- GBP Libor/Swap
- GBP UK Govt. curve
- JPY Libor/Swap
- Municipal Bond curve

The active rate indexes in QRM can be divided into two types: Directly from yield curves (e.g. USD Libor 1M) and Equation based indexes (e.g. Fed Fund Target). The equation based indexes can be further divided into

- QRM defined rate indexes, including ‘USD Fed Funds Rate (QRM)’ and ‘USD Prime (QRM)’;
- ALM defined rates.

7.4.4 The QRM Configuration

The data input into the QRM model can be briefly separated into two types: balance sheet data and market data³⁰.

Balance Sheet Data

The balance sheet data includes the spot detailed position level data for each account, the GL file and the NII forecasting balance and pricing margin. The position level data comes mainly from ALMIS (using Accounting systems HFM and TM1 as supplement), the GL comes from accounting systems and the NII forecasting balances and pricing margin comes from Line of Business.

Market Data

The market data includes yield curve and foreign exchange rate offered mostly by QRM Market Service. The market data input does not include rate indexes, because the rate indexes are either directly derived from yield curve, or calculated from equations. The forecasts for yield curves, rate indexes and foreign exchange rate for stress test scenarios are sourced from Moody's model #2399 and input into the planning scenarios.

³⁰ For a detailed description of the QRM configuration, please refer to *QRM Model ID #2539*

7.4.5 AD&Co Prepayment Model

The MBS prepayment model is a vendor model developed by vendor Andrew Davidson & Co Inc. (AD&Co). On the QRM platform, ALM-IRR uses the AD&Co 5.2h version prepayment model to forecast the prepayment speed for Agency MBS, the whole loan mortgage portfolio and regulatory purposes for FR 14Q, 10Q/10K, CCAR and ICAAP reporting. Vendor options for prepayment modeling integrated within QRM were AD&Co and QRM's internal models. ALM-IRR chose AD&Co because of more advanced modeling (e.g., Active-Passive Decomposition of the mortgage pool). Other models used within the bank, such as BlackRock and Moody's could not be integrated with QRM. AD&Co uses a non-linear regression procedure in the statistical software package SAS to estimate the prepayment model.

The table below details the investment portfolio and also depicts the portfolio distribution by book value, market value, DV01 (i.e. change in market value corresponding to 1bps change), and Convexity01 (i.e. change in DV01 corresponding to 1bps change) as of July 30, 2015.

(in mm)	Book Value	Market Value	Economic Value	OAD	Convexity
Agency MBS Fixed Rate					
FHLMC	12,871	13,005	13,050	3.5	(0.39)
GNMA	1,476	1,486	1,499	3.0	(0.07)
FNMA	15,453	15,608	15,643	3.4	(0.47)
Agency MBS Float Rate					
FHLMC	190	200	203	1.1	(0.00)
GNMA	8	9	9	1.2	0.00
FNMA	278	292	297	1.0	0.00
Agency CMO Fixed Rate	4,487	4,509	4,532	3.6	(0.30)
Agency CMO Float Rate	10,160	10,192	10,243	0.4	(0.31)

Compared with other industry models, e.g. BlackRock Aladdin Prepayment, the AD&Co prepayment model employs an enhanced approach, the Active-Passive Decomposition (APD) method, to simulate path-dependent effects, e.g., burnout or "catch-up" for prepay-penalty pools. The main idea behind APD is to separate borrowers into two distinct groups: active and passive. Active borrowers are more sensitive to refinance opportunities and are more likely to prepay to take advantage of a lower interest rate, a more favorable loan type, or to cash out on

the equity built up on their home. Passive borrowers are much less sensitive to refinance opportunities. It is further assumed that there is no migration between active and passive borrowers. AD&Co uses a non-linear regression procedure in the statistical software package SAS.

For non-agency RMBS, ALM-IRR uses the AD&Co Loan dynamics model ("LDM") integrated with QRM and Intex. LDM is a loan level model that dynamically models prepayments, defaults, and severities by transitioning the loans through different states (e.g., current, delinquent, default). Transition probabilities between states are differentiated between loan types, issuers, and vintages. Non-agencies account for \$2.63 billion in book value as of June 30, 2015, which is less than 1% of BNY assets. Alt-A MBS book value is \$1.3 billion, Prime MBS - \$900 million, and Prime MBS - \$430 million.

For detailed documentation of the prepayment models , refer model 2433 and 2434.

7.4.6 The Interest Rate Model - Shifted Log Normal Model

The QRM system is set up to use the one-factor shifted lognormal (SLN) model.

$$d\ln(r + \gamma) = [\Theta(t) - \alpha \ln(r + \gamma)]dt + \sigma dW$$

where,

- r is the short rate;
- γ is calibrated shift parameter;
 - $\Theta(t)$ is the drift adjustment to ensure arbitrage free. It is derived by make the zero bond prices observed on the market arbitrage free.
 - α is the calibrated mean reversion speed.
 - σ is the calibrated volatility.

Let $r = e^u - \gamma$, then μ is a single factor stochastic variable that evolves as a function of time according to the following partial differential equation:

$$du = [\Theta(t) - \alpha u]dt + \sigma dW$$

The shifted log normal model has three parameters:

- o The shift parameter (γ),
- o mean reversion speed (α) and
- o volatility (σ).

BNY Mellon parameterized QRM to calibrate the shift, mean reversion and volatility parameters from observed market prices. These three parameters are constant, i.e.; not time dependent. The market price / Black volatilities of the swaptions and caps are input into the model and the constant mean reversion parameter and relative volatility are calibrated from these prices. There are 196 swaptions and 160 caps used in the calibration. The shifted lognormal model has the probability of producing negative rates, because $r = e^u - \gamma$.

Shifted Lognormal Calibrated Parameters

	March	April
Sigma	26.29%	23.93%
a	5.97%	4.93%
Gamma	2.39%	

There are a number of advantages in using the one-factor short rate models. The most important is that the models are generally more tractable and very amenable to numerical and Monte Carlo simulations. They price option-imbedded positions much more quickly than the multiple factors models. This is important for balance sheet management purposes, when many positions need to be evaluated frequently. The weakness of the one-factor short-rate models is that it implies that movements across the entire term structure are perfectly correlated.

7.4.7 QRM OCI Calculations

For a detailed description of the QRM structure of the OCI forecasting model, please see the document Model 2122 – Other comprehensive income projections for the Investment portfolio.

7.5 Appendix Historical Market Data

Current Coupon – Current Coupon Rate (CCR) and **OAS** both involve finding a yield after removing the embedded-option value. OAS is a constant spread added to the spot yield curve to equate the model price to the market price. In computing CCR the yield curve is held constant and the cash flow stream is adjusted by adjusting the mortgage rate. The fair loan condition requires that at the origination of the loan the present value of the mortgage cash flows (PV(CF)) minus the value of the prepayment option (PP) equals the initial principal payment (BB).

The mortgage rate that satisfies this condition in the current interest rate environment is called the **Current Coupon Rate**.

$$PV(CF) - PP = BB$$

To achieve this equality, the term PV(CF) is adjusted because PP and BB are fixed at loan origination. The adjustment to PV(CF) is accomplished by leaving the current yield curve intact but changing the mortgage rate, thus changing the CF stream. Over time, as the mortgage seasons, the yield curve evolves, and so must the current coupon rate. This is in contrast to the existing mortgage rate, which is fixed since origination or since the most recent re-financing negotiation. The difference between the two rates is one of the factors that determine the incentive function in the prepayment. The general definition of "current coupon" in finance is the coupon rate that makes the instrument sell at par. In some cases that is interpreted as an interpolation, in some cases as the closest coupon with liquid trading in the market (usually you use the coupon with the highest price less than or equal to par, rather than the closest coupon).

Mortgage Rates

For the Supervisory CCAR exercise, Federal Reserve provides only the 30Y Mortgage Rate forecasts. AD&Co provided guidance on the custom CCY forecast for 15Y mortgage rate using 30Y mortgage rate (based on linear regression). The 20Y mortgage rates were derived by linear interpolation of the 15Y and 30Y mortgage rates. Linear function provided by AD&Co to derive 15Y rates from 30Y rates:

$$pmtg_15[i] = 1.0637 * pmtg_30[i] - 0.9151$$

7.6 Appendix Valuation Systems

Asset Type	Macro-economic variables input to valuation engine	Cashflow projections (deterministic/stochastic)	Prepayment Models	Default Models	Associated Model Names & Number
Agency MBS	Interest rates, OAS , Mortgage rates, HPI	Stochastic	AD&Co FixedMBS (Fixed), AD&Co Unified (float)		AD&Co Prepayment Model For Agency MBS & CM0 (2433), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
CDO/CLO	Interest rates, Credit spreads	Deterministic	CLO OTTI Model	CLO OTTI Model	OTTI for Collateralized Loan Obligations(2130), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet
Agency CMBS	Interest rates, Credit spreads	Stochastic	QRM Constant Hazard Rate Model		Behavior Model for CMBS_QRM(2402), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Non Agency CMBS	Interest rates, Credit spreads	Deterministic	CMBS OTTI Model	CMBS OTTI Model	OTTI for US ABS, US CMBS and Foreign RMBS(2454), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
ABS	Interest rates, Credit spreads	Deterministic	ABS OTTI Model	ABS OTTI Model	OTTI for US ABS, US CMBS and Foreign RMBS(2454), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Non-Agency RMBS	Interest rates, HPI, Credit spreads	Stochastic	LoanDynamics Model (AD&Co)	LoanDynamics Model (AD&Co)	Behavior Model for Non-Agency MBS(2434), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Foreign RMBS	Interest rates, Credit spreads, FX rates	Deterministic	Foreign RMBS OTTI Model	Foreign RMBS OTTI Model	OTTI for US ABS, US CMBS and Foreign RMBS(2454), NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Corporate/ Covered Bond	Interest rates, Credit spreads, FX rates	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Municipal Bond	Interest rates, Credit spreads	Callable- Stochastic (lattice), Non Callable - Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Sovereign Bond	Interest rates, Credit spreads ,FX rates	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
US Treasuries	Interest rates	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Agency Debentures	Interest Rates, Credit Spreads	Callable- Stochastic (lattice), Non Callable - Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Mutual Money Market Funds	Interest rates	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502), Money Market Break-the-Buck(2401)
ABCP	Interest Rates, Credit Spreads	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Supranational Bonds	Interest rates	Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)
Common Equity		Deterministic			NII forecast & Balance Sheet Valuation QRM (2359), Economic Paramter Projections (2399), Balance sheet forecast (2502)

Notes:

- FixedMBS is an AD&Co pool level prepayment model for fixed coupon collateral.
- Unified is an AD&CoAD&Co pool level prepayment model for floating coupon collateral.
- Constant Hazard Rate Model is QRM's CMBS model.
- The AD&Co Non Agency LoanDynamics model is used for private label RMBS issuance.

The Future Market Value configuration in QRM enables the calculation of the market value of securities at future time steps through a full revaluation. Risk factors input to the OCI Valuation model include

- Interest rate
- Foreign exchange rates
- Credit spread/option-adjusted spread shocks
- Asset class specific factors – Mortgage rates, HPI

The incremental change in Accumulated Other Comprehensive Income ("AOCI") in every period is driven by change in the mark-to-market of the securities in the portfolio and reflects changes due to amortized cost (including amortization and accretion), both on existing and new instruments per the growth and reinvestment plan consistent with the BNY Mellon balance sheet forecast.

The QRM interest rate model for valuation³¹ is one-factor shifted lognormal as documented in section 7.4.6

Securities without optionality and prepayment risk

Majority of BNY Mellon bond and obligations portfolio has no optionality and prepay risk. This includes Corporate Bonds, Covered Bonds, non-callable Municipal Bonds, Sovereign Bonds, Supranational Bonds and non-callable Agency Debentures. Cash flow projections for these security types are deterministic driven by interest rate forecasts (scenario specific interest rates for floating rate securities). The projected cashflows are discounted using the net discount rate³² at every future instance.

$$MV = \sum_i [CF_i \times e^{-(r_i + MTMspread_t)}]$$

Where,

³¹ QRM Market Valuation and Interest Rate Models are documented in Model 2359

³² Discount curve for municipals includes the BAU Muni curve with shocks to benchmark US Treasury curve. Details are documented in Section A of Model 2122- OCI Projections for Investment Portfolio

- $(r_i + \text{MTMSpread})t_i$ is the Discount Curve $[i] = \text{Underlying Yield Curve } [i] + \text{OAS/credit_spread}[i]$

Where $\text{OAS/credit_spread}[i] = \text{OAS/credit_spread_shock } [i] + \text{OAS/credit_spread } [0]$

$\text{OAS/Credit_spread } [0]$ is the spot MTM spread.

- CF_i is the sum of cash flows in period i
- r_i is the spot rate of period i from the discounting yield curve, in the format of continuous compounding;
- t_i is the time length to period i , in the format of year.

In the current market valuation, the market price is input to the valuation engine to calculate the Option Adjusted Spreads (OAS)/Mark-to-Market (MTM) spread using the current market configuration. During future valuation, the forecasted shock to the credit spread/OAS is input to the model and the market price is determined using the projected OAS/MTM spread along with the future market configuration (interest rate, exchange rate, mortgage rate and HPI assumptions). The QRM framework reports mark-to-market gain/loss (Clean Market Value – Book Value) for each AFS security while taking into account the effect of the outstanding principal in each period.

Securities with optionality and no prepayment risk

BNY Mellon portfolio with optionality and no prepay risk is limited to callable municipal bonds and agency debentures. For callable bonds, the cashflows are driven by short rate lattice tree interest rate modelling. QRM uses a trinomial lattice tree³³ with standard backward pricing method. The lattice is calibrated to the current (market) term structure of interest rates.

The revaluation of securities at each point in the projection horizon is same as defined above using the cashflows with call optionality.

Securities with prepayment risk

BNY Mellon structured securities portfolio includes Agency MBS & CMO, CLO, CMBS, Non-Agency RMBS, ABS and Foreign MBS. Behavioral assumptions for the Agency RMBS (prepayment) and Non Agency RMBS (prepayment, default and severity) portfolio are modeled using AD&Co models. Agency CMBS (prepayment) is modeled using the QRM CHRM model.

³³ Additional details on the QRM Lattice tree is attached in the appendix

Behavioral assumptions for other credit sensitive structured securities (ABS, International RMBS, CLO and CMBS) are derived from the corresponding OTTI forecasting (i.e. Model #2454 and #2130) and integrated into QRM-FMV framework for OCI calculation. The cash flow for these security types incorporates the behavioral assumptions driven by scenario specific macroeconomic inputs (interest rates, asset specific factors such as HPI, Mortgage rates)³⁴. These cashflows are forecasted at each point in the projection horizon, and discounted using the net discount rate. The revaluation of securities at each point in the projection horizon is same as defined above using the dynamic cashflows and full Monte-Carlo simulation (300paths)³⁵.

Refer to Model 2122 documentation for details on the OCI valuation engine.

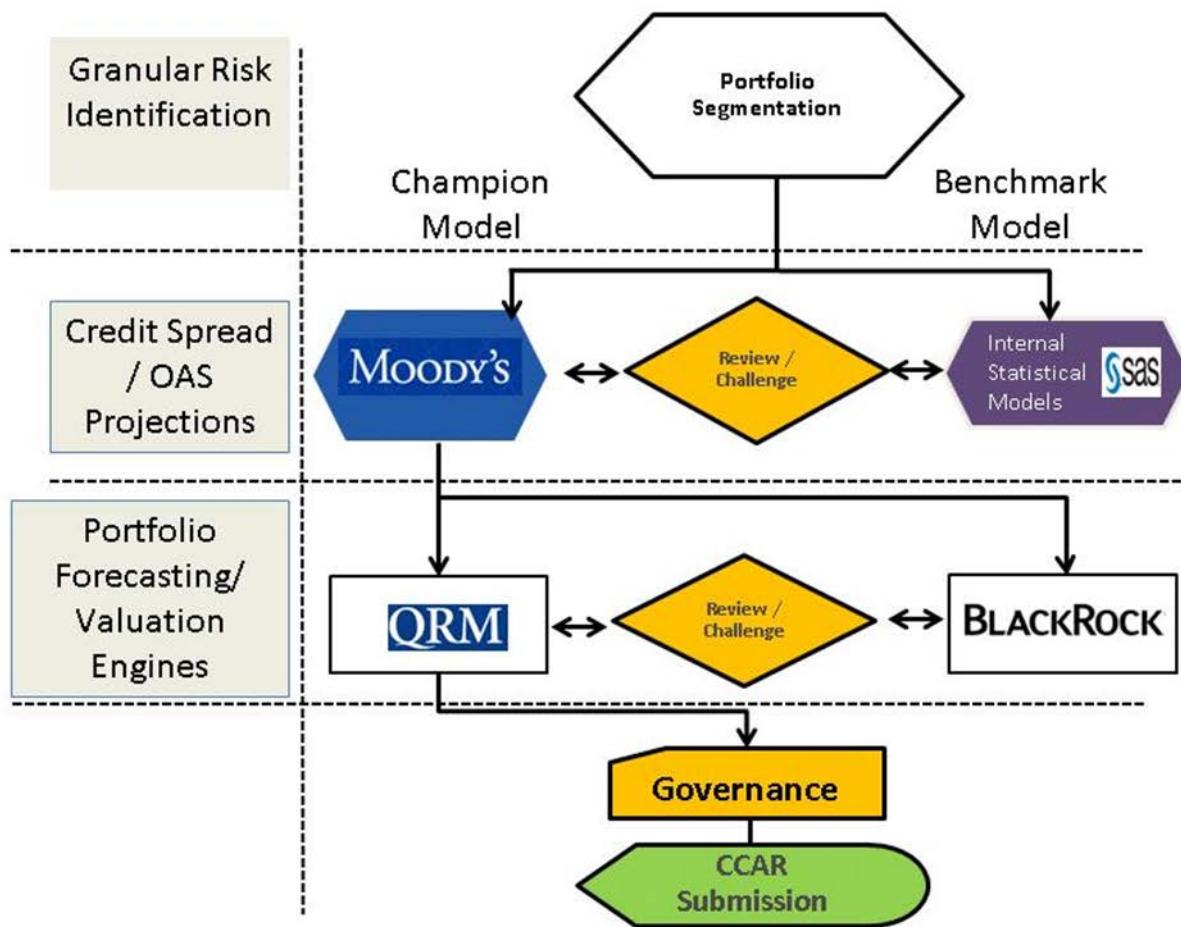
7.7 Appendix Investment Portfolio OCI Modelling Flow Chart

Primary and Benchmark Design and Flow Chart

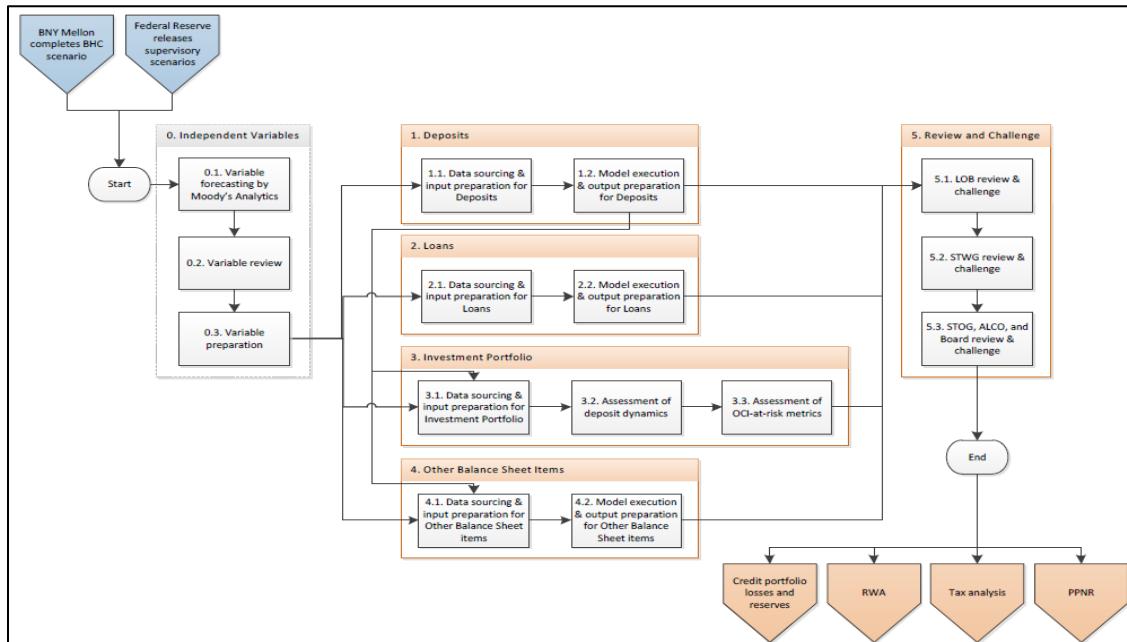
³⁴ For detailed documentation on behavioral models, refer Models 2433, 2434, 2402, 2130, 2454

³⁵ Details in documentation for Model 2359 and 2122

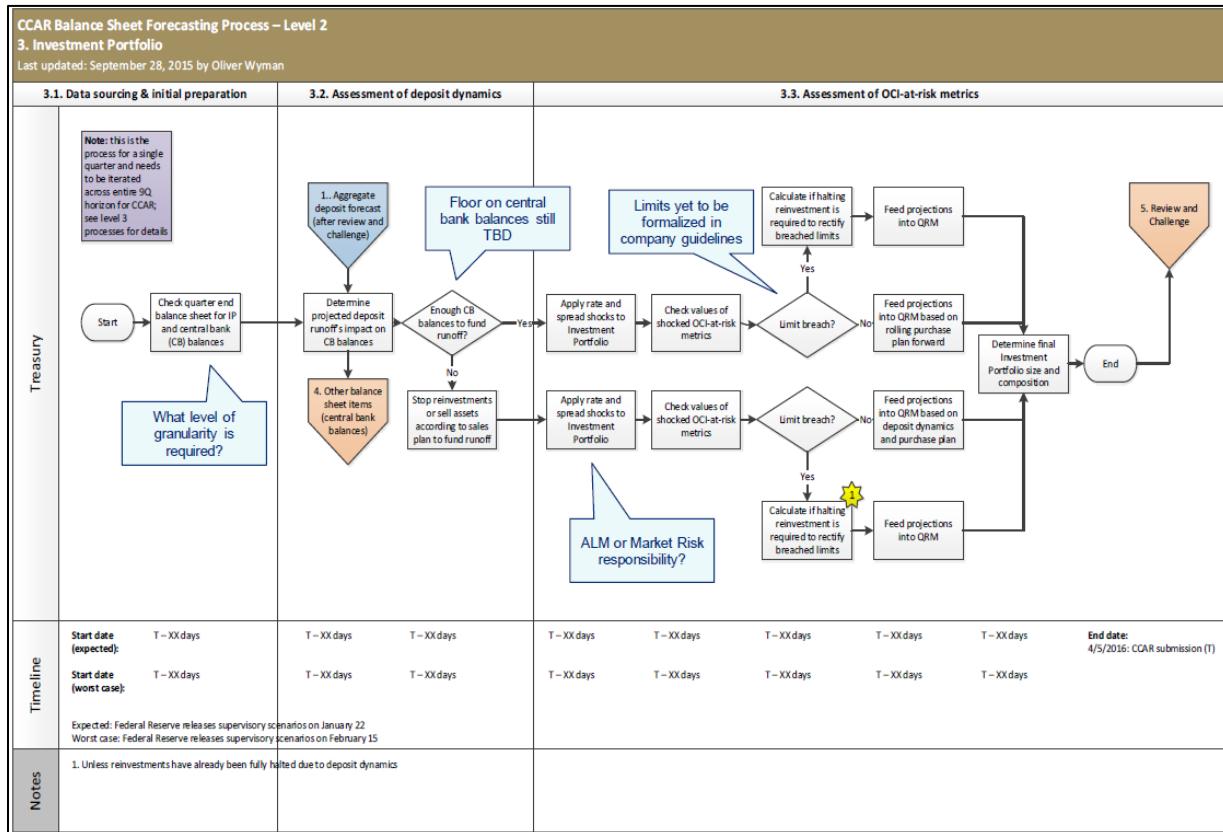
Investment Portfolio OCI Modeling Framework



Level 1 balance sheet forecasting process flowchart



Level 2 draft process: 3. Investment Portfolio



7.8 Appendix OCI Modeling Project 2016

BNYM's Granular and Rigorous CCAR OCI Modeling Process

Action plan for developing an enhanced fair value estimation framework



- Identify granular segments to adequately capture specific risks inherent in the investment portfolio
- Assess materiality, QRM (future market value calculator) operational feasibility, and confirm segmentation
- Identify data sources/vendors
- Finalize segmentation
- Establish a database to capture and store market data
- Develop champion and challenger frameworks that project spreads using forecasted economic drivers
- Revise based on analytical results
- Present results through governance structure

BNYM has resources dedicated to building, documenting, operating, and maintaining the new framework.

7.9 Appendix Moody's Analytics US Agency RMBS OAS Projection Methodology

Executive Summary

- BNY Mellon's investment portfolio has been segmented at a granular level to approximately capture risks embedded in various asset classes
- Moody's analytics is developing statistical models to project credit spread/OAS for each granular portfolio segment
- BNY Mellon has sourced and provided relevant historical data to Moody's for conducting the statistical models
- U.S. Agency RMBS represents 31% of BNY Mellon investment portfolio as of date June 2015

- Moody's has developed a two stage regression process for modeling US Agency RMBS OAS, which is detailed here

The Moody's Analytics

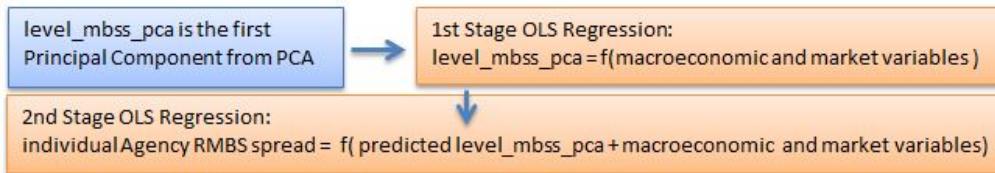
Statistical Methodology – US Agency RMBS OAS

Two Stage Regression:

In this statistical model US Agency RMBS OAS projection methodology is decomposed into two stages: In the first stage, overall market trend of Agency RMBS spreads is forecasted. In the second stage, the market trend projection is incorporated to predict different Agency RMBS spreads. Overall market spread trend captures RMBS spreads' prevailing curve due to econometric and market dynamics. Based on the overall trend, each spread's idiosyncratic variation is further specifically projected by their different characteristics such as maturities, coupon rates and government sponsored enterprise sources. For example, 15 Year versus 30 Year, current coupon versus coupon rate of 3.5, and Freddie Mac versus Fannie Mae.

10 different Agency RMBS OAS data series are considered to derive a market trend representative index, which is used as the dependent variable of first stage regression. Boyarchenko 2014 introduced a market value-weighted index based on the universe of outstanding Agency MBS Pass-through in the Federal Reserve Bank of New York Staff Reports no. 674. Similar to this fixed income indices idea, in this model a representative index is constructed using principal component analysis (PCA) that is further described in the next section. Principal component analysis is applied on the 10 different Agency RMBS OAS data series, and the first principal component is used as an approximation of the overall market spread trend (titled 'level_mbss_pca' in the below chart). In this first stage regression, level_mbss_pca is the dependent variable and macroeconomic and market indicators are independent variables. Maximum Likelihood is the estimation approach.

Using the projected market trend from the first stage, another linear regression is employed to predict individual Agency RMBS spreads. Our predictions were preceded based on the historical patterns exhibited by the relationship between the individual spreads and the trend line we created in the first stage. For each spread, different macroeconomic variables are utilized to extrapolate its variation from predicted market trend. Through these explicit macroeconomic drivers, idiosyncratic variation of each spread is clearly explained.



In a summary, as shown in above chart, this projection methodology for US Agency RMBS OAS is based on a two stage regression, by incorporating principal component analysis to generate the approximation of overall spread market trend. Next two sections will give more details on principal component analysis and variable selection process in the two stage linear regressions.

Principal Component Analysis

Principal Component Analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. It uses an orthogonal linear transformation that transforms the data into a new coordinate system such that the greatest variance by some projected repetition of the data comes to lie on the first coordinate(first principal component), the second greatest variance on the second coordinate, and so on. The eigenvalue corresponding to the first principal component is the largest eigenvalue of data's covariance matrix. And the ratio of the largest eigenvalue divided by sum of all eigenvalues illustrates how much variation can be explained by this first principal component. PCA is commonly used variable dimension reduction technique as well.

Variable Selection

In the above two stage regression processes, a key aspect is variable selection to identify which core driver best explain the dynamic behavior of the dependent variable. Aligned with principles of modern econometrics, here the approach towards variable selection is based on a combination of economic theory or intuition, regulatory assumptions, and a consideration of the statistical properties of the estimated model. For models built using pure data-mining techniques or principles such as machine learning, though they may fit the existing data well, are more likely to fail in a changing external environment because they lack theoretical underpinnings. Below is the variable selection procedure to find the best performing model in any given iteration of the process where the models are compared:

- Identify potential drivers to enter the model based on macroeconomic intuition and consistency with regulatory assumptions. An example of such intuition in variable

selection would be an instance where the best drivers based on the statistical results could be 1m Libor rate, PRA-provided 3m Libor rate, and monetary policy rate. Although bringing in any of these three drivers makes little difference to the model's statistical power, there is a large difference in the PRA-provided forecasts of the Libor versus policy rate. Ensuring the models are in line with regulatory assumptions and are intuitive are key considerations during model building.

- Based on potential drivers selected in the first step, best subset selection procedure is then applied, and up to three core drivers are selected, which should not be highly correlated with each other. Here a maximum correlation of ± 0.75 between drivers was imposed. In this best subset selection procedure, all possible combinations of available variables are tested, including all lag combinations up to two quarters. This ensures that the tested variables are explored as thoroughly as possible. And in the selected drivers, all the coefficients must be statistically significant at a 5% level, and the resulting coefficient estimates should have expected signs and magnitudes.
- From the models that pass the selection criteria presented above the best model is chosen by maximizing the ratio of adjusted R square to RMSE, where $Adj.R^2 = 1 - (1 - R^2) \frac{n-1}{n-m-1}$ and $RMSE = \sqrt{\frac{1}{n} \sum_1^n (y_i - \hat{y}_i)^2}$. While the adjusted R square describes the fraction of total variance explained by variation in the drivers considering the degrees of freedom of the regression equation, the RMSE captures the average deviation of estimates from observe values.

The final models selected by this search procedure are then reviewed for consistency with regulatory assumptions. The forecasts obtained should not be overly sensitive or dominated by any driver. And the forecasts pattern should be consistent with market expectation under regulatory assumptions.

As illustrated in previous sessions, the Moody's US Agency RMBS OAS projection methodology is developed based on a two stage regression. For each stage of regression, drivers are selected based on a combination of economic intuition, regulatory assumption and statistical robustness. The best prediction models employ a combination of statistical rigor with a healthy dose of economic principle. Hence our models combine expert judgment with statistical optimization. Models built this way enjoy the additional benefit of ease of interpretation. In the next section we use Fannie Mae 15 Year Current Coupon Spread as an example to illustrate.

Example: Fannie Mae 15 Year Current Coupon Spread

a. PCA and overall market spread trend

Principal component analysis is applied on 10 Agency RMBS spread data series from Jan.1990 to Jun.2015.

Principal components/covariance	Obs. =	127
	Comp. =	10
	Trace =	10
	Rho =	1

		Eigenvalue	Difference	Proportion	Cumulative
Eigenvalues	Comp1	7.66	6.51	0.77	0.77
Eigenvalues	Comp2	1.14	0.63	0.11	0.88
Eigenvalues	Comp3	0.51	0.23	0.05	0.93
Eigenvalues	Comp4	0.29	0.08	0.03	0.96
Eigenvalues	Comp5	0.21	0.11	0.02	0.98
Eigenvalues	Comp6	0.10	0.05	0.01	0.99
Eigenvalues	Comp7	0.05	0.02	0.01	1.00
Eigenvalues	Comp8	0.03	0.02	0.00	1.00
Eigenvalues	Comp9	0.01	0.01	0.00	1.00
Eigenvalues	Comp10	0.00	0.00	0.00	1.00

From the PCA result table, we can see the first two principal components explain 88% variation of overall data. And the second component has 6.51 eigenvalue difference from the first component, which means the first component explains the majority information of the overall spreads data.

Principal components (eigenvectors)

Variable	Comp1	Comp2	Unexplained	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp10
fhlmc_15y_45_2005	0.35	-0.10	0.00	-0.30	0.21	-0.02	-0.55	-0.49	0.07	-0.43
fhlmc_15y_50_2005	0.34	-0.26	0.00	0.00	0.26	-0.06	-0.41	0.28	0.00	0.67
fhlmc_15y_50_2008	0.32	-0.37	0.00	0.22	0.21	0.12	0.20	0.51	0.07	-0.54
fhlmc_15y_45_2009	0.31	-0.34	0.00	0.26	0.15	0.40	0.39	-0.46	-0.05	0.23
fhlmc_15y_40_2010	0.31	0.14	0.00	-0.24	-0.40	0.40	-0.20	0.40	0.08	-0.02
fhlmc_30y_cc	0.28	0.41	0.00	0.57	-0.36	0.25	-0.21	-0.17	0.00	-0.01
fnma_15y_45_2005	0.33	-0.16	0.00	-0.34	-0.47	-0.28	0.36	-0.14	0.46	0.11
fnma_15y_35_2011_loas	0.28	0.50	0.00	0.22	0.42	-0.35	0.13	0.06	0.45	0.02
fnma_15y_40_2011	0.34	-0.07	0.00	0.17	-0.25	-0.59	0.03	0.01	-0.62	-0.07
fnma_30y_45_2005	0.29	0.45	0.00	-0.47	0.26	0.22	0.33	0.03	-0.43	0.04

From the table of PCA scoring coefficients, we can see for first component, scoring coefficient of different spread series is comparable from each other, showing it is a balanced information mixture. And we name this first principal component as level_mbss_pca.

b. 1st Stage Linear Regression

In this regression, dependent variable is the first principal component level_mbss_pca. A carefully chosen list of candidacy drivers based on economic intuition include: U.S. Fixed

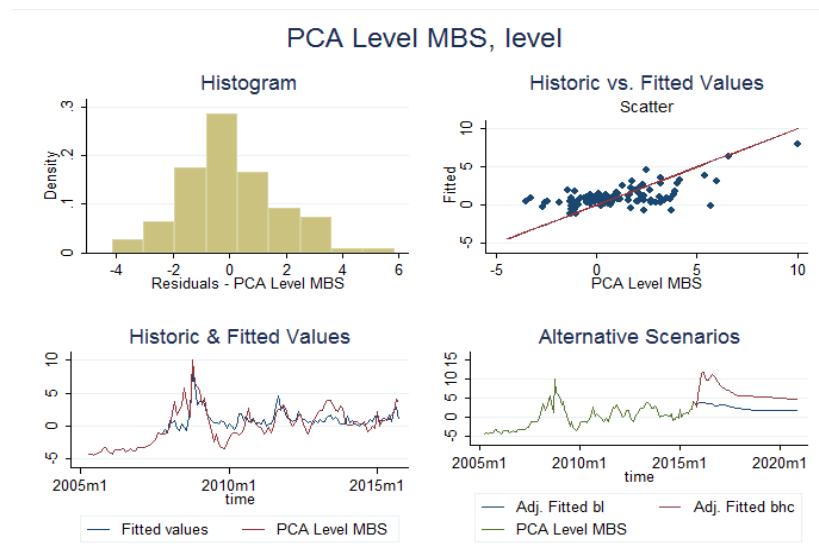
Effective Mortgage Rate, U.S. 1-Yr Adjustable Mortgage Rate, Global Equity Factor, Global Equity Volatility Factor, Global Growth Factor, US HPI growth rate, US GDP growth rate, spread of AAA Corporate Bond from 3m-Libor, spread of BAA Corporate Bond from 3m-Libor, spread of 10-Yr Interest Rate from 3m-Libor, spread of 30-Yr Interest Rate from 3m-Libor and spread of 10-yr Swap Rate from 3m-Libor. This list is then put through variable selection procedure described above in section 2.5.3 and 4.2.

The final drivers selected are Global Equity Volatility Factor (ff_gevf_bh) and Lag3 of U.S. 1-Yr Adjustable Mortgage Rate (us_adjustable_morate_bh). R square is 0.39 and adjusted R square is 0.38. Details about this final model can be seen in below regression result table.

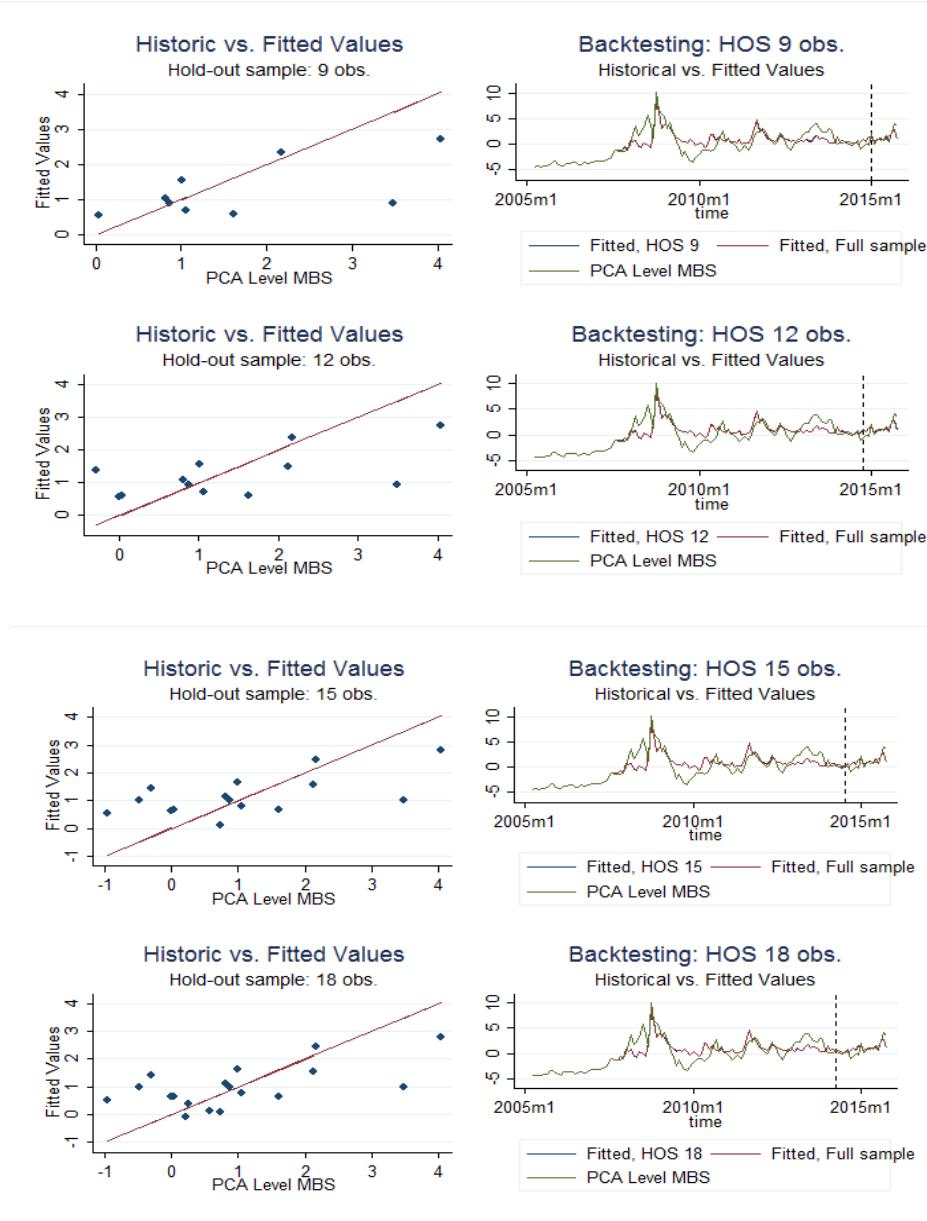
Implementation wise, Stata command ‘regress’ is used to estimate each linear regression model with robust standard errors. The model is built from September 2007 to October 2015. To correct for autocorrelation, Stata command ‘newey’ is used for different lags for autocorrelation. This Newey –West variance estimator is an extension that produces consistent estimates when there is autocorrelation in addition to possible heteroskedasticity.

	b	se	z	pvalue	ll	ul
ff_gevf_bh	0.91	0.14	6.26	0.00	0.62	1.19
L3.us_adj_morate_bh	-0.84	0.34	-2.50	0.01	-1.50	-0.18
_cons	4.05	1.08	3.75	0.00	1.93	6.16

From t statistics, we can see global equity volatility factor is the most influential factor on the overall spread level. US Housing Price has negative relationship with the overall market spread trend level_mbss_pca. Forecast curves of the target variable level_mbss_pca can be seen in below figures.



Model diagnostics results including Autocorrelation analysis, Heteroscedasticity test, Stationarity test, Sensitivity Test and Residual Diagnostics can be seen in the corresponding segment-level documentation. Below is the hold-out sample testing results:



c. 2nd Stage Linear Regression

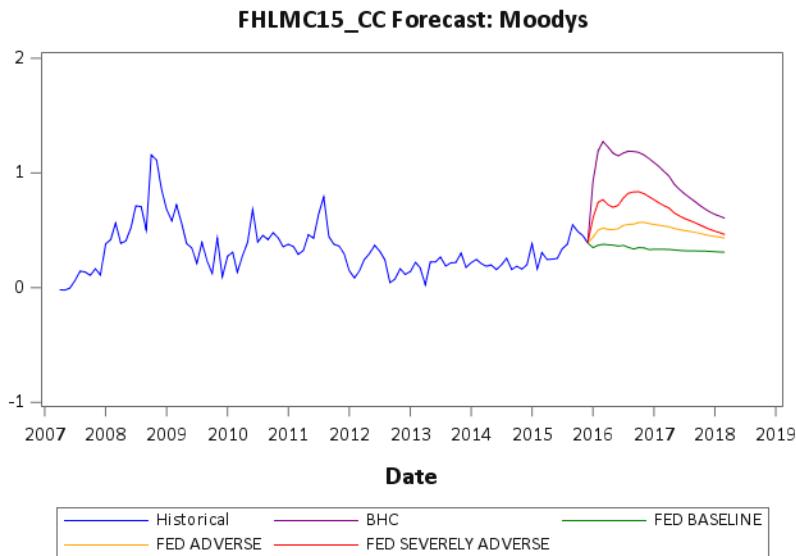
In this regression, dependent variable is the Fannie Mae 15 Year Current Coupon spread. A carefully chosen list of candidate drivers based on economic intuition include: level_mbss_pca, U.S. Fixed Effective Mortgage Rate, US HPI growth rate, US GDP growth rate, AAA Corporate Bond from 3m-Libor, spread of BAA Corporate Bond from 3m-Libor, spread of 10-Yr Interest Rate from 3m-Libor, spread of 30-Yr Interest Rate from 3m-Libor, spread of 10-yr Swap Rate

from 3m-Libor, Global Growth Factor, Global Equity Factor and Global Equity Volatility Factor. Up to lag 3 transformations of these drivers are considered.

The final drivers selected are predicted level_mbss_pca from 1st stage (ff_level_mbss_pca_bl), year over year growth rate of U.S. Housing Price (r12_us_hpi_bl) and Global Equity Volatility Factor (ff_gevf_bl). The model is built from September 2007 to October 2015. R square is 0.78 and adjusted R square is 0.78. Details about final model can be seen in below table.

	b	se	z	pvalue	ll	ul
ff_gevf_bhc	4.30	1.19	3.63	0.00	1.98	6.63
ff_pca_level_mbss_bhc	4.03	0.95	4.25	0.00	2.17	5.89
r12_us_hpi_bhc	-192.70	37.04	-5.20	0.00	-265.30	-120.10
_cons	20.61	1.49	13.87	0.00	17.70	23.53

Forecasts for the three Supervisory scenarios and BHC idiosyncratic Stress scenario can be seen in below charts:



Reference

Nina Boyarchenko, Andreas Fuster and David O. Lucca, "Understanding Mortgage Spreads" Staff Report No. 674, May.2014

7.10 CCAR 2016 Modeling Enhancements from CCAR 2015

For CCAR 2016, BNY Mellon developed an enhanced framework to model securities fair value estimation and supporting control, governance and documentation. The enhancements to the estimation of securities OCI included

- Granular forecasting of credit spreads specific to asset class to adequately capture specific risks inherent in the portfolio.
- Shocking the Option-Adjusted Spread ("OAS") for mortgage backed securities and collateralized mortgage obligations.
- Enhanced governance process and structure including segment level reviews for spread and OCI forecasts by the model owners together with the business subject matter experts and an independent team of risk managers.
- Significant documentation enhancements for future valuation methodology.
- Integrate dynamic behavioral cash-flow assumptions for credit sensitive structured securities including ABS, CLO, non-agency CMBS and foreign MBS from the models driving OTTI framework.
- New volume originations using representative cusips. This ensures the origination price is determined based on macroeconomic scenario.
- AFS OCI is directly output from QRM report, instead of using excel-based equations; this is a technique change.

The table below details the differences in credit/OAS shock approach between CCAR '16 and CCAR '15 for asset classes in the portfolio.

AFS Securities	Market Value (in millions \$)		OAS/Credit Spread Shock Approach	
	12/31/2015	9/30/2014	CCAR '16	CCAR '15
Agency MBS/CMO	23,514	29,599	Statistical model used to derive OAS shocks based on macroeconomic assumption inputs and individual segment characteristics MBS: Issuer, Term, Coupon, & Vintage CMO: Fixed/Float type, Cap for Floaters, WAL for Fixed ARM: Issuer	OAS not shocked
Agency Debentures	386	361	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as duration	OAS not shocked
Non-Agency RMBS	2,538	3,453	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Collateral Type and Original Rating	Corporate Bond spreads based on current rating
Municipal Bond	4,045	5,170	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Muni Type (Revenue/GO), Industry Type for Revenue Bonds (Transportation, Utility etc), Credit Rating	Corporate Bond spreads based on current rating
Sovereign Bond (ex. Germany & UK)	8,759	9,795	Statistical model used to derive credit spread shocks based on macroeconomic inputs from scenario and individual segment characteristics such as Currency and Country of Risk	No spread shock applied
CLO	2,351	2,489	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Credit Rating of security	Corporate Bond spreads based on current rating
CMBS	5,412	4,831	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics Agency CMBS: Issuer Non-Agency CMBS: subordination, Vintage	Corporate Bond spreads based on current rating
ABS	2,893	3,029	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as deal type (Auto, Student Loan, etc)	Corporate Bond spreads based on current rating
Corporate Bond	1,930	1,550	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Currency and Credit Rating	Corporate Bond spreads based on current rating
Covered Bond	2,172	3,400	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Currency and Country of Risk	Corporate Bond spreads based on current rating
Foreign RMBS	1,104	1,928	Statistical model used to derive credit spread shocks based on macroeconomic assumption inputs and individual segment characteristics such as Country of Risk and Issuing Currency	Corporate Bond spreads based on current rating
US Treasuries, Germany & UK Sov.	17,167	26,910	No spread shock applicable	No spread shock applicable
Mutual Fund	887	938	"Break the buck" analysis	"Break the buck" analysis
Other (ABCP, Supranational)	2,709	2,106	Statistical model used to derive credit spread shocks for ABCP based on macroeconomic assumption inputs and individual segment characteristics	No spread shock applied
TOTAL	75,867	95,559		

7.11 Appendix Reference Documents

The below referenced documents are available in the BNY Mellon document library

- Model 2122 : Other Comprehensive Income Projections for Investment Portfolio
- Model 2433 : Prepayment Model for Agency MBS, CMO and Whole Loan Mortgages (AD&Co Prepayment)
- Model 2434 : Behavior Model for Non-Agency MBS (AD&Co LDM)
- Model 2402 : Behavior Model for CMBS
- Model 2399 : Moody's economic scenario data
- Model 2502 : Stress testing Balance sheet Forecasting Model
- Model 2454, 2130: Other than temporary impairment models
- Model 2359 : NII Forecasting& Balance Sheet Valuation Model (QRM)

Additional Attachments:

- QRM Short Rate Model for Shifted Lognormal
- BlackRock OCI Modelling framework (benchmark)
- Internal credit spread modeling document (spread projections for investment portfolio under macroeconomic scenario)
- A summary for Moody's economic data (#2399) specific to OCI credit spreads