XIX.1.3.b. Market Risk (Model - 2290 Market Risk RWA)

BNY Mellon made projections of regulatory market risk risk-weighted assets over the nine quarter projection period using a modified version of its Monte Carlo VaR process. This process relied on aggregated sensitivities of the Firm's trading portfolio for all risk factors used in its production VaR ("VaR RF") calculation as inputs for determining forward VaRs.

The basic construction was to define two proxy mappings for each VaR RF one to drive changes to level of the instruments whose pricing uses the risk factor, and a second to determine changes to the sigma parameters defining the simulation dynamics of that risk factor at future quarterly time points. Once price level and the sigma parameter was established, a Monte Carlo process was used to generate 1,000 one-day forward simulation paths (consistent with BNY Mellon's production VaR calculation) to determine a forward VaR for the future quarterly date being considered. The proxies referenced the list of macroeconomic factors provided to the Market Risk Management team for the four CCAR scenarios.

The sensitivities considered were delta and gamma for individual risk factors. Within individual interest rate term structures, cross-gammas between points were specifically considered. Also vega was considered. The correlation matrix that determined the joint dynamics of the risk factors under simulation were based on the historical cross-factor correlations from the VaR calibration period being used. For regular VaR, this was the two-year period ending on September 30, 2014. For SVaR, this was the one-year period ending on September 30, 2012. These calibration periods are consistent with those used in BNY Mellon's production VaR processes as of the starting date of the projections.

Additionally, standardized charges were estimated based on projections of changes to market values of instruments subject to this charge. Therefore, if the forecast determined in a subsequent quarter that market value for the equity portfolio increased 10%, the standardized charge for this portfolio was increased 10% from the level assessed as of September 30, 2014.Additionally, BNY Mellon computes a very small "de minimis" charge for its regulatory RWA calculations. For purposes of CCAR forecasts, the de minimis charge was held constant over the nine quarters of projections.The combination of the forecasted VaR, SVaR, standardized charges and the de minimis amount taken together within the regulatory RWA formula defined the projected RWA result.

XIX.1.3.b.1. Projection Summary

The Market Risk Management Group ("MRM") made forecasts of market risk RWA for the Firm's trading portfolio for each of the four specified scenarios - three supervisory and one bank holding company stress ("BHC Stress") scenarios. The forecasts were based on forward estimates of one-day value-at-risk (VaR) and one-day stressed VaR ("SVaR") using portfolio sensitivities mapped to the macroeconomic risk factors provided in the scenarios from which new pricing levels and simulation dynamics were derived.

The projections took advantage of the Firm's production regulatory VaR setup but with some modification to support the particular constraints inherent to the CCAR scenario definitions and the forward-looking projection process. Full methodology definitions are provided Section XIX.1.3.b.3.

The table below presents the RWA results.

Table 60: Market Risk RWA ($ in Billions)

Market Risk RWA - Total Company										
	2014		**2015**				**2016**			
($ in Billions)	**3Q**	**4Q**	**1Q**	**2Q**	**3Q**	**4Q**	**1Q**	**2Q**	**3Q**	**4Q**
Supervisory Baseline	$3.49	$3.61	$ 3.5	$ 3.5	$3.56	$3.61	$3.65	$3.64	$3.72	$3.72
Supervisory Adverse	$3.49	$3.96	$4.23	$4.38	$4.39	$4.42	$4.45	$4.36	$4.29	$4.29
Supervisory Severely	$3.49	$ 5.4	$4.97	$5.46	$ 5.5	$ 5.2	$4.53	$4.07	$3.78	$3.58
BHC Stress	$3.49	$ 4.4	$4.97	$5.46	$5.82	$5.89	$5.51	$5.07	$4.67	$4.35

The BHC Stress Scenario produced the most severe increase, causing market risk RWA to peak at $5.89 Billion in Fourth Quarter 2015. The supervisory Severely Adverse Scenario was next most severe, peaking at $5.50 Billion of RWA in Third Quarter 2015. This compares to a starting point reported RWA of $3.49 Billion as of Third Quarter 2014.

Based on post-processing analysis, we found that these results were particularly driven by sensitivities and shifts attributed to EUR and municipality interest rates, equity volatilities, and USDEUR FX spot rates.

To baseline the VaR results underlying these RWA calculations, we start by noting that one-day VaR on 9/30/2014 for BNY Mellon was $4.26 Million. The SVaR on this date was $7.44 Million based on a calibration on the one-year period ending 3/30/2012.

The projected values for one-day VaR and SVaR are presented in the table below.

Table 61: Bank Holding Company One-Day VaR and SVaR Capital Projections for CCAR Scenarios (in $Millions)

	One-Day VaR				One-Day SVaR			
	Baseline	**Adverse**	**Severely Adverse**	**BHC stress**	**Baseline**	**Adverse**	**Severely Adverse**	**BHC stress**
3Q14	$ 4.26	$ 4.26	$ 4.26	$ 4.26	$ 7.44	$ 7.44	$ 7.44	$ 7.44
4Q14	$ 4.89	$ 5.74	$ 10.50	$ 7.52	$ 7.88	$ 10.72	$ 17.30	$ 13.11
1Q15	$ 4.51	$ 6.76	$ 9.99	$ 9.14	$ 7.44	$ 12.53	$ 16.01	$ 16.87
2Q15	$ 4.30	$ 7.04	$ 13.04	$ 10.83	$ 7.75	$ 13.90	$ 17.60	$ 19.62
3Q15	$ 4.31	$ 7.27	$ 13.83	$ 11.85	$ 8.36	$ 14.20	$ 17.38	$ 21.83
4Q15	$ 4.31	$ 6.94	$ 13.10	$ 12.24	$ 8.91	$ 15.18	$ 15.60	$ 22.23
1Q16	$ 3.96	$ 7.22	$ 10.02	$ 11.40	$ 9.71	$ 15.43	$ 12.87	$ 19.88
2Q16	$ 3.82	$ 7.15	$ 8.09	$ 10.51	$ 9.83	$ 14.99	$ 10.75	$ 16.98
3Q16	$ 3.92	$ 6.94	$ 7.12	$ 9.11	$ 10.47	$ 14.87	$ 9.03	$ 14.94
4Q16	$ 3.85	$ 6.89	$ 6.19	$ 8.08	$ 10.58	$ 15.07	$ 8.02	$ 13.20

The most severe one-day VaR was under the Severely Adverse Scenario which peaked at $13.83 Million in Third Quarter 2015. Second most severe was under BHC Stress Scenario, peaking at $12.24 Million in Fourth Quarter 2015. The most and second largest SVaR results were $22.23 Million (4Q15) under BHC Stress Scenario and $17.60 Million under Severely Adverse Scenario (2Q15).

For SVaR, the initial set of volatilities and correlations of risk factors was taken from the stressed period used to calibrate the production SVaR. As of 9/30/2014, this was the one-year calibration period ending on 3/30/2012. Because BNY Mellon's determination of the stressed calibration period is updated monthly with the possibility that the current VaR period overtakes the historical calibration period as being the "most stressed", the estimation process considered whether the projected VaR over the nine quarters ever overtook the SVaR based on historical period, in which case, it would have been appropriate the substitute the SVaR estimate with the larger VaR estimate. This did not happen.

Specific Risk

Specific risk captures idiosyncratic risk tied to a particular security issuer that is unexplained by movements in the broader market. The Firm’s specific risk standard charge as of September 30,2014 was $162.1 Million made up of these components: $1.1 Million for sovereign debt positions, $39.2 Million for GSE debentures, $10.6 Million for depository institutions, $2.1 Million for public sector entity debt positions, $74.4 Million for corporate debt positions; and $34.7 Million for equity positions. These numbers are additive to the capital.

Specific risk charges were projected forward based on the market value changes implied by the application of risk factor sensitivities to the macro scenarios. The relative change of the market value of

portfolios subject to standardized charges was directly applied to the charge assessed as of 3Q 2014. The projected equity and interest rate specific charges are presented in the table below.

Table 62: Equity and Interest rate specific charges projections (in $Millions)

	Equity Specific Charges				Interest Rate specific Charges			
	Baseline	Adverse	Severely Adverse	BHC Stress	Baseline	Adverse	Severely Adverse	BHC Stress
Q3 2014	$ 34.69	$ 34.69	$ 34.69	$ 34.69	$ 128.12	$ 128.12	$ 128.12	$ 128.12
Q4 2014	$ 35.07	$ 32.93	$ 29.05	$ 24.08	$ 127.22	$ 122.70	$ 125.30	$ 127.22
Q1 2015	$ 35.49	$ 31.39	$ 21.19	$ 20.21	$ 125.69	$ 118.61	$ 124.31	$ 125.73
Q2 2015	$ 35.93	$ 30.00	$ 17.28	$ 17.38	$ 124.59	$ 116.13	$ 123.89	$ 125.40
Q3 2015	$ 36.39	$ 28.80	$ 14.87	$ 15.59	$ 123.04	$ 113.53	$ 123.67	$ 124.97
Q4 2015	$ 36.86	$ 27.57	$ 14.59	$ 14.25	$ 121.45	$ 111.07	$ 124.19	$ 124.67
Q1 2016	$ 37.33	$ 26.69	$ 15.41	$ 13.81	$ 120.05	$ 109.18	$ 124.77	$ 124.83
Q2 2016	$ 37.82	$ 26.17	$ 16.29	$ 14.04	$ 118.89	$ 107.26	$ 125.61	$ 125.18
Q3 2016	$ 38.32	$ 25.76	$ 17.77	$ 14.41	$ 117.31	$ 105.66	$ 126.39	$ 125.85
Q4 2016	$ 38.83	$ 25.42	$ 19.54	$ 14.93	$ 116.39	$ 103.95	$ 126.82	$ 126.38

De Minimus Charge

The final addition to capital is that of the *de minimis* charge, which was $5.2 Million as of Third Quarter 2014. This charge captures small risk impacts not covered by the main VaR model. This amount was held constant over the nine projection quarters across the four scenarios.

Risk-Weighted Assets

Currently, BNY Mellon uses a backtest multiplier of 3, and reports 10-day VaR and Stressed VaR by scaling the one-day amounts by the square root of time. Given the results for one-day VaR, one-day Stressed VaR (SVaR), specific risk standard charge and de minimus charges, the following formula was applied to derive forward RWA:

RWA=12.5 · [3 · SQRT(10) · (VaR + SVaR) + SpecificRiskStandardCharge + DeMinimisCharge]

XIX.1.3.b.2. Assumptions & Methodology

VaR and Stressed VaR

The methodology used to calculate market risk RWA is based on a Monte Carlo simulation of all risk factors underlying BNY Mellon's portfolio. The Monte Carlo process computes VaR and Stressed VaR using portfolio sensitivities (i.e., “delta-gamma” VaR).

The calibration of the simulation parameters parallels production regulatory processes, and uses two years (500 days) of historical data for VaR and one year (250 days) of "stressed period" data for Stressed VaR. The model accounts for approximately 5,000 interest rate, FX and equity risk factor points.

The forecasted risk factors provided in the supervisory and bank holding company ("BHC") scenarios were used to generate forecasts for all of the risk factors underlying BNY Mellon's calculation of VaR. Proxy mapping definitions were used to define driving risk factors for each of the VaR risk factors.

Two mappings were defined for each risk factor - one to drive the level of the risk factor over the projection period and a second to load the sigma parameter of the risk factor used in the simulation of VaR at future quarterly steps. Additionally, the historical correlations - calibrated to the historical calibration period and which was assumed to stay constant over time - was used to generate the joint risk factor distribution which then became the basis for the final VaR and Stressed VaR computations.

The key components of the methodology are:

- Framework to generate forecasts for all risk factors underlying BNY Mellon's portfolio and their volatilities;
- Delta, Gamma sensitivity calculations for the trading portfolio for all underlying risk factors;
- Delta, Gamma VaR calculation based on forecasted risk factors and their volatilities;
- Simulation engine to generate joint distribution of the risk factors based on a correlation matrix, levels and sigma parameters.

The approach uses an "invariance of Greeks" assumption, meaning, the first and second order sensitivities of the portfolio with respect to the underlying risk factors are assumed to remain unchanged over time. This assumption relies on the basic premise that hedging regimes currently in effect and which are expressed in the net sensitivities in the current portfolio will remain in place over time.

Factor levels and their sigma parameters for forward-time simulations are permitted to change according to the changes to the proxy factors defined in the four scenarios.

In formulaic terms, the VaR simulation process operates as described here:

$$\mathbf{SimRet}_{\mathbf{Qi}} = \boldsymbol{\sigma}_{\mathbf{projected}} \cdot \boldsymbol{\sigma}^{-1} \cdot \mathbf{R} \cdot \mathbf{W}^{0.5} \cdot \mathbf{N}$$

where,
$\mathbf{SimRet}_{\mathbf{Qi}}$ = Simulated VaR risk factors returns for forward quarter i (size = Number of Simulation Paths[1,000];
$\boldsymbol{\sigma}_{\mathbf{projected}}$ = Diagonal matrix with projected volatilities based on proxy factor changes for VaR risk factors;
$\boldsymbol{\sigma}^{-1}$ = Inverse of the original calibrated diagonal volatility matrix;
$\mathbf{R}$ = Historical returns of VaR risk factors over calibration period (size = Number of Risk Factors * Number of Historical Dates);
$\mathbf{W}^{0.5}$ = Diagonal matrix of normalized exponential weights, as used in production VaR. The weighting factor is 0.993 where "normalized" means the weights have been scaled to sum to 1.00;
$\mathbf{N}$ = Matrix of independently-generated random standard normal variables (size = Number of Historical Dates * Number of Simulation Paths[1,000]);

We also note the following related properties of this formulation:

The variance-covariance matrix ("VCV") and R are related: $\mathbf{VCV} = \mathbf{R} \cdot \mathbf{W} \cdot \mathbf{R}^{T}$
$\mathbf{SimRet}_{Current} = \mathbf{R} \cdot \mathbf{W}^{0.5} \cdot \mathbf{N}$

And as a confirmation of the logic of the $\text{SimulateReturns}_{Qi}$ formulation, we provide the following:

$\mathbf{SimRet}_{Current} \cdot \mathbf{SimRet}_{Current}^{T} = \mathbf{R} \cdot \mathbf{W}^{0.5} \cdot \mathbf{N} \cdot \mathbf{N}^{T} \cdot \mathbf{W}^{0.5} \cdot \mathbf{R}^{T} = \mathbf{VCV}$
$\mathbf{SimRet}_{Qi} \cdot \mathbf{SimRet}_{Qi}^{T} = \boldsymbol{\sigma}_{projected} \cdot \boldsymbol{\sigma}^{-1} \cdot (\mathbf{R} \cdot \mathbf{W}^{0.5} \cdot \mathbf{N} \cdot \mathbf{N}^{T} \cdot \mathbf{W}^{0.5} \cdot \mathbf{R}^{T}) \cdot \boldsymbol{\sigma}_{projected} \cdot \boldsymbol{\sigma}^{-1} = \mathbf{VCV}_{Qi}$

where,
$\mathbf{VCV}_{Qi}$ = Variance-covariance matrix for projected quarter i.

The projected SimRet_{Qi} vectors define shifted risk factor values which are used to reprice the trading portfolio. These repriced trades and positions determine a final P/L vector which is sorted to determine VaR or SVaR.

Standardized Charge

Standardized charges for equity and interest rate products are forecast through a separate process. Equity standard charge forecasts are based on the percentage change to equity price levels as determined by the VaR projection methodology. That is, if the VaR projection process forecasts the equity portfolio price level to increase 10% in the subsequent quarter, the the standardized charge is increased 10% for that quarter. The Dow Jones Index forecast in the four scenarios was used to drive the set of equity price risk factors.

The interest rate standardized charge - which covers sovereign, government-sponsored entity, depository institution, public sector and corporate fixed income products - the market value was forecast on a similar basis. The percentage change was calculated as the market value change of the portfolio relative to its current market value as determined by the driving sensitivities and the changes to the proxy factors from the four scenarios. In particular, the change in value of the fixed income portfolio was set to the sum of sensitivities of the driving risk factors multiplied by the corresponding changes in these risk factors as driven by the proxy factors provided in each scenario.

Computational Process

More specific steps used to compute RWA projections can be described as follows:

Step 1: Get the forecasts for the levels of the risk factors (“core risk factors” or "CRF") defined in the four CCAR scenarios;

Step 2: Define mappings of all VaR risk factors to CRFs for the purpose of levels projection;

Step 3: Define a second set of mappings of all VaR risk factors to a CRF for purposes of projecting the sigma parameters of the factor to be used in forward simulations of VaR. For this purpose, all equity prices were mapped to the S&P 500 VIX index and interest rates were mapped to swaption volatilities;

Step 4: Generate sensitivity shifts for all risk factors;

Step 5: Run RiskWatch (the production VaR re-pricing engine) re-pricings to get portfolio valuations for the sensitivity shifts;

Step 6: Calculate delta, gamma and cross-gamma sensitivities using RiskWatch re-pricing results;

Step 7: Calibrate a historical correlation matrix of risk factors to prepare for MC simulations of VaR. Generate MC random scenarios of the risk factor space using current levels. projected sigma parameters and the historical correlation matrix;

Step 8: For each projection up to nine quarters forward, do the following:

- Calculate shifts between projected and current value for all CRF (as either multiplicative or additive change);
- Calculate shifts in level and sigmas of all VaR risk factors by applying the appropriate shifts defined in the CCAR scenario CRF proxies.
- Re-scale MC scenario shift results from Step 7 above according to the shifts in levels and volatilities to obtain projected simulations;
- Calculate delta-gamma VaR by using the sensitivities and projected simulations;

Step 9: Enter the projected VaR (and stressed VaR - see below) into the post-processing spreadsheet, currently named "CCAR_Capital_Projections.xlsx". Input data is entered into the tab “input data”;

In order to calculate stressed VaR projections we repeat steps 1-8 above for the historical data for the “stressed period” identified by Quarterly studies.

Step 10: Take as inputs the most recent VaR, SVaR, and market risk standardized charge amounts for Equities, Sovereigns, GSE, depositary institutions, Munis, Corporates, as well as Credit standardized charge, and de minimis charges. These are provided by the Market Risk Monitoring Group;

Step 11: Projected VaR and stressed VaR values are normalized to the most recent regulatory filing amounts;

Step 12: Projected Equity and Interest rate standardized charges are normalized to the most recent regulatory filing amounts.

Step 13: Projected amounts are combined into RWA projections and tabs for FRY-14A forms are populated for each scenario.

Key Assumptions

The key assumptions for the market risk RWA projection model are listed below.

Portfolio-level net sensitivities are stable over time

The projections assume sensitivities of BNY Mellon's trading portfolio remain unchanged over time. More specifically, it assumes that though BNY Mellon's particular set of positions may change in the future, it will remain hedged in a way that keeps the degree of exposure to key risk factors on a netted

basis stable. Assuming the sensitivities to the market risk factors will remain unchanged allows us to preserve hedges in our forecast portfolio.

The correlation structure between risk factors are stable over time

The joint dynamics of the risk factors employed in CCAR are based on a correlation matrix computed from the historical calibration period used for the VaR or SVaR measurements. For VaR, this is the two years of historical data ending on 9/30/2014 and for SVaR, the one year of historical data ending on 9/30/2009. This correlation matrix is held constant for each of the quarterly forward time steps.

Mappings of VaR risk factors to the limited set of supervisory risk factors and bank holding company stress factors provides for reasonable and realistic risk factor shifts over the projection horizon

All VaR risk factors are mapped to two core risk factors ("CRF") provided in the supervisory scenarios and the bank holding company stress scenario - one representing a proxy of the risk factor itself (to drive the change in its level) and a second to a proxy of the sigma parameter of the risk factor (to use in forward-time VaR simulation). More specifically:

1. Each risk factor's level will be shocked, in relative or absolute terms depending on the assignment, by the same amount as the corresponding CRF to which it is mapped.

2. The sigma parameter of each risk factor will be shocked by the same amount as the market volatility time series provided in the CRF scenarios to which it is mapped.

For level mappings, changes to risk factor were based on MRM-assigned a shift-type definition - either additive or multiplicative.

For sigma parameter mappings, the shocks to sigma were always performed on a relative basis. For example, the relative change from the current sigma to the forecasted sigma for AAPL stock was set to the relative change in the proxy CRF VIX index supplied in each of the scenarios.

Because of the limited set of risk factors provided in the four macro scenarios and the great array of risk factors used in BNY Mellon's production VaR process, the proxy mappings were necessarily coarse in their construction. This methodology assumes these proxy settings and shift-type settings reasonably capture the behavior of the VaR risk factors at future time steps.

XIX.1.3.b.3. Progress Related to Remediation of MRAs, Observations & Common Themes

The Federal Reserve identified issues that BNY Mellon is required to address in order to meet supervisory expectations in its April 21 correspondence to us. Remediation of these elements, which were contained as the market risk elements of Comment 5 (Appropriateness of RWA Projection Assumptions), and Common Theme 7 (RWA Methodologies), were addressed through modeling changes developed for this year's estimates.

BNY Mellon received an MRA in response to last year's CCAR submission concerning the lack of risk factor specificity in the modeling of RWA. The previous forecasts relied on basic regressions of VaR results against macroeconomic factors provided in the CCAR scenarios.

As a response to that MRA, Market Risk Management developed a completely new modeling methodology for this year's forecasts as described in the previous sections. The model incorporates a much more granular consideration of portfolio dynamics - at the portfolio sensitivity level - and adjusts market value level and simulation sigma parameters based on changes suggested by the CCAR scenarios. It also incorporates a Monte Carlo VaR process based on these adjusted inputs that parallels the processed used in BNY Mellon's production VaR calculation.

This increases the number of risk factors dynamics permitted to contribute to forward RWA from just the three regression variables used previously to about 5,000 risk factors currently used for production VaR/ SVaR.

Additionally, we include market value-based projections of issuer related specific risk charges. As described in previous sections, the projected changes were based on forecasted changes to the market value levels of the portfolios the are subject to this charge.