



THE BANK OF NEW YORK MELLON

## **Model Documentation**

**Model Name:** Market Risk RWA (CCAR)

**Model ID:** 2290

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## Executive Summary

This model will be used for Capital Charge computation for the purpose of Comprehensive Capital Analysis and Review (CCAR).

The model calculates BNYM 1-day Value-at-Risk (VaR) and 1-day Stressed VaR based on the projections for the major macroeconomic risk factors provided by the Regulator (Federal Reserve). The model is based on Monte-Carlo (MC) simulation of all risk factors underlying BNYM portfolio and calculating VaR and Stressed VaR using the portfolio sensitivities (“delta-gamma” VaR).

The calibration of the MC simulation engine is based on 2 years of historical data over two years period preceding the effective date (VaR) and one year “stressed period” (Stressed VaR) identified during Quarterly Studies. The model covers interest rate, FX and equity risk factors.

The given forecast for the major risk factors is used to generate forecasts for all the risk factors underlying BNYM portfolio as well as their volatilities. This information in conjunction with historical correlations across all risk factors is used to generate the forecast for the joint risk factors distribution and use it for VaR and Stressed VaR computation.

For the purpose of CCAR we assume that projected sensitivities of BNYM portfolio to the underlying risk factors remain unchanged, i.e. for each forecast time horizon we use the sensitivities calculated on the “as of” date.

In addition to 1-day VaR and SVaR we forecast the equity and interest rate specific charges which are part of the Risk Weighted Assets (RWA) reporting. This is done using the above mentioned calculated sensitivities and the forecasts for the risk factors.

## Overview of Methodology

The key components of the methodology are the following:

- the framework to generate forecasts for all risk factors underlying BNNYM portfolio and their volatilities;
- Delta, Gamma sensitivities calculations for the BNYM portfolio with respect to 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 their correlations implied from historical data, levels and volatilities.

Since the regulatory requirements for CCAR are relatively new, there is no standard established yet in the financial engineering community for it. Presently it is hard to find what alternative approaches are being used by the other banks. The methodology suggested here allows for high degree of granularity with respect to handling underlying risk factors. The simulation engine employed by this approach is in line with BNYM methodology for calculating VaR and Stressed VaR.

We base our approach regarding BNYM portfolio composition at the future time horizons on a “greeks invariance” assumption. This means that the first and second order sensitivities of the portfolio with

respect to the underlying risk factors remain unchanged. This assumption implies that the hedges that are in effect presently will stay in place although the factors levels and their volatility will change according to the forecasts provided by the Regulator. The CCAR implemented framework allows for calculating 1-day VaR and SVaR for the portfolio constructed this way based on the forecasted scenarios.

The Risk Weighted Assets (RWA) is calculated using the formula below:

$$RWA = 12.5 \cdot [\text{Backtest Multiplier} \cdot \sqrt{10} \cdot (\text{VaR} + \text{SVaR}) + \text{Specific Risk Standard Charge} + \text{De Minimus Exposures}]$$

Currently, BNY Mellon uses a backtest multiplier of 3, and reports 10 day VaR and Stressed VaR by scaling by the square root of time.

Based on the definition provided by Basel II, specific risk represents risks caused by the idiosyncratic risk tied to a particular firm (but not related to general market movement). Specific risk is additive to the capital.

We generate forecasts for equity and interest rate standardized charges separately. The specific charges are calculated by BNYM Mellon according with Basel requirements and based on the mark-to-market values of the positions scaled by the regulator provided multipliers. For equity charge the projected value equals to today's value plus a percentage change. This percentage change is equal to the percentage change in the forecast for the driving equity risk factor provided by the Regulator for the corresponding scenario. In the 2015 exercise the Dow Jones Index forecast was used as equity driving risk factor. For the interest rate charge the forecasted value equals to today's value plus a percentage change. The percentage change is calculated as the market value change in the portfolio value relative to its Mark-to Market value at as-of-date. The portfolio value change is equal to the sum of sensitivities to driving risk factors multiplied by the corresponding changes in the driving risk factors provided by the regulator for a given scenario. According the "invariance of greeks" assumptions in our approach the sensitivities for the future forecast quarters are equal to the as-of-day sensitivities. The same set of sensitivities is used for the 1-day VaR and SVaR projection as well as for specific charges projection. The percentage change is obtained by dividing the change in the portfolio value by its mark-to market value.

## In-Scope Products and Processes

In scope processes are the following:

- forecast generation for the levels and volatilities for all risk factors underlying BNNYM portfolio via mappings to the core risk factors for which the forecasts are provided;
- Simulation of the risk factors based on their forecasted levels and volatilities and historically implied correlations;
- Delta, Gamma sensitivities calculation for the BNYM portfolio with respect to all underlying risk factors by generating specific one factor shift scenarios and running them through ALGO;
- Delta, Gamma VaR calculation based on forecasted risk factors and their volatilities;
- Forecast the specific charges for interest rates and equity.

## Model Inputs, Parameters, Assumptions and Qualitative Adjustments

Model inputs include the following:

- The forecasts for major macroeconomic factors provided by the Regulator (delivered in the form of spreadsheet);
- The forecasts for a few major risk factors provided internally (delivered in the form of spreadsheet);
- Historical data for all BNYM risk factors for correlation calibration (contained in a text files);
- End-of-day market data for all risk factors
- Sensitivities of BNYM portfolio to all underlying risk factors (calculated from RiskWatch (RW) valuations of BNYM portfolio for a set of specifically designed one-factor shift scenarios and contained in a text file);

The assumptions on which the CCAR model is based are listed below:

### Regarding portfolio composition at the future time horizon:

For the purpose of CCAR we assume that projected sensitivities of BNYM portfolio to the underlying risk factors remain unchanged, i.e. for each fore time horizon we use the sensitivities calculated on the “as of” date. Any assumption about future portfolio composition will be subjective and hard to justify. The rational for this assumption is that however BNYM portfolio might change in the future response to the changes in the market place, it will remain hedged with respect to its main driving factors similarly at it is at the “as-of-date”. Assuming the sensitivities to the market risk factors will remain unchanged allows us to preserve hedges in our forecast portfolio.

### Regarding risk factors forecast:

All BNYM risk factors (RF) are mapped to the core risk factors (CRF) for which the forecasts are provided. For each CRF the decision is made regarding how the shift (from current value to forecasted value) is applied to the risk factors mapped into this CRF, i.e. whether the change is treated as multiplicative or additive). The details of this mapping are given in this document.

### Regarding risk factors simulation:

The joint dynamics (cross correlations) of the risk factors in the Monte-Carlo engine employed in CCAR is based on the historical time period (last two years of data preceding the “as-of-date” for VaR and one year stressed period for Stressed VaR). The levels of the risk factors and their volatilities used in calculating risk measures at the future times will change as follows. For each risk factor its level will be shocked (in relative or absolute terms) by the same amount as the corresponding “Core (or major) Risk Factor” it is mapped to. The volatility of each factor will also be shocked by the same amount as the Core risk Factor this volatility is mapped to. Therefore two types of mapping are provided for each risk factor – one for levels and one for volatility forecasted value calculation. In the 2015 CCAR exercise the volatilities for all equity risk factors were mapped S&P500 volatility, and the volatilities for all remaining risk factors were mapped to a USD swaption volatility. The volatility shocks for all factors were performed on the relative basis. For example, the relative change from the current volatility value to the forecasted volatility value for AAPL stock volatility is equal to the relative change from the current S&P500 volatility value to its forecasted value.

## Description of Calculations

The RWA projections calculation are described in “CCAR desktop procedure” document. A detailed description of the inputs is presented in Appendix C.

## Calibration Procedures

Calibration procedure involves using historical data for a specified period to identify common set of dates for which historical data is available for the majority of the RF, calculating returns for these RF over the common dates, performing regression analysis for the rest of RF with missing data and identifying the RF that are treated as idiosyncratic risks in MC simulations.. This process is described in detail in reference [1].

## Theoretical Analysis

The suggested CCAR approach is based on the following assumptions:

- The portfolio sensitivities at the projection horizon are the same as its sensitivities at the “as-of-date”;
- The correlations across RF at the projection horizon are the same as in the calibration period (two years preceding the “as-of-date” for VaR and one year of the identified stress period for Stressed VaR);
- The projected values for all risk factors are set based on the changes (additive or multiplicative) in the projected CRF and specified mappings as described in Appendix A.

The assumption regarding the portfolio composition at the projected time horizon is central to the approach. The invariance of the Greeks approach that we chose to employ expresses the view that well hedged BNYM portfolio will remain as such under the forecasted scenarios. The implemented framework, however, is perfectly capable of handling different assumptions regarding the portfolio composition in the future. Given a portfolio composition at a future time horizon we can repeat the calculation steps 1, 2, and 6 and obtain the portfolio valuations based on forecasted RF directly from RW. Calculation sensitivities, DeltaGamma VaR and rescaling VaR will be redundant steps in the case.

The goal of CCAR requirement for a bank is to demonstrate its ability to calculate risk measures based on the projected values for the risk factors at the future dates. The current approach achieves this goal by introducing a flexible framework with high granularity with respect to the risk factors underlying BNYM portfolio. The simulation engine is very similar to the production simulation engine currently used by BNYM and is described in [1].

## Model Outputs Testing

Scenario generation testing is documented in [1].

### Sensitivity and Delta-Gamma VaR Calculation Testing

As described in Appendix B the sensitivities of a given portfolio to the underlying risk factors are calculated by processing the valuation results of the portfolio for the shift scenarios designed for this purpose. In each of such scenarios either a single RF shifted by 0.0001 (for the purpose of delta calculation) or a pair of RF shift either in one or in opposite directions (for the purpose of gamma and cross gamma calculation).

Below we show a few examples of testing sensitivity and DeltaGamma VaR starting with relatively simple BNYM sub-portfolios.

The test 1 was performed for a portfolio of cash FX positions, FX\_NOSTRO\_Trading\*FX\*NYC. The risk factors for this portfolio are FX rates for a number of currencies versus USD. In this case gamma sensitivities are zero and delta sensitivities should be equal to the corresponding currency amount. The results confirm the expected, the sensitivities are exactly equal to the currency amount for each of the underlying risk factors. The Table 1 below presents the theoretical value, currency amount and VaR from the production run as well as delta sensitivities, end-of-day values, historical volatilities and VaRs from the tested model. The total VaR for this sub-portfolio is \$889.607 K versus \$1.024M in production.

Table 1: FX Cash portfolio (FX\_NOSTRO\_Trading\*FX\*NYC)

Currency	Production			Calculated				Difference		
	Theo Value	Currency Amount	VaR	Delta	EOD	Hist Vol	VaR	Delta (relative)	VaR differer	VaR Relative Differen
AED	753,356	2,767,036	-33	2,767,040	0.272	0.03%	-33	0.0002%	0	0.00%
ARS	22,215	187,296	-205	187,296	0.119	11.06%	-387	0.0001%	-182	-47.11%
AUD	29,137,003	31,360,983	-436,372	31,361,000	0.929	6.88%	-392,221	0.0001%	44,151	11.26%
BBD	11,130	22,351	-75	22,351	0.498	0.10%	-1	0.0003%	73	0.00%
BDT	188,947	14,656,592	-710	14,656,600	0.013	2.12%	-630	0.0001%	79	0.00%
BGN	8,595	13,025	-69	13,025	0.660	5.11%	-66	0.0000%	3	0.00%
BHD	169,094	63,748	-85	63,749	2.653	0.34%	-79	0.0001%	7	0.00%
BMD	2,111,836	2,111,836	0	2,111,840	1.000	15.87%	0	0.0002%	0	0.00%
BRL	-17,341	-39,329	-296	-39,329	0.441	9.62%	-236	0.0000%	59	0.00%
BWP	42,484	382,644	-370	382,644	0.111	5.43%	-301	0.0000%	70	0.00%
CAD	36,112,078	39,596,110	-379,920	39,596,100	0.912	5.34%	-375,905	0.0000%	4,015	1.07%
CHF	6,683,591	6,245,893	-89,804	6,245,890	1.070	5.87%	-82,228	0.0000%	7,576	9.21%
CNY	3,107,630	19,083,203	-5,878	19,083,200	0.163	1.36%	-5,896	0.0000%	-18	0.00%
COP	0	502	0	502	0.001	6.02%	0	-0.0040%	0	0.00%
CRC	81,268	43,873,578	-857	43,873,600	0.002	6.60%	-781	0.0000%	76	0.00%
CZK	309,942	6,632,571	-3,134	6,632,570	0.047	6.57%	-2,907	0.0000%	227	7.79%
DKK	2,402,270	13,855,515	-19,445	13,855,500	0.173	5.08%	-17,893	-0.0001%	1,551	8.67%
EGP	60,332	431,532	-121	431,531	0.140	1.31%	-115	-0.0001%	6	0.00%
EUR	13,227,785	10,249,433	-137,666	10,249,400	1.291	5.12%	-131,445	-0.0003%	6,221	4.73%
FJD	66,345	123,651	-573	123,651	0.537	4.93%	-476	-0.0001%	97	0.00%
GBP	2,321,913	1,440,547	-24,584	1,440,550	1.612	4.85%	-23,042	0.0002%	1,542	6.69%
GHS	150,852	555,890	-5,875	555,890	0.271	30.16%	-6,605	0.0000%	-730	-11.06%
GNF	0	15	0	15	0.000	15.87%	0	0.0000%	0	0.00%
GTQ	0	-1	0	0	0.130	15.87%	0	0.0000%	0	0.00%
HKD	1,339,815	10,384,655	-333	10,384,700	0.129	0.16%	-320	0.0004%	13	0.00%
HRK	140,385	829,064	-1,287	829,065	0.169	5.56%	-1,136	0.0001%	151	13.26%
HUF	663,433	161,878,063	-9,040	161,878,000	0.004	8.19%	-7,640	0.0000%	1,400	18.32%
IDR	91,621	1,076,945,207	-1,196	1,076,950,000	0.000	15.87%	-2,037	0.0004%	-842	-41.31%
ILS	274,203	988,464	-1,996	988,464	0.277	4.48%	-1,843	0.0000%	153	8.31%
INR	-115,007	-6,954,243	-1,242	-6,954,240	0.017	6.89%	-1,253	0.0000%	-11	0.00%
ISK	-47,593	-5,657,633	-470	-5,657,630	0.008	5.29%	-357	0.0000%	113	31.66%
JMD	54,925	6,182,636	-318	6,182,640	0.009	5.63%	-472	0.0001%	-153	-32.51%
JOD	3,821,938	2,702,874	-25,399	2,702,870	1.414	3.69%	-21,358	-0.0002%	4,041	18.92%
JPY	2,195,957	232,543,431	-38,351	232,543,000	0.009	6.07%	-34,901	-0.0002%	3,450	9.89%
KES	455,078	40,307,721	-2,067	40,307,700	0.011	2.64%	-1,849	-0.0001%	218	11.82%



KHR	0	0	0	0	0.000	15.87%	0	0.0000%	0	0.00%
KRW	410,819	420,868,434	-3,632	420,868,000	0.001	5.04%	-2,976	-0.0001%	656	22.04%
KWD	1,405,005	402,402	-2,989	402,402	3.492	1.30%	-2,590	0.0000%	399	15.39%
LKR	8,269	1,076,826	-18	1,076,830	0.008	1.21%	-16	0.0004%	3	0.00%
LTL	333,032	890,921	-2,750	890,920	0.374	5.13%	-2,458	-0.0001%	292	11.89%
MAD	1,271,060	10,945,221	-9,559	10,945,200	0.116	4.72%	-8,830	-0.0002%	729	8.26%
MUR	547,889	16,984,534	-4,097	16,984,500	0.032	4.95%	-4,319	-0.0002%	-222	-5.13%
MXN	30,377	399,005	-307	399,005	0.076	6.05%	-258	0.0000%	48	0.00%
MYR	1,108,617	3,518,169	-8,948	3,518,170	0.315	4.89%	-7,654	0.0000%	1,293	16.90%
NAD	67,413	728,391	-1,033	728,391	0.093	9.40%	-878	0.0000%	155	17.68%
NGN	48,988	7,948,054	-359	7,948,050	0.006	4.49%	-315	-0.0001%	44	0.00%
NOK	8,164,753	51,670,209	-85,450	51,670,200	0.158	6.76%	-77,856	0.0000%	7,594	9.75%
NZD	2,916,099	3,519,674	-38,149	3,519,670	0.829	7.35%	-30,448	-0.0001%	7,701	25.29%
OMR	1,055,958	406,538	-146	406,538	2.597	0.07%	-105	-0.0001%	41	0.00%
PEN	92,655	264,605	-490	264,604	0.350	3.48%	-449	-0.0002%	42	0.00%
PGK	102,717	41,267	0	41,267	2.489	15.87%	-2,495	0.0000%	-2,495	-100.00%
PHP	2,883,523	125,726,352	-19,552	125,726,000	0.023	4.23%	-18,621	-0.0003%	931	5.00%
PKR	225,700	23,045,144	-1,291	23,045,100	0.010	4.78%	-1,594	-0.0002%	-303	-18.99%
PLN	2,265,136	7,338,485	-27,718	7,338,490	0.309	6.93%	-23,428	0.0001%	4,290	18.31%
QAR	2,100,000	7,646,668	-391	7,646,670	0.275	0.11%	-310	0.0000%	82	0.00%
RON	418	1,429	-4	1,429	0.292	5.99%	-4	-0.0126%	0	0.00%
RSD	3,643	335,903	-35	335,903	0.011	5.86%	-30	0.0000%	5	0.00%
RUB	4,156,160	154,038,848	-58,073	154,039,000	0.027	8.82%	-50,337	0.0001%	7,736	15.37%
SAR	79,385	297,739	-6	297,739	0.267	0.04%	-5	0.0000%	1	0.00%
SBD	32,856	4,539	0	4,539	7.239	15.87%	-828	-0.0004%	-828	-100.00%
SEK	2,087,673	14,839,944	-23,020	14,839,900	0.141	6.91%	-21,919	-0.0003%	1,101	5.02%
SGD	1,016,458	1,278,142	-5,561	1,278,140	0.795	3.13%	-4,561	-0.0002%	1,000	21.91%
SZL	12,796	138,251	-191	138,251	0.093	9.43%	-171	-0.0001%	20	0.00%
THB	1,851,209	59,260,710	-12,209	59,260,700	0.031	4.01%	-10,801	0.0000%	1,408	13.03%
TND	-103,670	-183,195	-963	-183,195	0.566	5.33%	-828	0.0000%	135	16.34%
TRY	231,643	503,353	-3,337	503,353	0.460	9.08%	-2,968	-0.0001%	369	12.42%
TWD	-205,679	-6,170,500	-677	-6,170,500	0.033	1.91%	-560	0.0000%	117	20.93%
UGX	0	-139	0	-139	0.000	4.94%	0	0.0000%	0	0.00%
USD	4,074,492,045	4,074,492,045	0	0	0.000	15.87%	0	0.0000%	0	0.00%
UYU	47,650	1,145,975	-587	1,145,980	0.042	7.18%	-515	0.0004%	72	0.00%
VEF	4,696	29,547	-33	29,548	0.159	15.87%	-114	0.0006%	-81	0.00%
VND	7	144,900	0	144,900	0.000	15.87%	0	0.0000%	0	0.00%
XAF	0	-1	0	0	0.002	5.10%	0	0.0000%	0	0.00%
XCD	46,173	123,513	0	123,512	0.374	15.87%	-1,166	-0.0004%	-1,166	-100.00%
XPF	16,820	1,555,855	0	1,555,860	0.011	15.87%	-402	0.0003%	-402	-100.00%
ZAR	932,045	10,067,059	-14,229	10,067,100	0.093	9.49%	-12,284	0.0004%	1,946	15.84%
ZMW	30,768	186,610	-593	186,611	0.165	12.55%	-566	0.0003%	27	0.00%
<b>Total</b>	<b>4,215,597,185</b>		<b>-1,024,000</b>				<b>-889,607</b>		<b>134,393</b>	<b>15.11%</b>



Next we show the results for the portfolio of 6 FX European options shown in Table 2a, (FX\_OTC\_OPTION\_EUROPEAN\*Trading\_FX\*NYC). The Delta and Gamma sensitivities for this portfolio are shown in Table 2b. The resulting VaR for this triple is 10% different from the production VaR. The difference of such order is expected between DeltaGamma and full revaluation VaR.

Table 2a: FX\_OTC\_OPTION\_EUROPEAN\*Trading\_FX\*NYC portfolio composition

Maturity	Theo Value	Model Delta	Currency1	Cur1Amt	Currency2	Cur2Amt	Strike Price	Forward Rate	Call Option	VaR
9/12/2014	66,545	-0.8075	CAD	10,900,000	USD	-10,000,000	0.9174311927 USD	1.0965	FALSE	-53,925
9/12/2014	294,291	-0.9998	CHF	9,070,000	USD	-10,000,000	1.1025358324 USD	0.9345	FALSE	-122,434
9/12/2014	134,524	-0.9290	JPY	1,045,000,000	USD	-10,000,000	0.009569378 USD	105.8950	FALSE	-109,725
10/3/2014	7	-0.9982	MXN	131,570,222	USD	-10,000,000	0.07600504 USD	13.1570	FALSE	-7
10/3/2014	29,888	-0.9999	SGD	12,537,000	USD	-10,000,000	0.7976389886 USD	1.2575	FALSE	-29,888
9/12/2014	423,988	1.0000	USD	13,330,000	EUR	-10,000,000	0.7501875469 EUR	1.2906	TRUE	-145,901
<b>Total</b>	<b>949,244</b>									<b>-366,000</b>

Table 2b: Sensitivities and DeltaGamma VaR

	EOD	Hist Vol	Delta	Gamma	VaR
:FXCAD	0.9187	5.34%	-8,819,760	473,900,000	-59,229
:FXCHF	1.0741	5.87%	-9,068,440	660,000	-122,384
:FXJPY	0.0095	6.07%	-943,375,000	1,507,520,000,000	-108,201
:FXMXN	0.0766	6.05%	-65,703,800	1,312,710,000,000	-1,638
:FXSGD	0.7977	3.13%	-12,535,600	0	-45,582
:FXEUR	1.2956	5.12%	-9,999,960	10,000	-139,349
<b>Total</b>					<b>-326,676</b>

Test 3 presents the results for all FX triples. The results confirm that the sensitivities and DeltaGamma VaR numbers are correct.

Table 3: FX portfolios triples DeltaGamma VaRs versus production, in \$1000

Portfolio	Production	DeltaGamma VaR	Difference	Relative Difference
FX_FUTURE*Trading_FX*NYC	-228.00	-152.12	75.88	-33.28%
FX_NOSTRO*BNYMI*BNE	-2.00	-2.81	-0.81	0.00%
FX_NOSTRO*Offshore_Funding*IBF	-7.00	-5.80	1.20	-17.19%
FX_NOSTRO*Trading_FX*BRU	-15.00	-12.60	2.40	-15.97%
FX_NOSTRO*Trading_FX*FRA	-19.00	-18.81	0.19	-1.00%
FX_NOSTRO*Trading_FX*HON	-764.00	-699.85	64.15	-8.40%
FX_NOSTRO*Trading_FX*LON	-343.00	-295.24	47.76	-13.92%
FX_NOSTRO*Trading_FX*NYC	-1,024.00	-889.61	134.39	-13.12%
FX_NOSTRO*Trading_FX*SEO	-44.00	-40.20	3.80	-8.63%
FX_NOSTRO*Trading_FX*SHA	-30.00	-26.34	3.66	-12.19%
FX_NOSTRO*Trading_FX*SIN	-10.00	-8.94	1.06	-10.61%
FX_NOSTRO*Trading_FX*SOF	-7.00	-6.47	0.53	-7.63%
FX_NOSTRO*Trading_FX*SYD	-10.00	-8.75	1.25	-12.48%
FX_NOSTRO*Trading_FX*TAI	-30.00	-28.41	1.59	-5.31%
FX_NOSTRO*Trading_FX*TOK	-1.00	-0.61	0.39	-38.95%
FX_NOSTRO_SR*EQD*Derivative_Trading	1.00	0.00	-1.00	0.00%
FX_OTC_OPTION_AMERICAN*FXD*Derivative_Trading	-125.00	-149.13	-24.13	0.00%
FX_OTC_OPTION_AVERAGE_RATE*FXD*Derivative_Trading	-175.00	-196.59	-21.59	0.00%
FX_OTC_OPTION_BARRIER_DOWN_OUT*FXD*Derivative_Trading	-2.00	-1.97	0.03	0.00%
FX_OTC_OPTION_EUROPEAN*FXD*Derivative_Trading	-93.00	-76.87	16.13	-17.35%
FX_OTC_OPTION_EUROPEAN*IRD-LTFX*Derivative_Trading	-1,231.00	-1,246.40	-15.40	0.00%
FX_OTC_OPTION_EUROPEAN*Trading_FX*NYC	-366.00	-326.61	39.39	-10.76%
FX_SPOTFWD*FXD*Derivative_Trading	-119.00	-112.55	6.45	-5.42%
FX_SPOTFWD*Offshore_Funding*IBF	-7.00	-5.26	1.74	-24.89%
FX_SPOTFWD*Trading_FX*BRU	-20.00	-14.94	5.06	-25.29%
FX_SPOTFWD*Trading_FX*HON	-754.00	-717.61	36.39	-4.83%
FX_SPOTFWD*Trading_FX*LON	-638.00	-515.36	122.64	-19.22%
FX_SPOTFWD*Trading_FX*NYC	-949.00	-751.35	197.65	-20.83%
FX_SPOTFWD*Trading_FX*SEO	-47.00	-43.65	3.35	-7.13%
FX_SPOTFWD*Trading_FX*TAI	-80.00	-68.78	11.22	-14.02%
FX_SPOTFWD*Trading_FX*TOK	-104.00	-84.86	19.14	-18.40%

In Test 4 we analyze sensitivities for the interest rate triple Swaption\*IRD-IRD\*Derivative\_Trading. The non-zero greeks are shown in the Table 4b. Table 4a presents the comparison in resulting VaR. The discrepancy with Production is 4.2%.

Table 4a: VaR comparison for triple Swaption\*IRD-IRD\*Derivative\_Trading: DeltaGamma vs full revaluation in Production, in \$1000s.

	Production	DeltaGamma	Relative Difference
Swaption*IRD-IRD*Derivative_Trading	-15,584	-16,244	4.24%

Table 4b: Swaption\*IRD-IRD\*Derivative\_Trading sensitivities to the underlying risk factors

Tenor #	Name	Mapping Type	Type	Currency	EOD value	Hist Vol	Delta	Gamma
8	:IREUR_Interbank	Not Mapped	IR_Curve	EUR	0.35%	3.13%	737,200	0
9	:IREUR_Interbank	Not Mapped	IR_Curve	EUR	0.46%	2.87%	21,899,700	-79,000,000
10	:IREUR_Interbank	Not Mapped	IR_Curve	EUR	0.73%	2.21%	-24,650	35,000,000
11	:IREUR_Interbank	Not Mapped	IR_Curve	EUR	1.16%	1.78%	-4,817,750	15,000,000
0	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.17%	1.92%	-586,200	0
1	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.17%	1.44%	1,426,800	0
2	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.18%	1.18%	133,750	1,000,000
3	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.18%	0.95%	18,903,000	378,000,000
4	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.18%	0.79%	-12,200,200	-1,493,000,000
5	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.18%	1.12%	-175,226,000	-8,448,000,000
6	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.19%	1.57%	-232,878,000	17,117,000,000
7	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.22%	1.96%	-457,500	-1,360,000,000
8	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.26%	2.09%	384,270,000	-72,798,000,000
9	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.39%	2.03%	280,506,000	-25,041,000,000
10	:IRJPY_Interbank	Not Mapped	IR_Curve	JPY	0.64%	1.59%	245,334,000	-18,486,000,000
0	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.23%	2.58%	-26,921,100	-58,000,000
1	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.23%	1.16%	33,934,300	680,000,000
2	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.24%	0.89%	-75,903,900	-25,973,000,000
3	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.28%	1.16%	34,914,200	-36,791,000,000
4	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.35%	1.54%	-1,458,690,000	-61,603,000,000
5	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	0.74%	2.52%	-1,004,540,000	-527,434,000,000
6	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	1.19%	2.50%	471,243,000	-523,528,000,000
7	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	1.58%	2.19%	1,260,460,000	-436,033,000,000
8	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	1.86%	1.98%	1,997,920,000	391,405,000,000
9	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	2.26%	1.56%	451,646,000	-1,348,800,000,000
10	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	2.64%	1.29%	6,614,000,000	613,079,000,000
11	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	2.83%	1.20%	2,342,520,000	-157,191,000,000
12	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	3.02%	1.13%	477,314,000	186,576,000,000
13	:IRUSD_Interbank	Not Mapped	IR_Curve	USD	3.31%	1.06%	2,376,840,000	-478,956,000,000
9	:IREUR_EIB3M	Proxied	IR_Curve	EUR	0.33%	2.87%	24,643,200	29,366,000,000
10	:IREUR_EIB3M	Proxied	IR_Curve	EUR	0.61%	2.21%	-27,333,000	86,001,000,000
11	:IREUR_EIB3M	Proxied	IR_Curve	EUR	1.04%	1.78%	-10,278,500	-4,400,000,000
5	:IRUSD_Interbank1	Proxied	IR_Curve	USD	0.64%	2.52%	-14,816,400	196,000,000
6	:IRUSD_Interbank1	Proxied	IR_Curve	USD	1.08%	2.50%	-85,699,200	7,909,000,000
7	:IRUSD_Interbank1	Proxied	IR_Curve	USD	1.46%	2.19%	19,761,200	-99,000,000
8	:IRUSD_Interbank1	Proxied	IR_Curve	USD	1.74%	1.98%	112,989,000	11,625,000,000
9	:IRUSD_Interbank1	Proxied	IR_Curve	USD	2.15%	1.56%	101,944,000	9,827,000,000
10	:IRUSD_Interbank1	Proxied	IR_Curve	USD	2.55%	1.29%	-5,323,100	-60,000,000
11	:IRUSD_Interbank1	Proxied	IR_Curve	USD	2.75%	1.20%	-6,022,750	-79,000,000
12	:IRUSD_Interbank1	Proxied	IR_Curve	USD	2.95%	1.13%	-41,916,000	-1,440,000,000
13	:IRUSD_Interbank1	Proxied	IR_Curve	USD	3.25%	1.06%	-68,947,500	-3,779,000,000

2	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.11%	1.18%	-400	0
3	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.11%	0.95%	-22,350	1,000,000
4	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.12%	0.79%	20,350	1,000,000
5	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.17%	1.12%	1,390,750	-3,000,000
6	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.23%	1.57%	4,541,950	-11,000,000
7	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.27%	1.96%	4,662,700	-14,000,000
8	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.28%	2.09%	5,939,900	-22,000,000
9	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.23%	2.03%	6,086,150	-29,000,000
10	:IRJPY_USDCC	Proxied	IR_Curve	JPY	-0.03%	1.59%	8,025,050	-87,000,000
4	:IREUR_USDCC	Proxied	IR_Curve	EUR	-0.10%	1.66%	-20,000	0
5	:IREUR_USDCC	Proxied	IR_Curve	EUR	-0.10%	2.41%	1,150,700	0
6	:IREUR_USDCC	Proxied	IR_Curve	EUR	-0.09%	3.33%	2,069,150	-999,999
7	:IREUR_USDCC	Proxied	IR_Curve	EUR	-0.03%	3.32%	1,855,000	0
8	:IREUR_USDCC	Proxied	IR_Curve	EUR	0.06%	3.13%	4,811,850	-11,000,000
9	:IREUR_USDCC	Proxied	IR_Curve	EUR	0.17%	2.87%	11,181,300	-31,000,000
10	:IREUR_USDCC	Proxied	IR_Curve	EUR	0.47%	2.21%	15,724,700	-29,000,000
11	:IREUR_USDCC	Proxied	IR_Curve	EUR	0.93%	1.78%	67,747,800	-702,000,000
0	:index_euro1	Not Mapped	IRCap_Vol	IO2	26.81%	1.12%	-291,083,000	-1,772,000,000
2	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.21%	4.28%	-7,579,300	2,000,000
3	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.20%	1.35%	-955,450	-999,999
4	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.19%	1.66%	-171,200	28,000,000
5	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.18%	2.41%	11,302,500	5,000,000
6	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.20%	3.33%	14,810,200	98,000,000
7	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.26%	3.32%	-33,341,900	-320,000,000
8	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.35%	3.13%	-24,501,500	-602,000,000
9	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.46%	2.87%	-29,905,500	1,789,000,000
10	:IREUR_EIBOR	Proxied	IR_Curve	USD	0.73%	2.21%	5,556,350	-3,589,000,000
11	:IREUR_EIBOR	Proxied	IR_Curve	USD	1.16%	1.78%	422,407,000	-3,189,000,000
0	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.31%	1.92%	-590,350	3,000,000
2	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.32%	1.18%	429,600	2,000,000
3	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.33%	0.95%	21,403,600	152,000,000
4	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.33%	0.79%	-33,177,200	244,000,000
5	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.34%	1.12%	-82,223,000	5,354,000,000
6	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.34%	1.57%	29,420,500	6,437,000,000
7	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.36%	1.96%	-90,907,900	3,907,000,000
8	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.39%	2.09%	160,302,000	56,275,000,000
9	:IRJPY_LIB1Y	Proxied	IR_Curve	USD	0.51%	2.03%	145,507,000	16,954,000,000
6	:IRUSD_MUNI	Proxied	IR_Curve	USD	0.71%	2.50%	61,028,600	458,000,000
7	:IRUSD_MUNI	Proxied	IR_Curve	USD	1.04%	2.19%	101,913,000	1,261,000,000
8	:IRUSD_MUNI	Proxied	IR_Curve	USD	1.31%	1.98%	-9,771,650	-31,000,000
9	:IRUSD_MUNI	Proxied	IR_Curve	USD	1.73%	1.56%	-26,203,900	30,000,000
10	:IRUSD_MUNI	Proxied	IR_Curve	USD	2.14%	1.29%	-34,235,800	43,000,000
11	:IRUSD_MUNI	Proxied	IR_Curve	USD	2.36%	1.20%	-41,033,700	64,000,000
12	:IRUSD_MUNI	Proxied	IR_Curve	USD	2.61%	1.13%	-253,416,000	6,408,000,000
13	:IRUSD_MUNI	Proxied	IR_Curve	USD	3.11%	1.06%	-490,075,000	33,313,000,000

## Model Application and Limitations

The model will be used to calculate projected VaR numbers infrequently. The model relies on the historical data availability for BNYM risk factors and the portfolio sensitivities calculated from RiskWatch valuation results based on specially designed shift scenarios. Since the production VaR numbers rely on the same historical data and RW portfolio valuations, the existing monitoring procedures related to historical data availability should be able to identify potential problems related to CCAR.

## Sensitivity Analysis

For this model, the sensitivity analysis will not apply as the VaR method itself is sensitivity based. It is driven by many risk factors and none of them will be the dominating driver. Thus performing individual sensitivity analysis is unnecessary.

## Ongoing Performance Monitoring Approach

The model results for any specific date and corresponding market data should be reconciled with production numbers for the BNYM portfolio and the underlying triples. The discrepancies are expected due to Delta-Gamma nature of the CCAR approach versus full revaluation and some details of the scenario generation implementation between CCAR and production.

## 2015 CCAR submission

## Systems and IT Infrastructure

The model is implemented as C++ code on Windows 2010.

## Key Personnel

Model owner: Market Risk  
 Model Developer: Tanya Tamarchenko  
 Model user:  
 Model Control:

## References

T. Tamarchenko, Simulation Engine Model, 7/31/2014.

## Revision History

DATE	SECTION	BRIEF DESCRIPTION	VERSION #	REQUESTED BY
9/30/14	All	Initial document	1.0	

12/01/14	Model Inputs, Parameters, Assumptions and Qualitative Adjustments; Sensitivity Analysis; Appendix A		1.1	Model Validation
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## Appendix A: Mapping all risk factors to major forecasted risk factors for the purpose of establishing forecasts

The Regulator sets the forecasted values for the major macroeconomic variables. BNYM identifies the relevant factors for its portfolio to take the forecasted values. The Table A1 below illustrates such mapping for 2015 CCAR exercise.

Table A1: Forecasted variables vs BNYM RF

Regulator Forecasted Factor	BNYM Risk Factor	Tenor (days)
10-year Treasury yield	:IRUSD_Treasury	3650
Prime rate	:IRUSD_Prime	1825
Dow Jones Total Stock Market Index (Level)	:C26099405_Index_INDUA_Return	0
Euro area bilateral dollar exchange rate (USD/euro)	:FXEUR	0
Developing Asia bilateral dollar exchange rate (F/USD, index)	:FXCNY	0
Japan bilateral dollar exchange rate (yen/USD)	:FXJPY	0
U.K. inflation	:IRGBP_RPI	1825
U.K. bilateral dollar exchange rate (USD/pound)	:FXGBP	0
2-year swap rate (%)	:IRAUD_Interbank	730
2-year swap rate (%)	:IRCAD_Interbank	730
2-year swap rate (%)	:IRDKK_Interbank	730
10-year swap rate (%)	:IREUR_Interbank	3650
2-year swap rate (%)	:IRHKD_Interbank	730
2-year swap rate (%)	:IRHUF_Interbank	730
2-year swap rate (%)	:IRJPY_Interbank	730
2-year swap rate (%)	:IRMXN_Interbank	730
2-year swap rate (%)	:IRNOK_Interbank	730
2-year swap rate (%)	:IRPLN_Interbank	730
2-year swap rate (%)	:IRSGD_Interbank	730
2-year swap rate (%)	:IRSEK_Interbank	730
2-year swap rate (%)	:IRCHF_Interbank	730
2-year swap rate (%)	:IRGBP_Interbank	730
10-year swap rate (%)	:IRUSD_Interbank	3650
2-year swap rate (%)	:IRZAR_Interbank	730
S&P 500 6m Implied Equity ATM Options Vol	:SP500_C00000117_EQTV	184
Swaption Volatility Surface (Normal) 1x5y	:index_euro1	0
10y AAA US GO Muni Curve Level	:IRUSD_MUAAA	3650
10y AA/AAA US GO Muni Curve Spread	:IRUSD_MUAASP	3650
10y A/AAA US GO Muni Curve Spread	:IRUSD_MUASP	3650
10y BBB/AAA US GO Muni Curve Spread	:IRUSD_MUBBBSP	3650
10y US AA/AAA credit spread	:IRUSD_INAASP	3650
10y US A/AAA credit spread	:IRUSD_INASP	3650
10y US BBB/AAA credit spread	:IRUSD_INBBBSP	3650
10y US BB/AAA credit spread	:IRUSD_INBBSP	3650
10y US B/AAA credit spread	:IRUSD_INBSP	3650
MBS CCOAS USD	:IRUSD_MBS_CC_OAS	0



The Table A2 shows the forecast information in the form of input file for the BNYM CCAR model.

Table A2: Core Risk Factors forecasts, Adverse scenario

BNYM Risk Factor	IsMultiplicative	Tenor	Q4 2014	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
:IRUSD_Treasury	F	3650	0.0080	0.0120	0.0150	0.0180	0.0210	0.0230	0.0250	0.0270	0.0290	0.0300	0.0320	0.0330	0.0330
:IRUSD_Prime	T	1825	1.1818	1.3030	1.4242	1.5758	1.7273	1.8788	2.0303	2.1515	2.2727	2.3636	2.4242	2.4848	2.5455
:C26099405_Index_INDUA	T	0	0.9491	0.9047	0.8646	0.8301	0.7947	0.7692	0.7542	0.7424	0.7328	0.7267	0.7230	0.7238	0.7335
:FXEUR	T	0	1.0016	0.9952	0.9842	0.9707	0.9580	0.9572	0.9596	0.9636	0.9675	0.9731	0.9786	0.9834	0.9881
:FXCNY	T	0	0.9731	0.9731	0.9764	0.9797	0.9853	1.0012	1.0164	1.0321	1.0483	1.0546	1.0611	1.0650	1.0689
:FXJPY	T	0	1.1240	1.1228	1.1148	1.1025	1.0915	1.0894	1.0905	1.0937	1.0948	1.0981	1.1014	1.1025	1.1047
:IRGBP_RPI	F	1825	-0.0150	-0.0150	-0.0150	-0.0130	-0.0100	-0.0070	-0.0040	-0.0020	0.0000	0.0000	0.0010	0.0020	0.0020
:FXGBP	T	0	1.0358	1.0333	1.0284	1.0210	1.0142	1.0117	1.0099	1.0086	1.0068	1.0074	1.0074	1.0074	1.0080
:IRAUD_Interbank	T	730	0.9877	0.9229	0.8884	0.8811	0.8824	0.8819	0.8824	0.8824	0.8822	0.8799	0.9121	0.9776	1.0461
:IRCAD_Interbank	T	730	1.2449	1.4184	1.6323	1.8485	2.2446	2.5812	2.8543	2.9934	3.1183	3.2297	3.4165	3.5034	3.5046
:IRDKK_Interbank	T	730	0.9496	1.2932	1.5760	1.7137	1.7466	1.8092	1.7805	1.8110	1.7964	1.7396	1.7311	1.7346	1.7870
:IREUR_Interbank	T	3650	1.8631	2.1640	2.3007	2.2844	2.3157	2.3785	2.3978	2.4257	2.5197	2.5924	2.7373	2.7491	2.8001
:IRHKD_Interbank	T	730	1.6088	2.3237	2.9763	3.6014	4.1985	4.7061	5.1864	5.6319	6.0564	6.3568	6.7078	6.9513	7.0734
:IRHUF_Interbank	T	730	1.5650	2.1221	2.7386	2.6840	2.5616	2.5299	2.4753	2.4211	2.4211	2.4190	2.4190	2.4190	2.4066
:IRJPY_Interbank	F	730	0.0000	0.0003	0.0012	0.0021	0.0028	0.0026	0.0016	0.0006	0.0002	0.0001	0.0000	-0.0001	-0.0001
:IRMXN_Interbank	T	730	1.1633	1.5402	1.8935	1.8200	1.8297	1.8269	1.8762	1.9295	1.9867	2.0493	2.0581	2.0167	1.8540
:IRNOK_Interbank	T	730	1.6451	1.7834	1.9039	1.9988	2.0474	2.1355	2.2083	2.2551	2.3054	2.3444	2.3990	2.4139	2.4589
:IRPLN_Interbank	T	730	1.2406	1.8940	2.0941	2.1830	2.2402	2.2941	2.3484	2.4011	2.4542	2.4720	2.5017	2.5335	2.5574
:IRSGD_Interbank	T	730	2.3141	2.9362	3.4607	4.3084	5.3192	6.1691	7.0713	7.8558	8.4533	8.6829	8.8285	9.1547	9.2547
:IRSEK_Interbank	T	730	2.6084	2.9986	3.3096	3.6144	3.9126	4.1279	4.3341	4.5528	4.7620	4.8617	5.0787	5.1122	5.1793
:IRCHF_Interbank	F	730	0.0059	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066
:IRGBP_Interbank	T	730	1.4064	1.5934	1.7494	1.9293	2.1157	2.3844	2.4829	2.6819	2.7870	2.8946	3.0045	3.1167	3.1928
:IRUSD_Interbank	T	3650	1.4350	1.5032	1.6218	1.7315	1.8464	1.9265	2.0040	2.0830	2.1593	2.1982	2.2681	2.3070	2.3173
:IRZAR_Interbank	T	730	1.2262	1.2403	1.2540	1.2682	1.2616	1.2540	1.2469	1.2399	1.2328	1.2257	1.2182	1.2116	1.2257
:SP500_C00000117_EQTV	T	184	1.3186	1.3243	1.3303	1.1990	1.1609	1.1602	1.1205	1.0870	1.0682	1.0548	1.0488	1.0413	1.0427
:index_euro1	T	0	1.0979	1.1654	1.1808	1.1319	1.1010	1.0680	1.0157	0.9674	0.9316	0.9046	0.8867	0.8724	0.8656
:IRUSD_MUAAA	T	3650	1.2996	1.6138	1.7084	1.7577	1.7703	1.8417	1.8829	1.8804	1.9034	1.9066	1.9276	1.9353	1.9345
:IRUSD_MUAASP	T	3650	1.2459	1.5181	1.6004	1.6423	1.6536	1.7155	1.7504	1.7483	1.7682	1.7707	1.7890	1.7954	1.7947
:IRUSD_MUASP	T	3650	1.1699	1.3365	1.3894	1.4133	1.4216	1.4609	1.4808	1.4796	1.4922	1.4933	1.5051	1.5083	1.5078
:IRUSD_MUBBBSP	T	3650	1.3286	1.4608	1.5182	1.5358	1.5482	1.5916	1.6074	1.6068	1.6208	1.6207	1.6348	1.6360	1.6355
:IRUSD_INAASP	T	3650	0.9151	1.0419	1.0502	1.1013	1.0978	1.1182	1.1473	1.1232	1.0957	1.0731	1.0547	1.0404	1.0279
:IRUSD_INASP	T	3650	0.9384	1.0642	1.0723	1.1229	1.1194	1.1396	1.1682	1.1445	1.1173	1.0950	1.0768	1.0626	1.0503
:IRUSD_INBBSP	T	3650	0.9958	1.1204	1.1284	1.1782	1.1748	1.1946	1.2227	1.1994	1.1727	1.1508	1.1328	1.1188	1.1066
:IRUSD_INBBSP	T	3650	0.9885	1.0964	1.1033	1.1460	1.1431	1.1600	1.1839	1.1641	1.1413	1.1225	1.1071	1.0951	1.0846
:IRUSD_INBSP	T	3650	1.0353	1.1394	1.1460	1.1869	1.1842	1.2004	1.2233	1.2043	1.1825	1.1645	1.1497	1.1381	1.1280
:IRUSD_MBS_CC_OAS	T	0	1.1211	3.0418	3.4870	3.6042	3.3624	3.5973	3.7249	3.5070	3.4482	3.3810	3.3019	3.2504	3.1724

For the majority of BNYM risk factors the forecasts are not provided. We'll use the term "core RF", or CRF, for the risk factors in the second column of Table A1. Each RF is mapped to CRF explicitly. The table A3 shows the input file to CCAR model that contains this information.

Table A3: Risk factor type – Currency pair mapping to Core Risk Factor

RF	CRF_level	CRF_vol
:AAPL_C03783310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:ABT_C00282410_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:ABX_C06790110_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:ADBE_C00724F10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:AFL_C00105510_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:AIG_C02687478_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:APC_C03251110_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:AVGO_C0486510_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:AXP_C02581610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:AZN_C04635310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:BAC_C06050510_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:BBT_C05493710_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:BCR_C06738310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:BMJ_C11012210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:BRKB_C08467070_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:C_C17296742_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CAT_C14912310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV

:CBRL_C22410J10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CE_C15087010_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CMCSA_C20030N10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:COF_C14040H10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:COST_C22160K10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CRM_C79466L30_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CSCO_C17275R10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:CVX_C16676410_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:DIS_C25468710_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:DOV_C26000310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:DOW_C26054310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:DVN_C25179M10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:EEM_C46428723_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:EFA_C46428746_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:ETN_CG2918310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:F_C34537086_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:FCX_C35671D85_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:FDX_C31428X10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:GE_C36960410_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:GM_C37045V10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:GS_C38141G10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HAL_C40621610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HCA_C40412C10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HD_C43707610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HOG_C41282210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HON_C43851610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HPQ_C42823610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:HUBB_C44351020_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:IBM_C45920010_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:ICE_C45866F10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:IJR_C46428780_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:IM_C45715310_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:INDUA_C26099405_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:INTC_C45814010_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:IVZ_CG491BT10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:JCI_C47836610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:JNJ_C47816010_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:JPM_C46625H10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:KO_C19121610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:LLY_C53245710_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:LNKD_C53578A10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:LOW_C54866110_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:LVS_C51783410_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MCD_C58013510_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MET_C59156R10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MO_C02209S10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MRK_C58933Y10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MS_C61744644_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MSFT_C59491810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:MU_C59511210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:NBR_CG6359F10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:NFLX_C64110L10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:OSK_C68823920_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:PCAR_C69371810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV

:PEP_C71344810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:PFE_C71708110_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:PG_C74271810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:PHM_C74586710_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:PM_C71817210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:POT_C73755L10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:QCOM_C74752510_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:SBUX_C85524410_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:SJM_C83269640_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:SP500_C00000117_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:SPY_C78462F10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:SWN_C84546710_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:T_C00206R10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:TEVA_C88162420_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:TGT_C87612E10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:UNP_C90781810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:UPS_C91131210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:USB_C90297330_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:VLO_C91913Y10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:WAG_C93142210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:WFC_C94974610_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:WMT_C93114210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:XLF_C81369Y60_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:XOM_C30231G10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:XON_C46122T10_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:YHOO_C98433210_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:YUM_C98849810_EQTV	:SP500_C00000117_EQTV	:SP500_C00000117_EQTV
:factorGB	:C26099405_Index_INDUA_Return	:SP500_C00000117_EQTV
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:FXARS_Forward	:IRMXN_Interbank	:index_euro1
:FXAUD_Forward	:IRAUD_Interbank	:index_euro1
:FXBGN_Forward	:IRZAR_Interbank	:index_euro1
:FXBHD_Forward	:IRZAR_Interbank	:index_euro1
:FXBRL_Forward	:IRZAR_Interbank	:index_euro1
:FXBWP_Forward	:IRZAR_Interbank	:index_euro1
:FXCAD_Forward	:IRCAD_Interbank	:index_euro1
:FXCHF_Forward	:IRCHF_Interbank	:index_euro1
:FXCLP_Forward	:IRDKK_Interbank	:index_euro1
:FXCNY_Forward	:IRSGD_Interbank	:index_euro1
:FXCOP_Forward	:IRDKK_Interbank	:index_euro1
:FXCZK_Forward	:IRSEK_Interbank	:index_euro1
:FXDKK_Forward	:IRDKK_Interbank	:index_euro1
:FXEGP_Forward	:IRSGD_Interbank	:index_euro1
:FXEUR_Forward	:IREUR_Interbank	:index_euro1
:FXGBP_Forward	:IRGBP_Interbank	:index_euro1
:FXHKD_Forward	:IRHKD_Interbank	:index_euro1
:FXHRK_Forward	:IREUR_Interbank	:index_euro1
:FXHUF_Forward	:IRHUF_Interbank	:index_euro1
:FXIDR_Forward	:IRHKD_Interbank	:index_euro1
:FXILS_Forward	:IRHKD_Interbank	:index_euro1
:FXINR_Forward	:IRHKD_Interbank	:index_euro1
:FXISK_Forward	:IRZAR_Interbank	:index_euro1
:FXJOD_Forward	:IRZAR_Interbank	:index_euro1
:FXJPY_Forward	:IRJPY_Interbank	:index_euro1

:FXKES_Forward	:IRDKK_Interbank	:index_euro1
:FXKRW_Forward	:IRHKD_Interbank	:index_euro1
:FXKWD_Forward	:IRHKD_Interbank	:index_euro1
:FXKZT_Forward	:IRZAR_Interbank	:index_euro1
:FXLKR_Forward	:IRZAR_Interbank	:index_euro1
:FXLTL_Forward	:IRZAR_Interbank	:index_euro1
:FXMAD_Forward	:IRZAR_Interbank	:index_euro1
:FXMUR_Forward	:IRZAR_Interbank	:index_euro1
:FXMXN_Forward	:IRMXN_Interbank	:index_euro1
:FXMYR_Forward	:IRZAR_Interbank	:index_euro1
:FXNAD_Forward	:IRDKK_Interbank	:index_euro1
:FXNGN_Forward	:IRSEK_Interbank	:index_euro1
:FXNOK_Forward	:IRNOK_Interbank	:index_euro1
:FXNZD_Forward	:IRJPY_Interbank	:index_euro1
:FXOMR_Forward	:IRUSD_Interbank	:index_euro1
:FXPEN_Forward	:IRUSD_Interbank	:index_euro1
:FXPHP_Forward	:IRUSD_Interbank	:index_euro1
:FXPKR_Forward	:IRUSD_Interbank	:index_euro1
:FXPLN_Forward	:IRUSD_Interbank	:index_euro1
:FXQAR_Forward	:IRUSD_Interbank	:index_euro1
:FXRON_Forward	:IRDKK_Interbank	:index_euro1
:FXRSD_Forward	:IRDKK_Interbank	:index_euro1
:FXRUB_Forward	:IRZAR_Interbank	:index_euro1
:FXSAR_Forward	:IRZAR_Interbank	:index_euro1
:FXSEK_Forward	:IRSEK_Interbank	:index_euro1
:FXSGD_Forward	:IRSGD_Interbank	:index_euro1
:FXTHB_Forward	:IRSGD_Interbank	:index_euro1
:FXTND_Forward	:IRSGD_Interbank	:index_euro1
:FXTRY_Forward	:IRSGD_Interbank	:index_euro1
:FXTWD_Forward	:IRHKD_Interbank	:index_euro1
:FXUSD_Forward	:IRUSD_Interbank	:index_euro1
:FXZAR_Forward	:IRZAR_Interbank	:index_euro1
:EUR_GBP-Simulation	:index_euro1	:index_euro1
:EUR_JPY-Simulation	:index_euro1	:index_euro1
:EUR_USD-Simulation	:index_euro1	:index_euro1
:GBP_JPY-Simulation	:index_euro1	:index_euro1
:GBP_USD-Simulation	:index_euro1	:index_euro1
:JPY_USD-Simulation	:index_euro1	:index_euro1
:MXN_USD-Simulation	:index_euro1	:index_euro1
:FXAED	:FXCNY	:index_euro1
:FXAFN	:FXCNY	:index_euro1
:FXAOA	:FXCNY	:index_euro1
:FXARS	:FXCNY	:index_euro1
:FXAUD	:FXJPY	:index_euro1
:FXBBD	:FXCNY	:index_euro1
:FXBDT	:FXCNY	:index_euro1
:FXBGN	:FXCNY	:index_euro1
:FXBHD	:FXCNY	:index_euro1
:FXBMD	:FXCNY	:index_euro1
:FXBOB	:FXCNY	:index_euro1
:FXBRL	:FXCNY	:index_euro1
:FXBWP	:FXCNY	:index_euro1
:FXBZD	:FXCNY	:index_euro1
:FXCAD	:FXEUR	:index_euro1

:FXCHF	:FXEUR	:index_euro1
:FXCLP	:FXEUR	:index_euro1
:FXCNY	:FXCNY	:index_euro1
:FXCOP	:FXEUR	:index_euro1
:FXCRC	:FXEUR	:index_euro1
:FXCVE	:FXEUR	:index_euro1
:FXCZK	:FXEUR	:index_euro1
:FXDJF	:FXEUR	:index_euro1
:FXDKK	:FXEUR	:index_euro1
:FXDZD	:FXEUR	:index_euro1
:FXEEK	:FXEUR	:index_euro1
:FXEGP	:FXEUR	:index_euro1
:FXEUR	:FXEUR	:index_euro1
:FXFJD	:FXEUR	:index_euro1
:FXGBP	:FXGBP	:index_euro1
:FXGHS	:FXEUR	:index_euro1
:FXGNF	:FXEUR	:index_euro1
:FXGTQ	:FXEUR	:index_euro1
:FXGYD	:FXEUR	:index_euro1
:FXHKD	:FXJPY	:index_euro1
:FXHNL	:FXJPY	:index_euro1
:FXHRK	:FXJPY	:index_euro1
:FXHUF	:FXJPY	:index_euro1
:FXIDR	:FXJPY	:index_euro1
:FXILS	:FXJPY	:index_euro1
:FXINR	:FXJPY	:index_euro1
:FXIRR	:FXJPY	:index_euro1
:FXISK	:FXEUR	:index_euro1
:FXJMD	:FXJPY	:index_euro1
:FXJOD	:FXJPY	:index_euro1
:FXJPY	:FXJPY	:index_euro1
:FXKES	:FXJPY	:index_euro1
:FXKGS	:FXJPY	:index_euro1
:FXKHR	:FXJPY	:index_euro1
:FXKRW	:FXCNY	:index_euro1
:FXKWD	:FXCNY	:index_euro1
:FXKZT	:FXCNY	:index_euro1
:FXLBP	:FXCNY	:index_euro1
:FXLKR	:FXCNY	:index_euro1
:FXLTL	:FXCNY	:index_euro1
:FXLVL	:FXCNY	:index_euro1
:FXMAD	:FXCNY	:index_euro1
:FXMUR	:FXCNY	:index_euro1
:FXMWK	:FXCNY	:index_euro1
:FXMXN	:FXCNY	:index_euro1
:FXMYR	:FXCNY	:index_euro1
:FXMZN	:FXCNY	:index_euro1
:FXNAD	:FXCNY	:index_euro1
:FXNGN	:FXCNY	:index_euro1
:FXNOK	:FXEUR	:index_euro1
:FXNZD	:FXEUR	:index_euro1
:FXOMR	:FXCNY	:index_euro1
:FXPAB	:FXCNY	:index_euro1
:FXPEN	:FXCNY	:index_euro1

:FXPGK	:FXCNY	:index_euro1
:FXPHP	:FXCNY	:index_euro1
:FXPKR	:FXCNY	:index_euro1
:FXPLN	:FXEUR	:index_euro1
:FXPYG	:FXJPY	:index_euro1
:FXQAR	:FXCNY	:index_euro1
:FXRON	:FXCNY	:index_euro1
:FXRSD	:FXCNY	:index_euro1
:FXRUB	:FXCNY	:index_euro1
:FXSAR	:FXCNY	:index_euro1
:FXSEK	:FXEUR	:index_euro1
:FXSGD	:FXCNY	:index_euro1
:FXSRD	:FXCNY	:index_euro1
:FXSZL	:FXCNY	:index_euro1
:FXTHB	:FXCNY	:index_euro1
:FXTND	:FXCNY	:index_euro1
:FXTRY	:FXCNY	:index_euro1
:FXTTD	:FXCNY	:index_euro1
:FXTWD	:FXCNY	:index_euro1
:FXUAH	:FXCNY	:index_euro1
:FXUGX	:FXCNY	:index_euro1
:FXUYU	:FXJPY	:index_euro1
:FXVEF	:FXJPY	:index_euro1
:FXVND	:FXJPY	:index_euro1
:FXXAF	:FXJPY	:index_euro1
:FXXCD	:FXJPY	:index_euro1
:FXXOF	:FXJPY	:index_euro1
:FXXPF	:FXCNY	:index_euro1
:FXYER	:FXCNY	:index_euro1
:FXZAR	:FXCNY	:index_euro1
:FXZMK	:FXCNY	:index_euro1
:FXZMW	:FXCNY	:index_euro1
:IRARS_Interbank	:IRMXN_Interbank	:index_euro1
:IRAUD_BBS3M	:IRAUD_Interbank	:index_euro1
:IRAUD_BBSW	:IRAUD_Interbank	:index_euro1
:IRAUD_Interbank	:IRAUD_Interbank	:index_euro1
:IRAUD_USDCC	:IRAUD_Interbank	:index_euro1
:IRBMD_Interbank	:IRMXN_Interbank	:index_euro1
:IRBRL_Interbank	:IRMXN_Interbank	:index_euro1
:IRBWP_Interbank	:IRZAR_Interbank	:index_euro1
:IRCAD_Interbank	:IRCAD_Interbank	:index_euro1
:IRCHF_Interbank	:IRCHF_Interbank	:index_euro1
:IRCOP_Interbank	:IRCHF_Interbank	:index_euro1
:IRCZK_Interbank	:IRCHF_Interbank	:index_euro1
:IRDKK_Interbank	:IRDKK_Interbank	:index_euro1
:IREGP_Interbank	:IRDKK_Interbank	:index_euro1
:IREUR_EIB1M	:IREUR_Interbank	:index_euro1
:IREUR_EIB1Y	:IREUR_Interbank	:index_euro1
:IREUR_EIB3M	:IREUR_Interbank	:index_euro1
:IREUR_EIBOR	:IREUR_Interbank	:index_euro1
:IREUR_EONIA	:IREUR_Interbank	:index_euro1
:IREUR_Interbank	:IREUR_Interbank	:index_euro1
:IREUR_Mmarket	:IREUR_Interbank	:index_euro1
:IREUR_Swaption	:IRUSD_Interbank	:index_euro1

:IREUR_USDCC	:IREUR_Interbank	:index_euro1
:IRGBP_Deposit	:IRGBP_Interbank	:index_euro1
:IRGBP_Interbank	:IRGBP_Interbank	:index_euro1
:IRGBP_LIB3M	:IRGBP_Interbank	:index_euro1
:IRGBP_RPI	:IRGBP_RPI	:index_euro1
:IRGBP_SONIA	:IRGBP_Interbank	:index_euro1
:IRGBP_Swaption	:IRGBP_Interbank	:index_euro1
:IRGBP_USDCC	:IRGBP_Interbank	:index_euro1
:IRHKD_HIBOR	:IRHKD_Interbank	:index_euro1
:IRHKD_Interbank	:IRHKD_Interbank	:index_euro1
:IRHUF_Interbank	:IRHUF_Interbank	:index_euro1
:IRIDR_Interbank	:IRUSD_Interbank	:index_euro1
:IRILS_Interbank	:IRUSD_Interbank	:index_euro1
:IRINR_Interbank	:IRSGD_Interbank	:index_euro1
:IRJPY_CapFloor6M	:IRJPY_Interbank	:index_euro1
:IRJPY_Interbank	:IRJPY_Interbank	:index_euro1
:IRJPY_Interbank1	:IRJPY_Interbank	:index_euro1
:IRJPY_LIB1Y	:IRJPY_Interbank	:index_euro1
:IRJPY_LIB3M	:IRJPY_Interbank	:index_euro1
:IRJPY_Swaption	:IRJPY_Interbank	:index_euro1
:IRJPY_TIB1M	:IRJPY_Interbank	:index_euro1
:IRJPY_TIB3M	:IRJPY_Interbank	:index_euro1
:IRJPY_TIBOR	:IRJPY_Interbank	:index_euro1
:IRJPY_USDCC	:IRJPY_Interbank	:index_euro1
:IRKES_Interbank	:IRSGD_Interbank	:index_euro1
:IRKRW_Interbank	:IRSGD_Interbank	:index_euro1
:IRLKR_Interbank	:IRZAR_Interbank	:index_euro1
:IRMAD_Interbank	:IRZAR_Interbank	:index_euro1
:IRMUR_Interbank	:IRZAR_Interbank	:index_euro1
:IRMXN_Interbank	:IRMXN_Interbank	:index_euro1
:IRMYR_Interbank	:IRZAR_Interbank	:index_euro1
:IRNOK_Interbank	:IRNOK_Interbank	:index_euro1
:IRNZD_Interbank	:IRDKK_Interbank	:index_euro1
:IRPEN_Interbank	:IRPLN_Interbank	:index_euro1
:IRPHP_Interbank	:IRZAR_Interbank	:index_euro1
:IRPKR_Interbank	:IRZAR_Interbank	:index_euro1
:IRPLN_Interbank	:IRPLN_Interbank	:index_euro1
:IRRON_Interbank	:IRPLN_Interbank	:index_euro1
:IRSEK_Interbank	:IRSEK_Interbank	:index_euro1
:IRSGD_Interbank	:IRSGD_Interbank	:index_euro1
:IRTHB_Interbank	:IRSGD_Interbank	:index_euro1
:IRTRY_Interbank	:IRSGD_Interbank	:index_euro1
:IRTWD_Interbank	:IRSGD_Interbank	:index_euro1
:IRUSD_CapFloor1M	:IRUSD_Interbank	:index_euro1
:IRUSD_CapFloor3M	:IRUSD_Interbank	:index_euro1
:IRUSD_CapFloor6M	:IRUSD_Interbank	:index_euro1
:IRUSD_FEDFD	:IRUSD_Treasury	:index_euro1
:IRUSD_GOAAA	:IRUSD_MUAAA	:index_euro1
:IRUSD_INAAA	:IRUSD_MUAAA	:index_euro1
:IRUSD_INAAASP	:IRUSD_INBBBSP	:index_euro1
:IRUSD_INAASP	:IRUSD_INAASP	:index_euro1
:IRUSD_INASP	:IRUSD_INASP	:index_euro1
:IRUSD_INBBBSP	:IRUSD_INBBBSP	:index_euro1
:IRUSD_INBBSP	:IRUSD_INBBSP	:index_euro1



:IRUSD_INBSP	:IRUSD_INBSP	:index_euro1
:IRUSD_INCCCSP	:IRUSD_INBSP	:index_euro1
:IRUSD_Interbank	:IRUSD_Interbank	:index_euro1
:IRUSD_Interbank1	:IRUSD_Interbank	:index_euro1
:IRUSD_LIA6M	:IRUSD_Interbank	:index_euro1
:IRUSD_LIB1Y	:IRUSD_Interbank	:index_euro1
:IRUSD_LIB6M	:IRUSD_Interbank	:index_euro1
:IRUSD_Mmarket	:IRUSD_Interbank	:index_euro1
:IRUSD_MUAAA	:IRUSD_MUAAA	:index_euro1
:IRUSD_MUAAAASP	:IRUSD_INBBBSP	:index_euro1
:IRUSD_MUAAASP	:IRUSD_MUAAASP	:index_euro1
:IRUSD_MUASP	:IRUSD_MUASP	:index_euro1
:IRUSD_MUBBBSP	:IRUSD_MUBBBSP	:index_euro1
:IRUSD_MUBBSP	:IRUSD_INBBSP	:index_euro1
:IRUSD_MUBSP	:IRUSD_INBSP	:index_euro1
:IRUSD_MUCCCSP	:IRUSD_INBSP	:index_euro1
:IRUSD_MUNI	:IRUSD_MUAAA	:index_euro1
:IRUSD_Prime	:IRUSD_Prime	:index_euro1
:IRUSD_Supranational	:IRUSD_Interbank	:index_euro1
:IRUSD_Swaption	:IRUSD_Interbank	:index_euro1
:IRUSD_Treasury	:IRUSD_Treasury	:index_euro1
:IRVEF_Interbank	:IRMXN_Interbank	:index_euro1
:IRZAR_Interbank	:IRZAR_Interbank	:index_euro1
:index_cap1m11	:index_euro1	:index_euro1
:index_cap1m21	:index_euro1	:index_euro1
:index_cap3m11	:index_euro1	:index_euro1
:index_cap3m21	:index_euro1	:index_euro1
:index_cap6m11	:index_euro1	:index_euro1
:index_cap6m21	:index_euro1	:index_euro1
:index_euro1	:index_euro1	:index_euro1
:IRUSD_MBS_CC_OAS	:IRUSD_MBS_CC_OAS	:index_euro1

Based on the mappings in Table A3, forecasted value of a risk factor is calculated so that the change in RF value is the same as the change in core RF value. “The change” is understood as multiplicative (for RF including equity prices, volatilities, IR and FX rates) or additive (for spreads). For example, the ratio of the forecasted value for AEX\_S1810101\_EQTV and its today’s value is the same as the ratio of the forecasted VIX and its today’s value. The difference between the forecast for :IRUSD\_INCCCSP and its today’s value will be the same as the difference between forecasted and today’s value for :IRUSD\_INBBBSP.

The mappings described above facilitate setting the forecasted levels for all RF. We also need to forecast the volatilities of all the risk factors used in VaR calculations. So far the Regulator provided the only variable indicating the forecasted volatility level, namely VIX for equities. We are going to apply the relative change between forecasted and today’s value of VIX to generate volatility forecast for all BNYM RF.

## Appendix B: Sensitivities Calculation

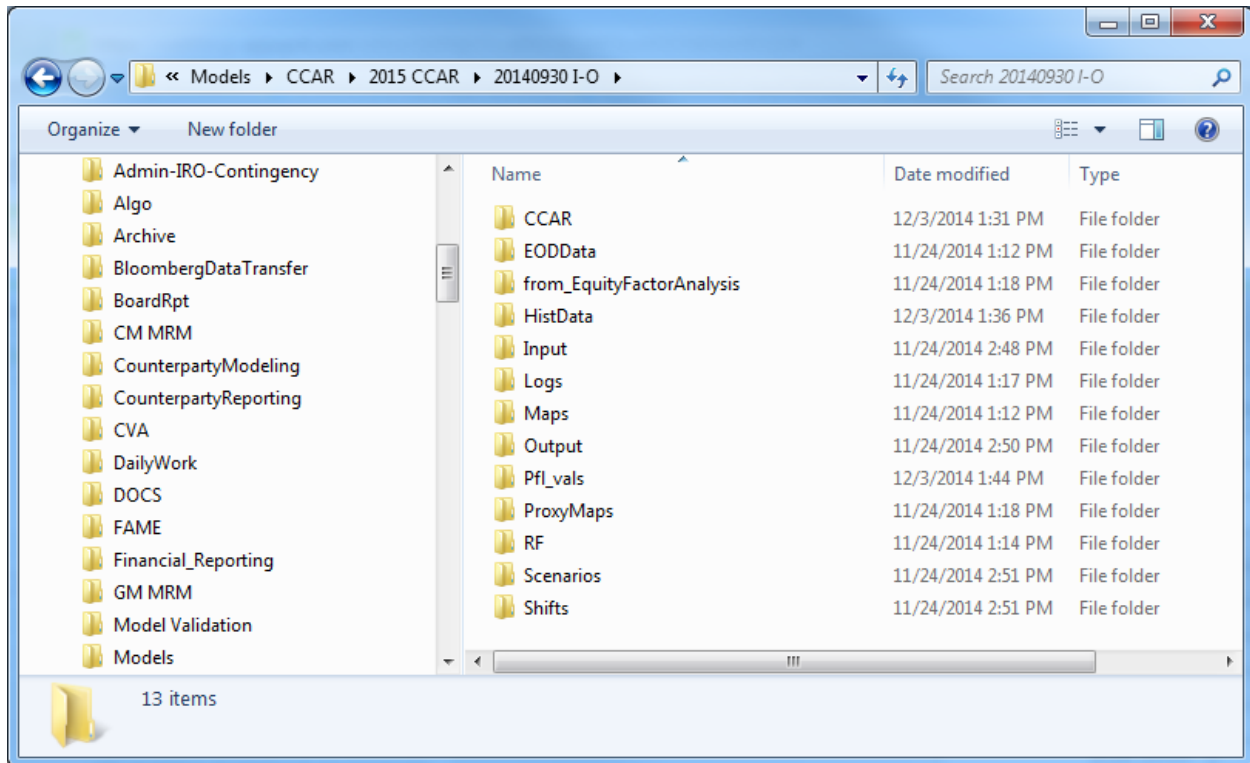
In order to calculate sensitivities (deltas, gammas and cross-gammas) of BNYM portfolio with respect to the underlying risk factors we need to create shift scenario file, pass it to RW, get valuation results for the BNYM portfolio and process valuation results to calculate the sensitivities. The shift scenario file has the same format as scenario files with MC simulations that are passed to RW for production VaR calculation so that no addition work was required from the technology side to use these scenarios in RW. The difference is that for sensitivities calculation the scenarios are very simple. 7 types of shift scenarios are specified: the Base scenario (no change in any RF), DeltaUp scenarios in each of which a single RF is changed by 0.0001, DeltaDn scenarios are the same as DeltaUp only the shift is negative, CrossGammaUpUp, CrossGammaDnDn, CrossGammaUpDn and CrossGammaDnUp are applicable to curves (IR curves or Equity volatility term structure). In each of these scenarios two risk factors corresponding to different terms on the curve are shifted simultaneously either in one direction (CrossGammaUpUp, CrossGammaDnDn) or in opposite directions (CrossGammaUpDn, CrossGammaDnUp). Each of the last 6 scenarios contains zero shifts for all risk factors except for one or two factors. Unfortunately RW requires that all scenarios in a scenario file have the same number of risk factors. Because of this limitation scenario file can become quite large although most of the space is taken by listing risk factors with zero shifts. Large size of shift scenario file is the reason we separated all risk factors into two sets: interest rate risk factors and all the rest. This leads to two shift scenario files with manageable size (350M for interest rate factors and 51MB for the rest).

Upon getting valuation results for shift scenarios from RW the sensitivities are calculated. The deltas, gammas and cross gammas are calculated as the differences between valuations for the appropriate scenarios normalized by the shift size. Cross are gammas only calculated across risk factors corresponding to certain interest rate curve of volatility term structure.

## Appendix C: Input files

The CCAR model is implemented as a C++ Visual Studio project. The input/out files structure is shown in Figure C1.

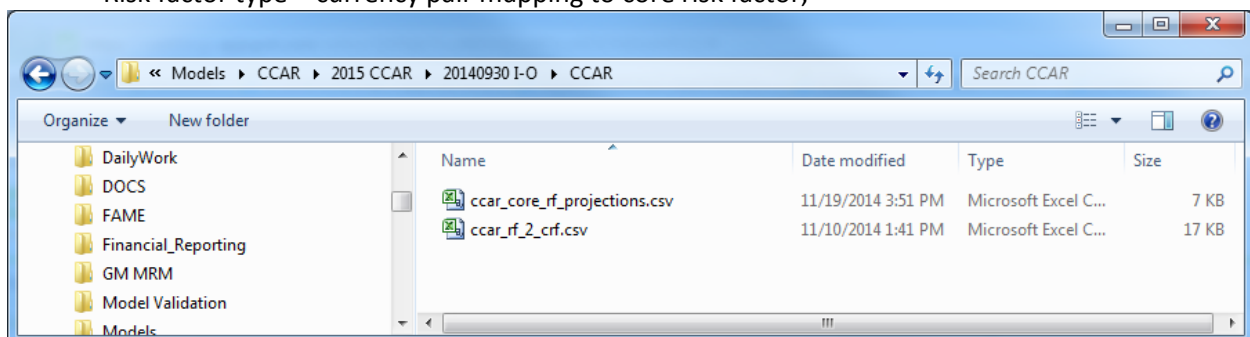
Figure C1: CCAR i/o files



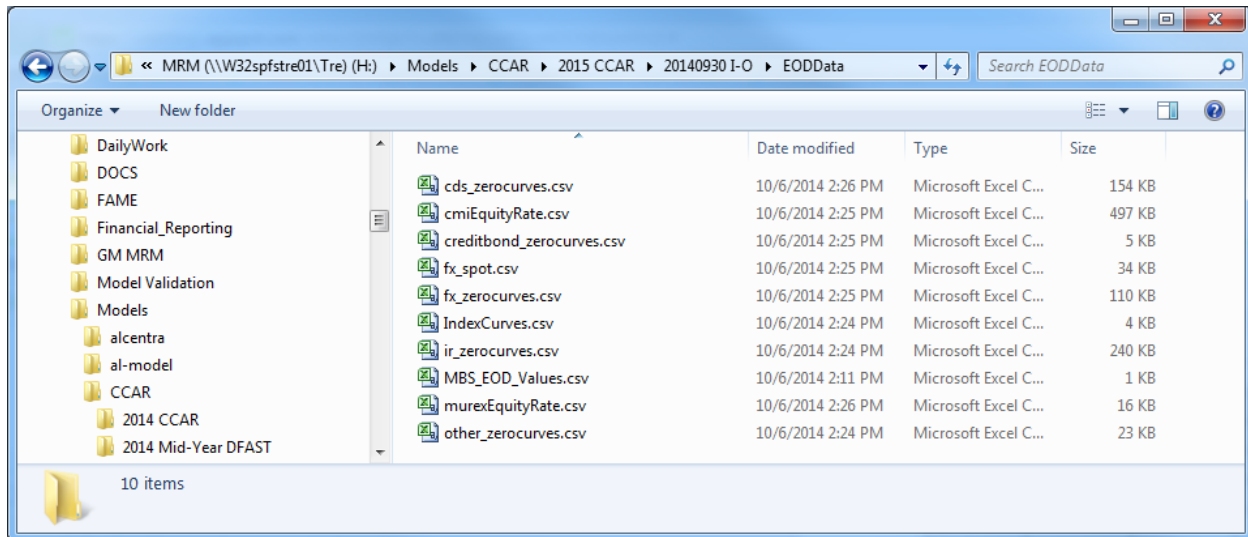
Input and output subdirectories and their content are shown in the figures below. The Input directories specific to CCAR are marked as “**CCAR specific**” as opposed to “**The same as for production VaR**”

**CCAR specific** : The sub-directory “CCAR” contains 2 input files:

- The given projections for CRF ;
- Risk factor type – currency pair mapping to core risk factor;

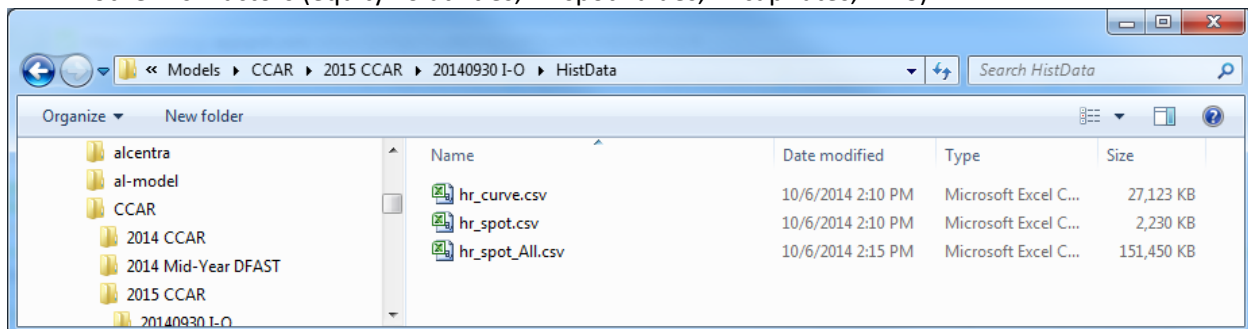


**The same as for production VaR :** The sub-directory “EODData” contains the end-of-date market data for interest rates, volatilities, equities. These files are used by the production VaR engine.



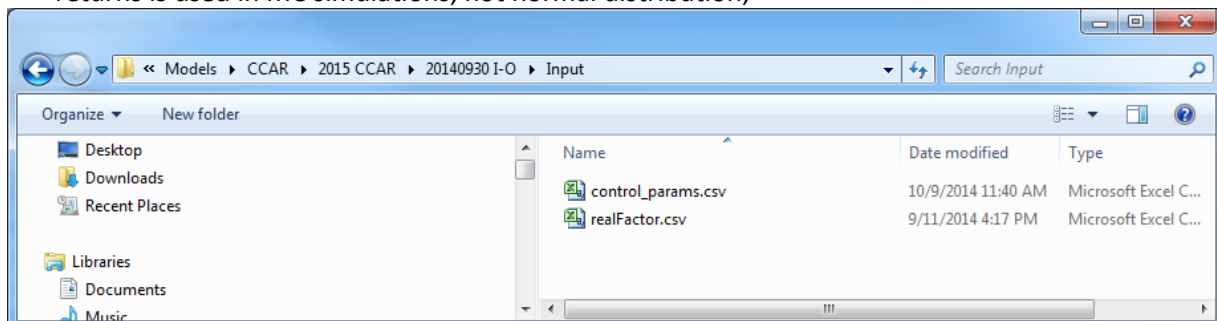
**The same as for production VaR:** the sub-directory “HistData” contains historical data for:

- Interest rate curves;
- Equities;
- All other risk factors (equity volatilities, FX spot values, IR cap rates, MBS).

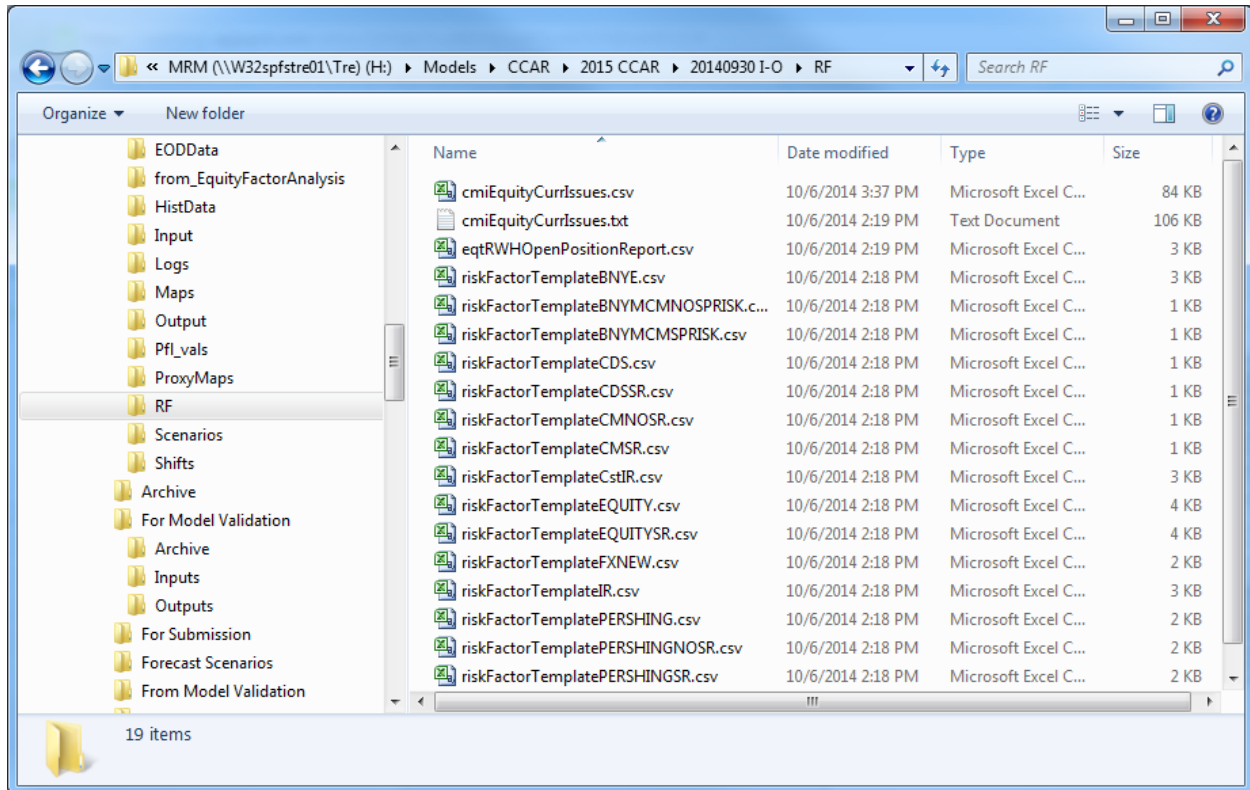


The sub-directory “Input” contains the files with the following information:

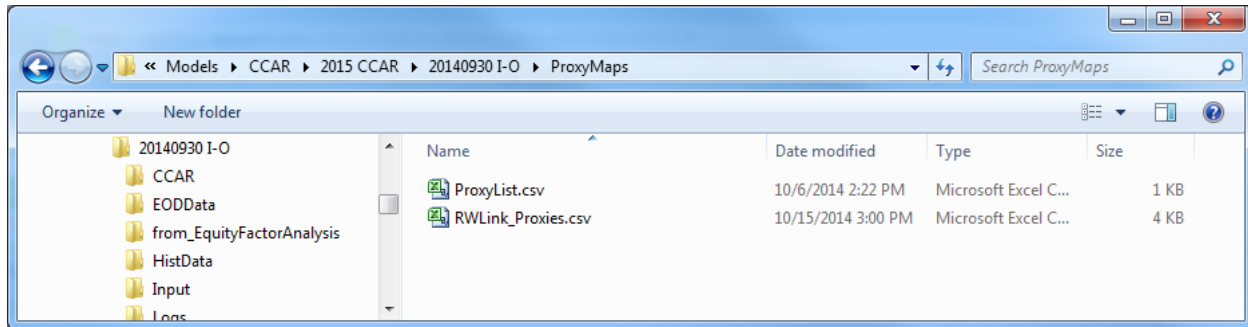
- **CCAR specific:** Control parameters for simulation engine (number of MC simulation, default volatilities for idiosyncratic risks, decay factor, percentile for VaR calculation, minimum number of returns to use regression, etc.);
- **The same as for production VaR:** The list of risk factors for which empirical distribution of log-returns is used in MC simulations, not normal distribution;



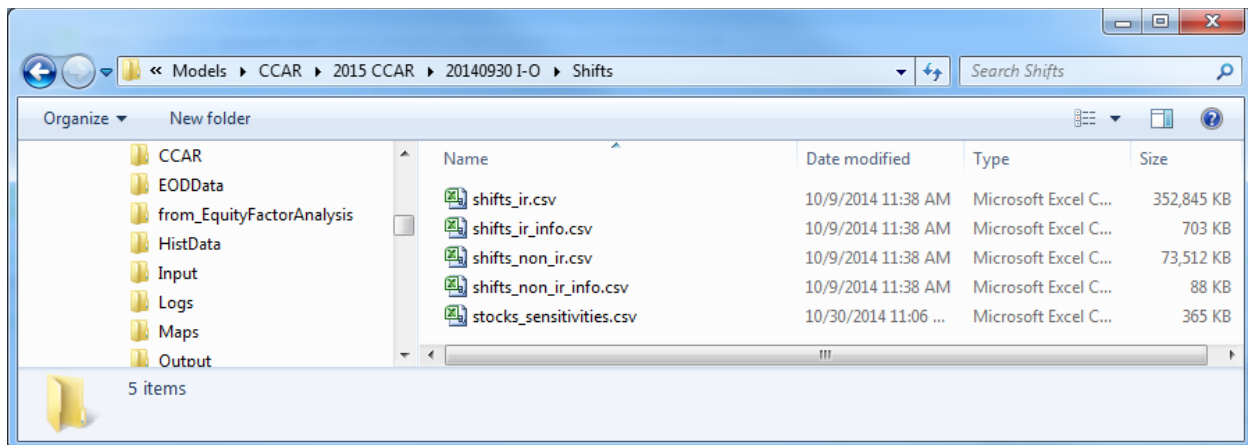
**The same as for production VaR** The subdirectory “RF” contains the lists of RF underlying BNY portfolio for the “as-of-date”. These files are created during the production VaR run and used in CCAR framework to identify relevant RF. From these lists the list of unique risk factor names is generated.



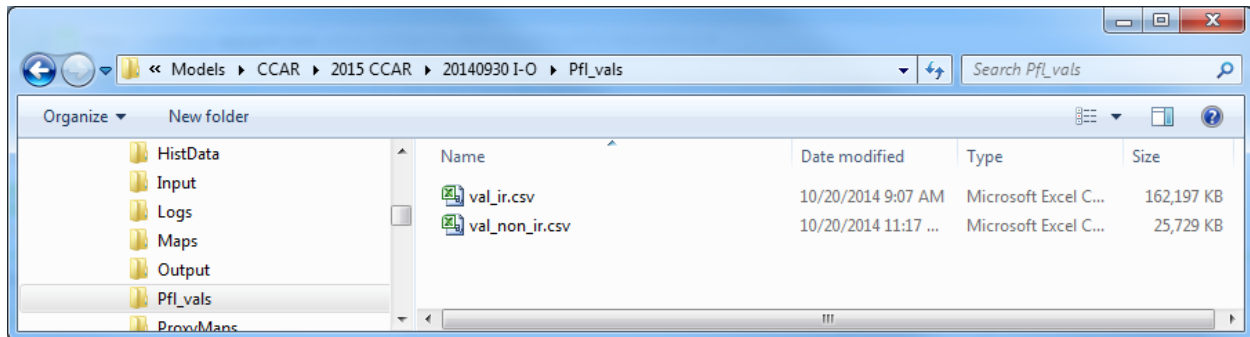
**The same as for production VaR :** The sub-directory “ProxyMaps” contains 2 files with proxy mappings use in VaR and Stressed VaR. These 2 files are used in production VaR calculation.



**CCAR specific:** The sub-directory “Shifts” contains shift scenarios for the sensitivities calculation. 7 types of shift scenarios are specified: the Base scenario (no change in any RF), DeltaUp scenarios in each of which a single RF is changed by 0.0001, DeltaDn scenarios are the same as DeltaUp only the shift is negative, CrossGammaUpUp, CrossGammaDnDn, CrossGammaUpDn and CrossGammaDnUp are applicable to curves (IR curves or Equity volatility term structure). In each of these scenarios two risk factors corresponding to different terms on the curve are shifted simultaneously either in one direction (GammaUpUp, CrossGammaDnDn) or in opposite directions (CrossGammaUpDn, CrossGammaDnUp). The scenarios are written in the same format as the MC scenario file so that no addition work was required to use these scenarios in RW. These scenarios are separated in two sets: interest rate and non-interest rate scenarios. The remaining 2 files contain the information about corresponding shift files. This information is generated by the program at the time of scenario files generation and is used later when valuation results calculated by RW need to be interpreted and converted to sensitivities.



**CCAR specific:** The sub-directory “Pfl\_vals” contains two files with the RiskWatch valuation results for the shift scenarios specified for the purpose of sensitivities calculation. All shift scenarios required to calculate delta and gamma sensitivities for BNYM portfolio are grouped into 2 sets: shifts for interest rate risk factors and shifts for the other remaining factors.



In order to generate CCAR projections for a given historical time period, two runs are required. During the first run the list of RF is read, historical data information is processed to determine the quality of historical data available for each factor and, depending on this, how each factor will be simulated. The factors that have full time series are simulated jointly based on the relationships implied by historical data. For the factors that have some data regression analysis is performed. The factors lacking data are simulated as idiosyncratic risk with default volatility. Some factors are in the input proxy list – their simulated returns are the same as for the corresponding proxy factor. The shift scenarios for sensitivity calculations are the main result of this run. These shift scenarios are then passed to RiskWatch. The results (two valuation files) are copied into the sub-director “Pfl\_vals”. Then the second run is performed where the RiskWatch valuation results are read and interpreted to calculate the sensitivities, the CCAR projections information is read and used to rescale the levels and volatilities of the risk factors and finally VaR projections are calculated for each time horizon.



**Purpose of the Addendum:**

The RWA for market risk projections for the Regulatory Bank BNYM portfolio are required for the CCAR exercise in addition to the Regulatory Company BNYM projections. The requirement to submit Bank RWA projections surfaced at the latest stage of the project. The approved CCAR methodology calls for calculating the Bank BNYM portfolio sensitivities to all underlying risk factors. This process requires information technology involvement and might be time consuming. Due to the time constraints BNYM took the alternative approximate approach for the purpose of 2015 submission only. This approach is justified by the fact that Regulatory Bank BNYM portfolio is the same in its composition as the Regulatory Company BNYM portfolio except for the Capital Market Subsidiary Trading positions that are part of the Company portfolio are not included in the Bank portfolio. In the future the calculations for Bank BNYM will be done in the same way as for the Company BNYM portfolio according to the CCAR methodology based on the sensitivities of the Bank portfolio to the underlying risk factors. The purpose of this Addendum is to justify that our approach to the Bank BNYM RWA market risk projections is valid and reasonable.

**Methodology:**

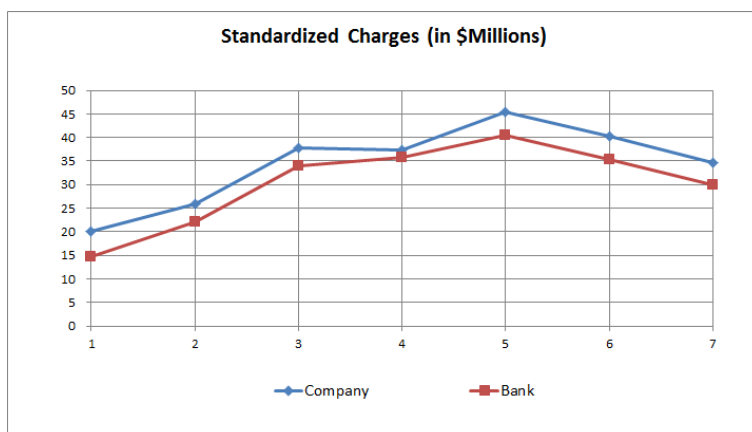
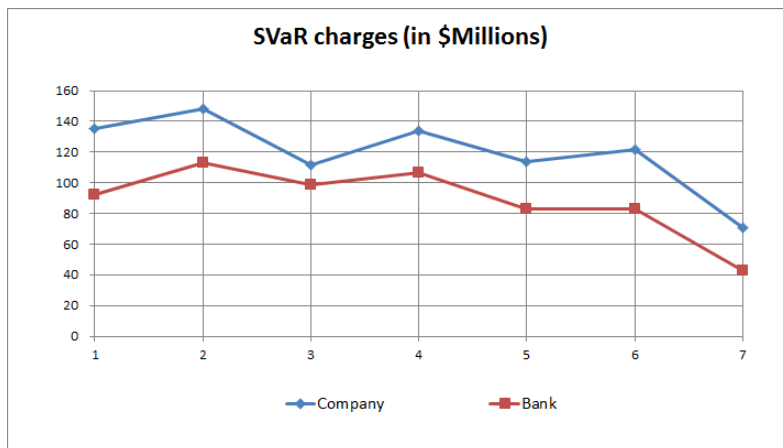
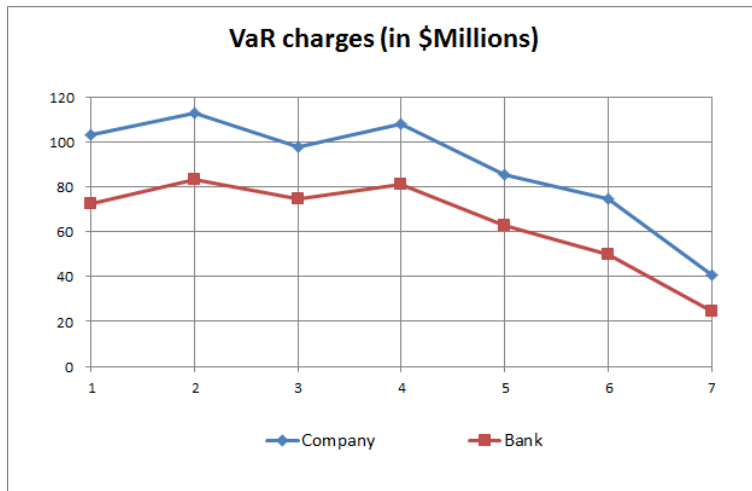
For each of the components (VaR, SVaR, equity changes) the projected values for the Bank BNYM portfolio in CCAR 2015 submission are calculated in exactly the same way as it is done for the Company BNYM portfolio. The calculations are described by steps 9-12 from the “CCAR Desktop Procedures” document. In the future submissions steps 1-8 from the “CCAR Desktop Procedures” document will be performed for the Bank BNYM portfolio. In this year submission we are using the results from steps 1-8 for the Company BNYM portfolio to handle both the Company BNYM and the Bank BNYM portfolios.

**Assumption:**

The Bank and Company portfolios’ capital charges and their components are closely related, see the schematic illustration in “MRM Risk Reporting Hierarchy Instrument View V1.1 (with Bank Highlights).vsd” document. The Regulatory Bank BNYM portfolio is the same in its composition as the Regulatory Company BNYM portfolio except for the Capital Market Subsidiary Trading positions that are part of the Company portfolio are not included in the Bank portfolio. If the Company values change by certain percentage then the Bank values change by very close amount from over a given time horizon.

**Evaluation of the Assumption:**

The figures below illustrate the fact that the quarter-to-quarter changes in the Bank charges closely follow the corresponding changes for the Company portfolio. The figures below present the reported values for Company and Ban portfolios for the quarters from Q1 2013 to Q3 2014. The values for the Bank change in sync with the values for the Company.



Additional analysis was performed to show the correlations between the Company and the Bank 1-day VaR and SVaR relative changes over quarter, 2 quarters,..., 9 quarters periods. The results are shown below. We used daily data for VaR and SVaR. The correlations between the Company and the Bank charges over a number of periods ranging from 30 to 280 days are consistently very high.

Table 1: 1-day VaR relative changes correlations between the Company and the Bank

Over period (days)	30	60	91	121	151	182	212	242	273
Company /Bank changes correlations	87.0%	91.0%	93.8%	92.5%	92.6%	93.1%	96.0%	95.0%	94.1%

Table 2: 1-day SVaR relative changes correlations between the Company and the Bank

Over period (days)	28	56	84	112	140	168	196	224	252	280
Company /Bank changes correlations	92.4%	92.1%	92.0%	92.8%	89.0%	84.2%	84.3%	86.0%	87.8%	94.2%

## **Results:**

The RWA projections for the Bank portfolio are presented in the Table 3.

Table 3: The current (Q3 2014) and projected RWA results for the Bank portfolio (in \$Millions)

	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016
Baseline	1,217	1,297	1,243	1,255	1,304	1,349	1,386	1,390	1,448	1,456
Adverse	1,217	1,539	1,726	1,829	1,854	1,887	1,916	1,874	1,845	1,852
Severely Adverse	1,217	2,374	2,098	2,390	2,405	2,222	1,813	1,531	1,353	1,233