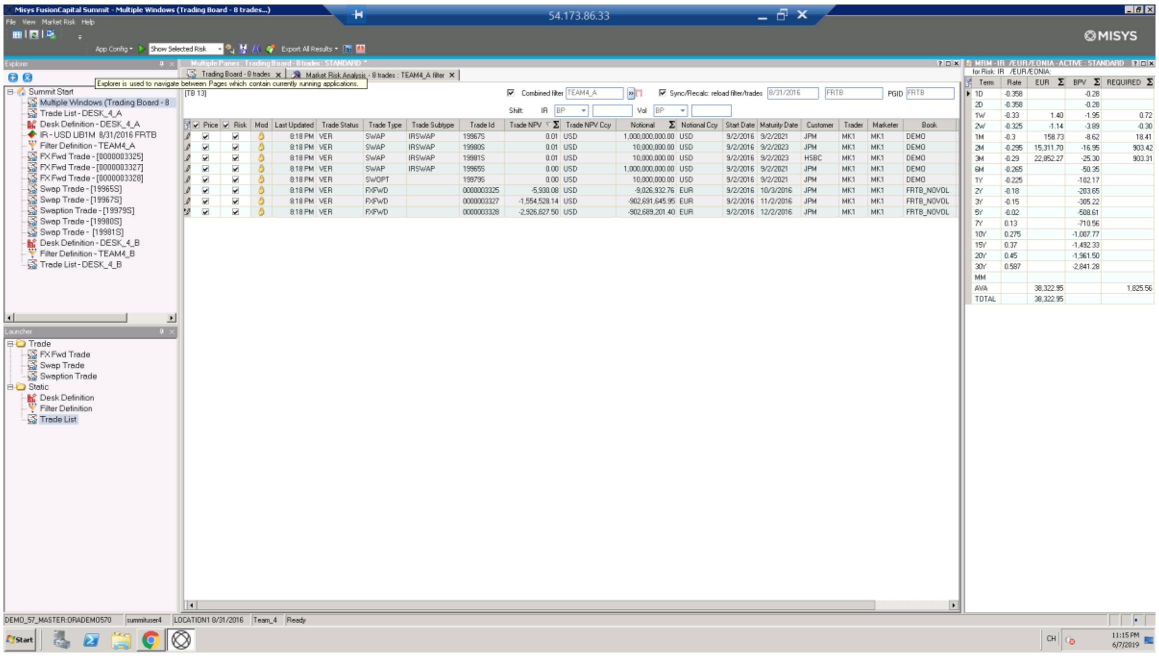
Capstone Homework One Report

Team 4

6/7/2019

I.Trades and FRTB dashboard

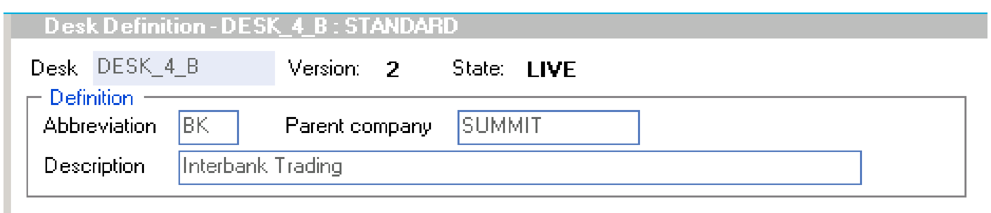
The final interface (shows the trading board) of Summit is like this:

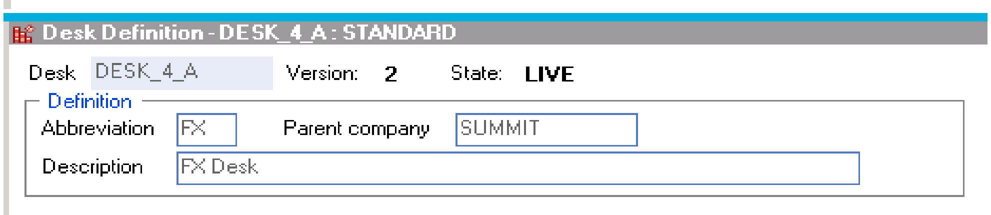


Set desk structures and enter trades:

We defined two desks: Desk_4_A and Desk_4_B. Desk_4_A is for trading foreign exchange forward, and Desk_4_B is for interbank trading.

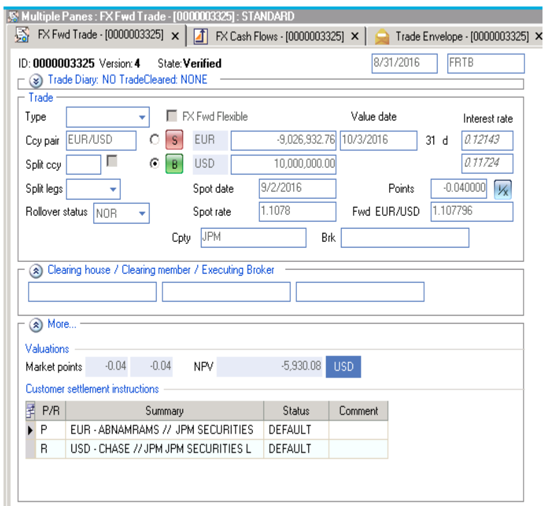
Here are the screenshots:



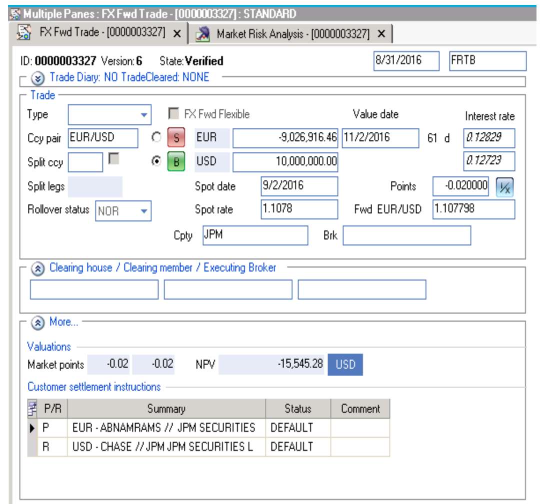


Then we entered each trade into their desk, and the result shows like this:

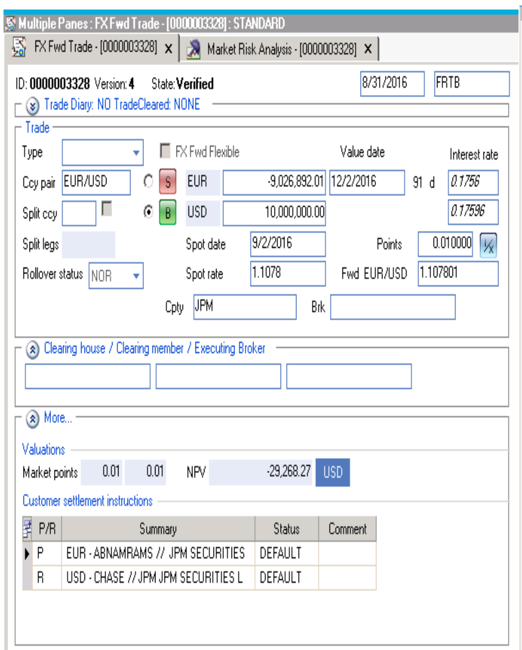
a)USD/EUR; 10,000,000; 1M Fwd



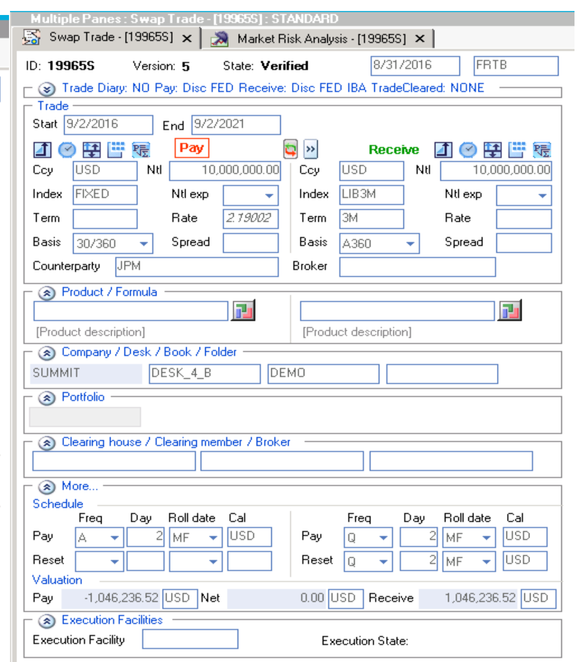
b)USD/EUR; 10,000,000; 2M Fwd



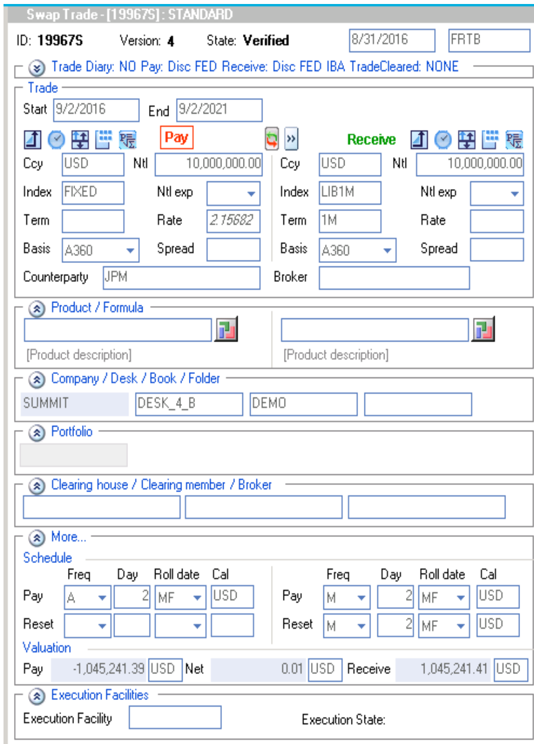
c)USD/EUR; 10,000,000; 3M Fwd

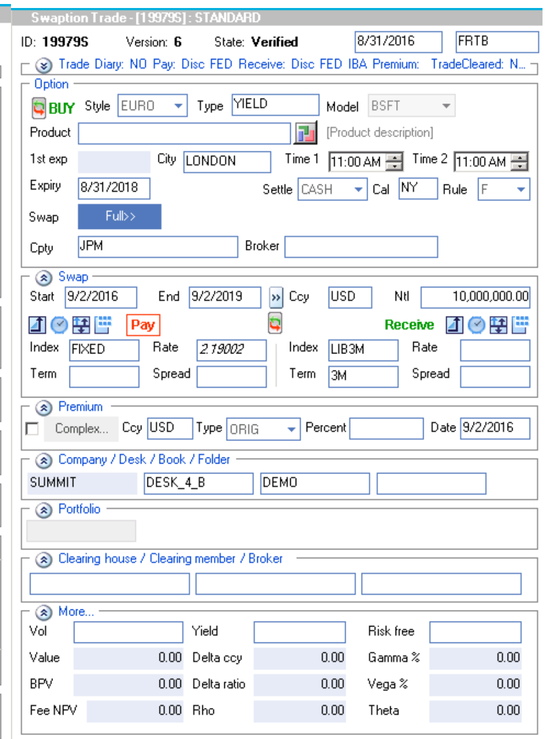


d)USD LIB3M Swap, 5Y; 10,000,000

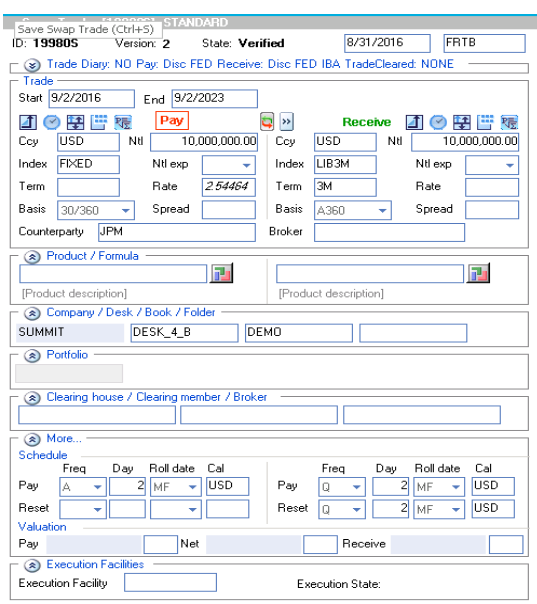


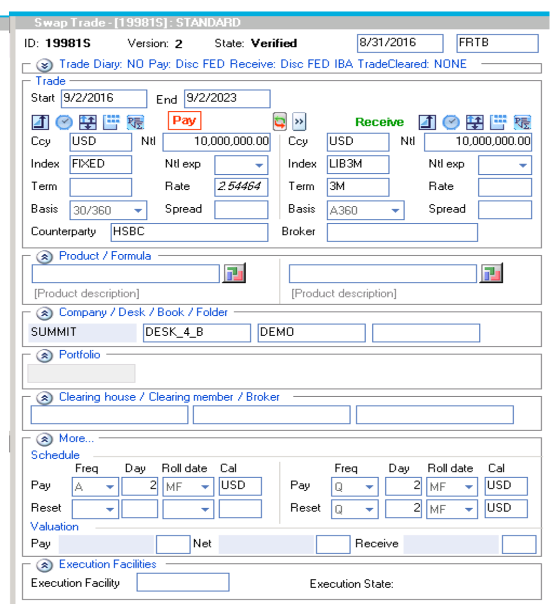
e)USD LIB1M Swap, 5Y; 10,000,000 f)USD LIB3M Swaption with same Delta as 4)





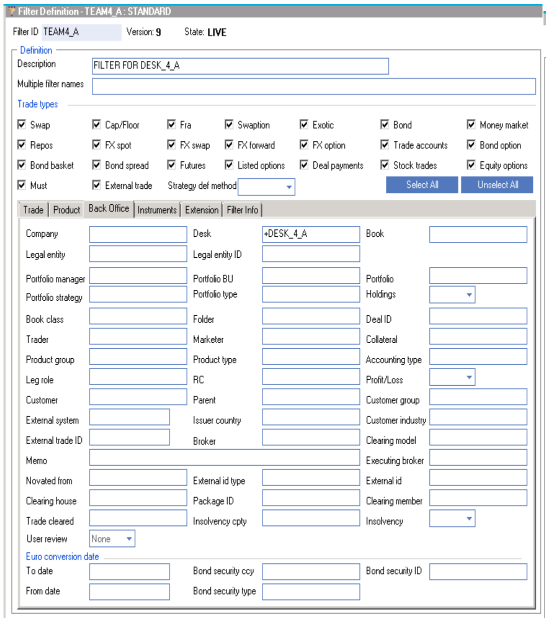
g)Pay Fixed Swap Collateralized; Receive Fixed Swap Uncollateralized; 10,000,000, 7Y

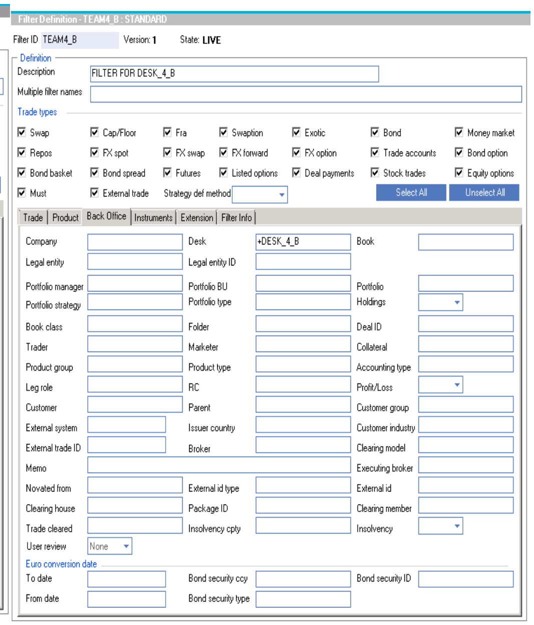




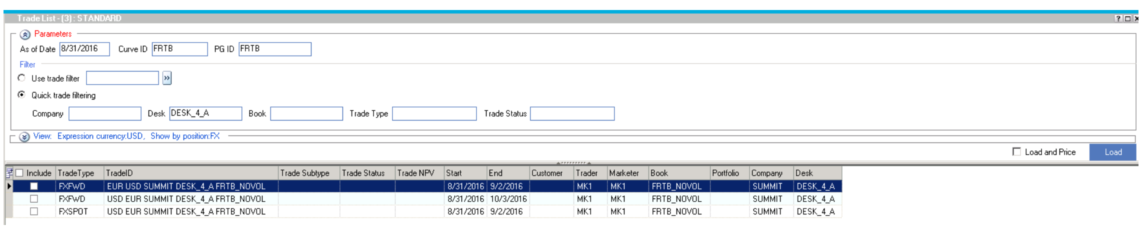
NPV and full hedge for each desk:

First, we defined a filter TEAM4_A and TEAM4_B to find the trades of each desk.

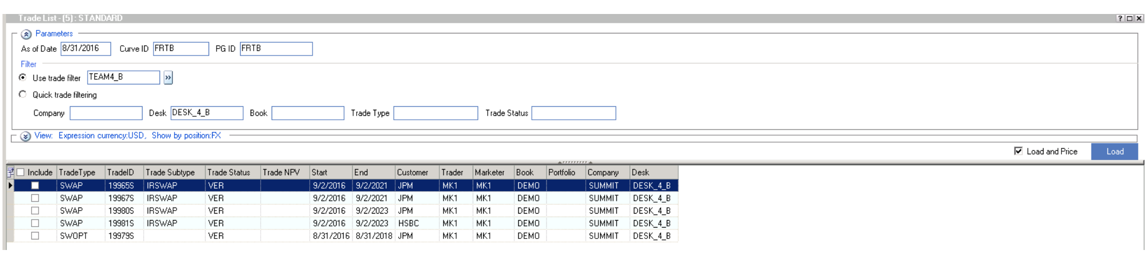




Then, we can get the trading list for each desk:

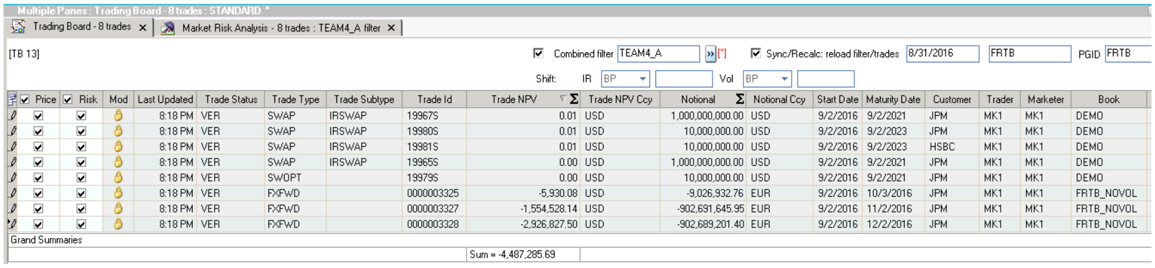


Include	TradeType	TradeID	Trade Subtype	Trade Status	Trade NPV	Start	End	Customer	Trader	Marketer	Book	Portfolio	Company	Desk
☐	FXFWD	EUR USD SUMMIT DESK_4_A FRTB_NOVOL				8/31/2016	9/2/2016		MK1	MK1	FRTB_NOVOL		SUMMIT	DESK_4_A
☐	FXFWD	USD EUR SUMMIT DESK_4_A FRTB_NOVOL				8/31/2016	10/3/2016		MK1	MK1	FRTB_NOVOL		SUMMIT	DESK_4_A
☐	FXSPOT	USD EUR SUMMIT DESK_4_A FRTB_NOVOL				8/31/2016	9/2/2016		MK1	MK1	FRTB_NOVOL		SUMMIT	DESK_4_A



Include	TradeType	TradeID	Trade Subtype	Trade Status	Trade NPV	Start	End	Customer	Trader	Marketer	Book	Portfolio	Company	Desk
☐	SWAP	19965S	IRSWAP	VER		9/2/2016	9/2/2021	JPM	MK1	MK1	DEMO		SUMMIT	DESK_4_B
☐	SWAP	19967S	IRSWAP	VER		9/2/2016	9/2/2021	JPM	MK1	MK1	DEMO		SUMMIT	DESK_4_B
☐	SWAP	19980S	IRSWAP	VER		9/2/2016	9/2/2023	JPM	MK1	MK1	DEMO		SUMMIT	DESK_4_B
☐	SWAP	19981S	IRSWAP	VER		9/2/2016	9/2/2023	HSBC	MK1	MK1	DEMO		SUMMIT	DESK_4_B
☐	SWOPT	19979S		VER		8/31/2016	8/31/2018	JPM	MK1	MK1	DEMO		SUMMIT	DESK_4_B

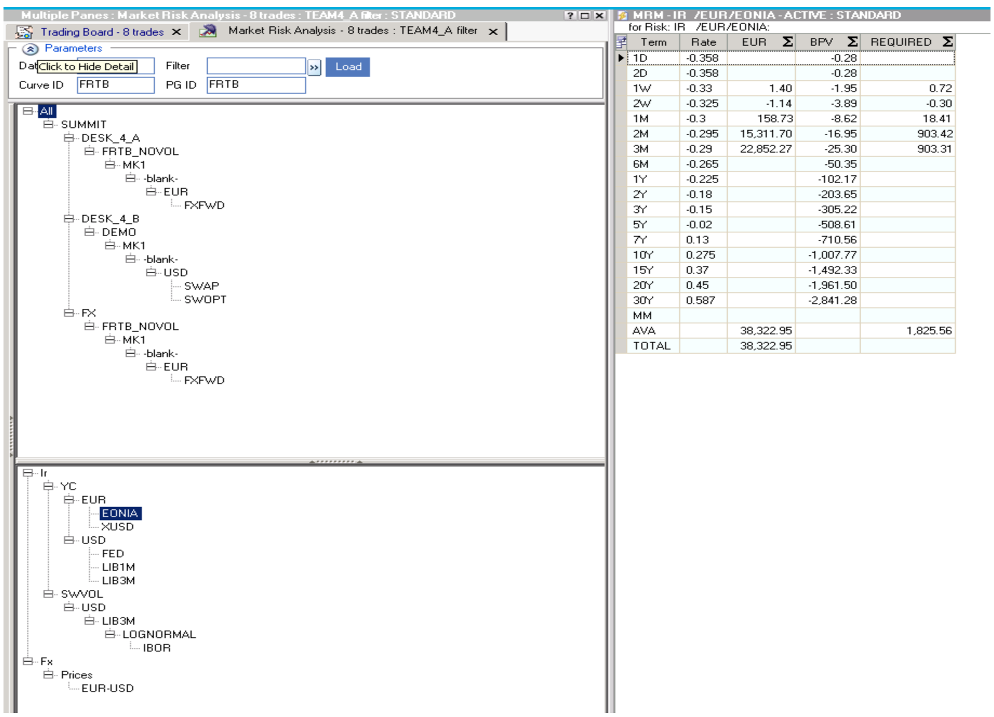
Finally, we can get the NPV of each desk:



Price	Risk	Mod	Last Updated	Trade Status	Trade Type	Trade Subtype	Trade Id	Trade NPV	Trade NPV Ccy	Notional	Notional Ccy	Start Date	Maturity Date	Customer	Trader	Marketer	Book
☑	☑		8:18 PM	VER	SWAP	IRSWAP	19967S	0.01	USD	1,000,000,000.00	USD	9/2/2016	9/2/2021	JPM	MK1	MK1	DEMO
☑	☑		8:18 PM	VER	SWAP	IRSWAP	19980S	0.01	USD	10,000,000.00	USD	9/2/2016	9/2/2023	JPM	MK1	MK1	DEMO
☑	☑		8:18 PM	VER	SWAP	IRSWAP	19981S	0.01	USD	10,000,000.00	USD	9/2/2016	9/2/2023	HSBC	MK1	MK1	DEMO
☑	☑		8:18 PM	VER	SWAP	IRSWAP	19965S	0.00	USD	1,000,000,000.00	USD	9/2/2016	9/2/2021	JPM	MK1	MK1	DEMO
☑	☑		8:18 PM	VER	SWOPT		19979S	0.00	USD	10,000,000.00	USD	9/2/2016	9/2/2021	JPM	MK1	MK1	DEMO
☑	☑		8:18 PM	VER	FXFWD		0000003325	-5,930.08	USD	-9,026,932.76	EUR	9/2/2016	10/3/2016	JPM	MK1	MK1	FRTB_NOVOL
☑	☑		8:18 PM	VER	FXFWD		0000003327	-1,554,528.14	USD	-902,691,645.95	EUR	9/2/2016	11/2/2016	JPM	MK1	MK1	FRTB_NOVOL
☑	☑		8:18 PM	VER	FXFWD		0000003328	-2,926,827.50	USD	-902,689,201.40	EUR	9/2/2016	12/2/2016	JPM	MK1	MK1	FRTB_NOVOL
Grand Summaries								Sum = -4,487,285.69									

For Desk_4_A, the total NPV is 0, and for Desk_4_B the total NPV is -4487285.69.

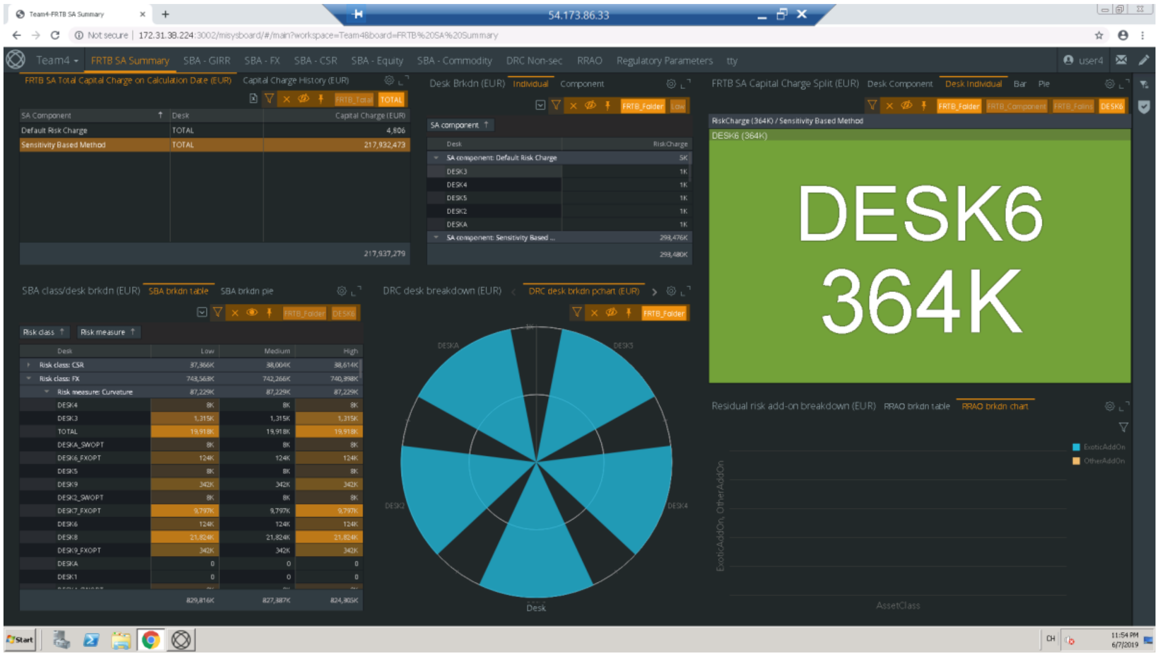
The MARKET RISK ANALYSIS (HEDGE) of the portfolio is shown below:



Term	Rate	EUR	BPV	REQUIRED
1D	-0.358		-0.28	
2D	-0.358		-0.28	
1W	-0.33	1.40	-1.95	0.72
2W	-0.325	-1.14	-3.89	-0.30
1M	-0.3	158.73	-8.62	18.41
2M	-0.295	15,311.70	-16.95	903.42
3M	-0.29	22,852.27	-25.30	903.31
6M	-0.265		-50.35	
1Y	-0.225		-102.17	
2Y	-0.18		-203.65	
3Y	-0.15		-305.22	
5Y	-0.02		-508.61	
7Y	0.13		-710.56	
10Y	0.275		-1,007.77	
15Y	0.37		-1,492.33	
20Y	0.45		-1,961.50	
30Y	0.587		-2,841.28	
MM				
AVA		38,322.95		1,825.56
TOTAL		38,322.95		

To avoid repetition, I only put the market risk screenshot of the portfolio against EONIA here, and you can get the full market risk analysis by clicking the different label.

Create a workspace in UXP called Team4:



I used the FRTB interface for our team.

II. Standard Approach

Texts in red are outline for the calculation. Others are comments and explanations.

Standardized approach capital requirement is the **simple sum of three components**:

1. Capital requirement under the sensitivities-based method:
   Aggregating three risk measures: **1. delta, 2. vega and 3. Curvature**; To calculate the overall capital requirement, the risk-weighted sensitivities are aggregated using **specified correlation parameters** to recognize diversification benefits between risk factors; calculate three sensitivities-based method capital requirement values, based on **three different scenarios on the specified values** for the correlation parameters

   These sensitivities are risk-weighted and then aggregated, first within risk buckets then across buckets within the same risk class

   Instruments subject to delta: all instruments held in trading desks (some exclusion)
   Instruments subject to vega and curvature: 1. Optionality 2. prepayment option 3. CF not linear function of underlying notional 4. All other instruments subject to delta risk

   Process to calculate the capital requirement under the sensitivities-based method:

   1. Aggregate risk weight sensitivities to risk factors to calculate delta and vega risk positions for each risk class
      For each risk class, a bank must determine its instruments' sensitivity to a set of prescribed risk factors, risk weight those sensitivities, and aggregate the resulting risk-weighted sensitivities separately for delta and vega risk:
      a. Determine **sensitivity** for each risk factor

         expressed in the reporting currency of the bank

         sensitivities are calculated as the change in the market value of the instrument as a result of applying a specified shift to each risk factor, assuming all the other relevant risk factors are held at the current level

         Delta calculation for each factor specified in MAR21.19-MAR21.24

Vega calculation specified in MAR21.25, 21.26

b. **Net sensitivities** to the same risk factor across all instruments in the portfolio to each risk factor k.
c. **Weighted sensitivity**: product of the net sensitivity and the corresponding risk weight
d. **Within bucket aggregation**: aggregating the weighted sensitivities to risk factors within the same bucket using the prescribed correlation
e. **Across bucket aggregation**: aggregating the risk positions across the delta (respectively vega) buckets within each risk class, using the corresponding prescribed correlations

2. Calculate curvature risk

   To calculate curvature risk capital requirements a bank must apply an upward shock and a downward shock to each prescribed risk factor and calculate the incremental loss for instruments sensitive to that risk factor above that already captured by the delta risk capital requirement

   a. For each instrument sensitive to curvature risk factor k, an upward shock and a downward shock must be applied to k. The size of shock (ie risk weight) is set out in [MAR21.98] and [MAR21.99].
   b. Calculate **net curvature risk capital requirement**

$$CVR_k^+ = -\sum_i \left\{ V_i\left(x_k^{RW(Curvature)^+}\right) - V(x_k) - RW_k^{Curvature} \times s_{ik} \right\}$$

$$CVR_k^- = -\sum_i \left\{ V_i\left(x_k^{RW(Curvature)^-}\right) - V(x_k) + RW_k^{Curvature} \times s_{ik} \right\}$$

   c. **Within bucket aggregation:** the curvature risk exposure must be aggregated within each bucket using the corresponding prescribed correlation
   d. **Across bucket aggregation:** curvature risk positions must then be aggregated across buckets within each risk class, using the corresponding prescribed correlations

3. Aggregated risk class level capital requirement to obtain the capital requirement at the entire portfolio level

   Aggregation of bucket level capital requirements and risk class level capital requirements per each risk class for delta, vega, and curvature must be repeated, corresponding to three different scenarios on the specified values for the correlation parameter

a. For each of three correlation scenarios, sum up the separately calculated delta, vega and curvature capital requirements for all risk classes to determine the overall capital requirement for that scenario.
b. Take maximum as the capital requirement

2. Default risk capital (DRC) requirement
   Captures the jump-to-default risk for instruments subject to credit risk; calibrated based on the credit risk treatment in the banking book in order to reduce the potential discrepancy in capital requirements for similar risk exposures across the bank
   a. Computed separately **gross JTD risk** of each exposure
   b. **Net long / short exposure** amounts per distinct obligor: With respect to the same obligator, the JTD amounts of long and short exposures are offset (where permissible) to produce net long and/or net short exposure amounts per distinct obligor.
   c. Net JTD risk positions are then **allocated to buckets**.
   d. Calculate **hedge benefit ratio** within a bucket using net long and short JTD risk positions. This acts as a discount factor that reduces the amount of net short positions to be netted against net long positions within a bucket. A prescribed risk weight is applied to the net positions which are then aggregated.
   e. Bucket level DRC requirements are aggregated as a simple sum across buckets to give the overall DRC requirement.

3. Residual risk add-on (RRAO):
   Ensure sufficient coverage of market risks for instruments
   Instruments with an exotic underlying and instruments bearing other residual risks are subject to the RRAO.
   RRAO is the simple sum of gross notional amounts of the instruments bearing residual risks, multiplied by a risk weight.
   a. The risk weight for instruments with an exotic underlying specified in [MAR23.3] is 1.0%.
   b. The risk weight for instruments bearing other residual risks specified in [MAR23.4] is 0.1%

III. Internal Model Approach

1 In order to use the IMA to determine market risk capital requirements, each trading desk must satisfy profit and loss attribution (PLA) tests on an ongoing basis. The bank must identify the set of risk factors to be used to determine its market risk capital requirements to conduct the PLA test.

2 As set out in [MAR32.4] to [MAR32.19], each trading desk also must satisfy back testing requirements on an ongoing basis to be eligible to use the IMA to determine market risk capital requirements.

3 Banks must update procedure 1 and 2 on a quarterly basis to test the eligibility and trading desk classification in PLA for trading desks in-scope to use the IMA.

4 Use ES models, [MAR33.1] to [MAR33.15], to determine the market risk capital requirements for risk factors that satisfy the risk factor eligibility test as set out, [MAR31.12] to [MAR31.24].

(1) calculation of expected shortfall

1. 97.5th percentile, one –tailed confidence level is applied.
2. the liquidity horizons described in [MAR33.12] must be reflected by scaling an ES calculated on a base horizon. *LHj* is the liquidity horizon *j*, with lengths in the following table:

Liquidity horizons, j — Table 1

j	LH_j
1	10
2	20
3	40
4	60
5	120

$$ES = \sqrt{(ES(P))^2 + \sum_{j \geq 2}\left(ES_T(P,j)\sqrt{\frac{(LH_j - LH_{j-1})}{T}}\right)^2}$$

3. The ES measure must be calibrated to a period of stress. This calibration is to be based on an indirect approach using a reduced set of risk factors. Banks must specify a reduced set of risk factors that are relevant for their portfolio and for which there is a sufficiently long history of observations.

   This reduced set of risk factors is subject to supervisory approval and must meet the data quality requirements for a modellable risk factor as outlined in [MAR31.12] to [MAR31.24].

   The identified reduced set of risk factors must be able to explain a minimum of 75% of the variation of the full ES model (ie the ES of the reduced set of risk factors should be at least equal to 75% of the fully specified ES model on average measured over the preceding 12-week period).

4. ES for market risk capital purposes

   The ES for the portfolio using the above reduced set of risk factors ($EEEERR,SS$), is calculated based on the most severe 12-month period of stress available over the observation horizon.

   $EEEERR,SS$is then scaled up by the ratio of (i) the current ES using the full set of risk factors to (ii) the current ES measure using the reduced set of factors. For the purpose of this calculation, this ratio is floored at 1.

   ESF,C is the ES measure based on the current (most recent) 12-month observation period with the full set of risk factors; and

   ESR,C is the ES measure based on the current period with a reduced set of risk factors.

$$ES = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}$$

5. The liquidity horizon n is determinate as below.

Liquidity horizon n by risk factor — Table 2

Risk factor category	*n*	Risk factor category	*n*
Interest rate: specified currencies - EUR, USD, GBP, AUD, JPY, SEK, CAD and domestic currency of a bank	10	Equity price (small cap): volatility	60
Interest rate: unspecified currencies	20	Equity: other types	60
Interest rate: volatility	60	Foreign exchange (FX) rate: specified currency pairs[1]	10
Interest rate: other types	60	FX rate: currency pairs	20
Credit spread: sovereign (investment grade, or IG)	20	FX: volatility	40
Credit spread: sovereign (high yield, or HY)	40	FX: other types	40
Credit spread: corporate (IG)	40	Energy and carbon emissions trading price	20
Credit spread: corporate (HY)	60	Precious metals and non-ferrous metals price	20
Credit spread: volatility	120	Other commodities price	60
Credit spread: other types	120	Energy and carbon emissions trading price: volatility	60
		Precious metals and non-ferrous metals price: volatility	60
Equity price (large cap)	10	Other commodities price: volatility	120
Equity price (small cap)	20	Commodity: other types	120
Equity price (large cap): volatility	20		

Footnotes

[1] USD/EUR, USD/JPY, USD/GBP, USD/AUD, USD/CAD, USD/CHF, USD/MXN, USD/CNY, USD/NZD, USD/RUB, USD/HKD, USD/SGD, USD/TRY, USD/KRW, USD/SEK, USD/ZAR, USD/INR, USD/NOK, USD/BRL, EUR/JPY, EUR/GBP, EUR/CHF and JPY/AUD. Currency pairs forming first-order crosses across these specified currency pairs are also subject to the same liquidity horizon.

(2) calculation of capital requirement for modellable risk factors

The aggregate capital requirement for modellable risk factors, IMCC, is calculated as below

$$IMCC = \rho(IMCC(C)) + (1-\rho)\left(\sum_{i=1}^{B} IMCC(C_i)\right)$$

where $IMCC(C) = ES_{R,S}\frac{ES_{F,C}}{ES_{R,C}}$ and $IMCC(C_i) = ES_{R,S,i}\frac{ES_{F,C,i}}{ES_{R,C,i}}$

5 Use stressed expected shortfall (SES) models, [MAR33.16] to [MAR33.17], to determine the market risk capital requirements for risk factors that do not satisfy the risk factor eligibility test

non-modellable risk factors

$$SES = \sqrt{\sum_{i=1}^{I} ISES_{NM,i}^2} + \sqrt{\sum_{j=1}^{J} ISES_{NM,j}^2} + \sqrt{\left(\rho * \sum_{k=1}^{K} SES_{NM,k}\right)^2 + (1-\rho^2) * \sum_{k=1}^{K} SES_{NM,k}^2}$$

6 default risk capital requirement

(1) value-at-risk (VaR)

(2) PD

(3) LGD

7 model-ineligible trading desk

(1) out-of-scope or ineligible

(2) calculated by aggregation, SA

8 Aggregation

(1) non-DRC

$$C_A = max\{IMCC_{t-1} + SES_{t-1};\ m_c \cdot IMCC_{avg} + SES_{avg}\}$$

(2) ACRtotal

$$ACR_{total} = min\{IMA_{G,A} + Capital\ surcharge + C_U\ ;\ SA_{all\ desk}\} + max\{0;\ IMA_{G,A} - SA_{G,A}\}$$

(3) surcharge

$$Capital\ surcharge = k \cdot max\{0, SA_{G,A} - IMA_{G,A}\}$$

IV. P&L Attribution

What is P&L?

Profit and loss (P&L) attribution (PLA): a method for assessing the robustness of banks' risk management models by comparing the risk-theoretical P&L predicted by trading desk risk management models with the hypothetical P&L.

Why do we need PLA test (P&L Attribution test)?

A bank must pass PLA test at the trading desk level to use the internal model approach (IMA) to determine market risk capital requirement for a trading desk. The implementation of the PLA test must begin on the date that the IM capital requirement becomes effective.

What does PLA test do?

The PLA test compares daily risk-theoretical P&L (RTPL) with the daily HPL for each trading desk. It intends to: (1) measure the materiality of simplifications in the bank's internal models; (2) prevents banks from using such models when such simplifications are considered material.

Requirements

- Must be performed on a standalone basis for each trading desk in scope for the use of the IMA.
- Both APL and HPL must be computed based on the same pricing models (e.g. same pricing functions, pricing configurations, model parametrization, market data, and systems) as the ones used to produce the reported daily P&L.
- RTPL:
    - The daily trading desk-level P&L by the valuation engine of the trading desk's risk management model, which must include all risk factors that are included in the banks expected shortfall(ES) model with supervisory parameters as well as any risk factors that are considered not modellable(not in ES model). It must not include any factors that the bank does not include in its trading desk's risk management model.
    - Should include all movements in all risk factors contained in the trading desk's risk management model.
- HPL used for PLA test should be identical to the HPL used for backtesting. This tells if the risk factors included and the valuation engines used in the trading desk's risk management model captures the material driver of the bank's P&L.

- HPL must be calculated by revaluing the positions held at the end of the previous day using market data of the present day. No intraday trading nor new nor modified deals.
- What to include and not to include:
    - Fees and commissions must be excluded from both APL and HPL as well as valuation adjustments for which separate regulatory capital approaches.
    - Any other market risk-related valuation adjustments must be included in the APL
    - only valuation adjustments updated daily must be included in the HPL unless the bank receives agreements that say otherwise.
    - Smoothing of valuation adjustments that are not calculated daily is not allowed. P&L due to the passage of time should be included in the APL and should be treated consistently in both HPL and RTPL.
    - Valuation adjustments that the bank is unable to calculate at the trading desk level are not required to be included in the HPL and APL for backtesting at the trading desk level but should be included for bank-wide backtesting. The bank must provide support for valuation adjustments that are not computed at a trading desk level.

Data Input Alignment

- Banks are allowed to align RTPL input data for its risk factors with the data used in HPL if these alignments are documented, justified to the supervisory authority and the certain requirements are fulfilled (see requirements on page 91).
- Adjustments to RTPL input data will be allowed when the input data for a given risk factor that is included in both RTPL and HPL differs due to different market data sources. Following adjustments can be done:
    - Directly replace the RTPL input data with HPL input data
    - Use the HPL input data to calculate the risk factor data needed in the RTPL/ES model
- If the HPL uses market data in a different manner to RTPL to calculate risk parameters that are essential to the valuation engine, the PLA test must reflect these differences, and therefore the results of HPL and RTPL. In this regard, HPL and RTPL are allowed to use the same market data only as a basis but must use their respective methods (which can differ) to calculate the respective valuation engine parameters.
- Banks are not permitted to align HPL input data for risk factors with input data used in RTPL.

PLA TEST

The New Version (Jan 2019)

There are two test metrics:

Metrics	What it measures
The Spearman Correlation Metric	Correlation between RTPL and HPL
The Kolmogorov-Smirnov Test Metric	Similarity in distribution of RTPL and HPL

To calculate each test metric for a trading desk, the bank must use the time series of the most recent 250 trading days of observations of RTPL and HPL.

Calculation Steps:

The Spearman Correlation Metric

- Rank the HPL return time series of based on the size of the P&L, from lowest to highest.
- Rank the RTPL return time series of based on the size of the P&L, from lowest to highest.
- Calculate correlation coefficient of the two time series using the formula below
  - $$r_S = \frac{cov(R_{HPL}, R_{RTPL})}{\sigma_{R_{HPL}} \times \sigma_{R_{RTPL}}}$$

- The Kolmogorov-Smirnov Test Metric
  - Calculate the empirical cumulative distribution function of RTPL
    - Empirical cumulative distribution is the product of 0.004 and the number of RTPL obs. that are less than or equal to the specified RTPL
  - Calculate the empirical cumulative distribution function of HPL
    - Empirical cumulative distribution is the product of 0.004 and the number of HPL obs. that are less than or equal to the specified HPL
  - KS test metric is the max absolute difference observed between these two functions at any P&L value

PLA Metrics Evaluation

Zone	Spearman Corr	AND/OR	KS
Green	>0.8	AND	<0.09
Amber	Neither Green nor Red		
Red	<0.7	OR	>0.12

- PLA Test Red Zone: ineligible to use IMA, must use SA

        - Risk exposures held by these ineligible trading desks must be included with the out-of-scope trading desks for purposes of determining capital requirement per the standardized approach.
        - A trading desk deemed ineligible to use the IMA must remain out-of-scope to use the IMA until:
            - the trading desk produces outcomes in the PLA test green zone; and
            - has satisfied the backtesting exceptions requirements over the past 12 months
    - PLA Test Amber Zone: not considered an out-of-scope trading desk for use of IMA
        - If a trading desk is in amber, it cannot return to green zone until:
            - the trading desk produces outcomes in the PLA test green zone; and
            - has satisfied its backtesting exceptions requirements over the prior 12 months
        - Trading desks in the PLA test amber zone are subject to a capital surcharge as specified in [MAR33.43]

The Old Version (Jan 2016)

There are two test metrics

- Metric 1: The mean of the difference between the risk-theoretical and hypothetical P&L (unexplained P&L) divided by the standard deviation of the hypothetical P&L; and
- Metric 2: The variance of the unexplained P&L divided by the variance of the hypothetical P&L.
- Calculated monthly and reported prior to the end of the following month

PLA Metrics Evaluation

- Experience a breach if:
    - Metric 1 is outside of the range of -10% to +10%, OR
    - Metric 2 is greater than 20%
- If the desk experiences four or more breaches within the prior 12 months:
    - Must be capitalized under SA
    - Must remain standardized methodology on a portfolio basis