ActiveViam

FRTB Accelerator Interpretation and Implementation of BCBS 457

SBM FX

4.0

Contents

1 FX **4**
1.1 Implementation Note . . . 4
1.1.1 Base Currency and Jurisdiction . . . 4
1.1.2 Base Currency Ambiguity . . . 5
1.1.3 Risk Factor and Bucket Naming . . . 5
1.2 Data Model (Core) . . . 6
1.2.1 Sensitivities . . . 6
1.2.2 Risk Factor [MAR10.9] . . . 7
1.3 Calculations . . . 8
1.3.1 ETL (Reference Implementation) . . . 9
1.3.2 Risk Factor Name . . . 9
1.3.3 Normalisation . . . 9
1.3.4 Vectorisation . . . 9
1.3.5 Interpolation . . . 10
1.3.6 Query Time (Core) . . . 10
1.4 Delta and Vega . . . 10
1.5 Curvature . . . 10
1.6 Input Files (Reference Implementation) . . . 15
1.6.1 SBM_Delta_Sensitivities*.csv . . . 15

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.6.2 SBM_Vega_Sensitivities*.csv . . . 16
1.6.3 SBM_Curvature_Sensitivities*.csv . . . 17
1.7 Config Files . . . 18
1.7.1 frtb-config.properties . . . 18
1.8 Datastore (Reference Implementation) . . . 20
1.8.1 Risk Factor Descriptions . . . 20
1.8.2 Sensitivities . . . 20
1.8.3 TradeBase . . . 21
1.8.4 RiskFactorDescription . . . 22
1.8.5 UnderlyingDescription . . . 22
1.8.6 Delta . . . 23
1.8.7 Vega . . . 24
1.8.8 Curvature . . . 25
1.9 Cube Schema (Reference Implementation) . . . 26
1.10 Configuration (Core) . . . 26
1.10.1 Delta Special Crosses . . . 27
1.10.2 Vertices . . . 27
1.10.3 Vega Liquidity Horizons . . . 28
1.10.4 Miscellaneous Parameters . . . 28

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1 FX

This section describes how the SBM FX Risk Class is implemented and how the BCBS 457 specification is interpreted.

Also covered here is the specialization of the data, calculations, and configuration for the FX risk-class, including:

- The data model, which describes the data used for the calculations and how it is structured, and how the data model is represented in the:
  - input files
  - datastore
  - cube
- The calculations, both in the ETL and at query time
- The parameters used in the query time calculations
- How the accelerator is configured for FX

1.1 Implementation Note

1.1.1 Base Currency and Jurisdiction

the FRTB Accelerator provides support for using a base currency, as described in [MAR21.14], and for changing the base and reference currencies as part of the jurisdictional support. This support involves transformations and filtering of the sensitivities and risk-factors; the details of this are documented in [FRTB FX Base and

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Reporting Currencies](../../../../../Content/PDFs_home-page/FRTB FX Base and Reporting Currencies v1.0 2019-06-28.pdf) and are beyond the scope of the current document.

If base currency and jurisdictional support are not required, then setting the counter currency to be the same as the reporting currency for all FX Delta and Curvature risk-factors (as in [MAR21.24](2)) will avoid the translations and filters.

For Vega, no translations or filters are applied.

1.1.2 Base Currency Ambiguity

When computing the FX Delta sensitivity in [MAR21.24], the FX spot rate used will be for the currency pair whose *right hand* currency is the bank's "base currency". This is the opposite of the common definition of a currency pair where the term "base currency" is often used to refer to the *left hand* currency of the pair.

1.1.3 Risk Factor and Bucket Naming

In the BCBS 457 specification, for Delta and Curvature the FX risk-factors are a currency pair where the counter currency is the reporting/base currency ([MAR21.14]), and similarly for the FX buckets ([MAR21.86]).

Because the reporting/base currency is fixed when calculating the capital charge, it can be dropped from the bucket name. So that the Delta and Curvature buckets are the left-hand side of the currency pair. This is consistent with worked example 3 in the note that accompanies BCBS 457.

The risk-factor name, when generated will still be the currency pair as this is used when supporting multiple jurisdictions.

For FX Vega, the currency pair is not restricted to the reporting/base currency. So the bucket name is the currency pair.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.2 Data Model (Core)

This section describes the data used for the FX calculations, including how the data is structured. This is a simplified description, for details on jurisdictional support including handling the reporting/base currency, see accompanying "FRTB FX Base and Reporting Currencies" document.

For FX Delta and Curvature, the **Risk Factor Currency** (Underlying) refers to the FX rate between the instrument currency and the reporting/base currency [MAR21.14](1). For FX Vega, the **Currency Pair** (Underlying) refers to the FX rate [MAR21.14](2).

The **Risk Factor** is used to identify sensitivities. However, it is not used directly in the calculations, instead the **Risk Factor Currency**, **Counter Currency**, **Currency Pair**, and tenor fields are used (as appropriate for the risk-measure). This means that multiple **Risk Factor Names** may be used for the same risk-factor.

The **Bucket** is the same as the **Risk Factor Currency** or **Currency Pair**.

1.2.1 Sensitivities

Field	Key	Risk Measure	Description
As-of Date	Y	All	Timestamp (at close of business) for the data (T-1)
Trade ID	Y	All	A unique identifier for the trade (or position)
Risk Factor Name	Y	All	A unique identifier for the risk-factor (not including vertices)
Risk Class	Y	All	"FX"
Risk Measure	Y	All	"Delta", "Vega", or "Curvature"
Option Maturity	Y	Vega	The maturity of the option
Sensitivity		Delta & Vega	The sensitivity value s_k
Shock Up/Down		Curvature	The up and down shocked prices.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Field	Key	Risk Measure	Description
Sensitivity Currency		All	Currency in which the sensitivity or shocked price is expressed.
Risk Weight		Curvature	Risk weight used for the shocked prices
PV Applied		Curvature	Has the PV been subtracted from the shocked prices?
Optionality		Delta	Should the Delta sensitivity be included in the Curvature Calculation?
Interpolated Sensitivities		Vega	Sensitivities interpolated to the prescribed vertices

1.2.2 Risk Factor [MAR10.9]

The **Risk Factor** is used to identify sensitivities. However, it is not used directly in the calculations, instead the Underlying, **Counter Currency**, and tenor fields are used (as appropriate for the risk-measure). This means that multiple **Risk Factor Names** may be used for the same risk-factor.

For Delta and Curvature, the **Risk Factor Currency** (Underlying) refers to the FX rate between the instrument currency and the reporting/base currency [MAR21.14](1). For Vega, the **Currency Pair** (Underlying) refers to the FX rate [MAR21.14](2).

Field	Key	Risk Measure	Description
As-of Date	Y	All	Timestamp (at close of business) for the data (T-1)
Risk Factor Name	Y	All	A name for the risk-factor (not including vertices, for Vega)
Risk Class	Y	All	“FX”
Risk Measure	Y	All	“Delta”, “Vega”, or “Curvature”
Option Maturity	Y	Vega	The maturity of the option (Vega)
Risk Factor Currency (Underlying)		Delta & Curvature	The left-hand side of the risk-factor currency pair

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Field	Key	Risk Measure	Description
Counter Currency		Delta & Curvature	The right-hand side of the risk-factor currency pair
Currency Pair (Underlying)		Vega	The risk-factor currency pair

The **Bucket** is the same as the **Risk Factor Currency** or **Currency Pair**.

Implementation notes (vectors of vertices):

- The Vega risk-factor name spans all maturities, so it represents multiple [MAR10.9] risk-factors.
- In the input files (default file format), multiple vertices and sensitivities may either be provided on the same row or different rows.
- In the datastore, we use vectors to store the sensitivities for all tenors.
- In the cubes, we use analysis hierarchies to expand the vectors.

1.3 Calculations

This section describes ETL from the reference implementation and the transformations / calculations applied to the sensitivities in the post-processors after they have been aggregated.

First, the ETL (Extract, Transform, Load) layer will apply some transformations as the data is loaded from the input files into the datastore.

Once the data is loaded into the datastore, it is available in the cube. The sensitivities in the cube may be partially aggregated upon commit to the datastore for BITMAP and LEAF aggregate providers. The remainder of the sensitivity aggregation is performed by ActivePivot at query time.

Then, also at query time, the post-processors calculate the capital charge from the aggregated sensitivities.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.3.1 ETL (Reference Implementation)

The ETL (Extract, Transform, Load) layer provided with the FRTB Accelerator , using the default file format, will perform the following transformations when data is loaded from the input files into the datastore.

1.3.2 Risk Factor Name

If the risk-factor name is not included in the input file (using the default file format), a name is generated as follows:

- **Delta:** *Risk Factor Currency | Counter Currency*
- **Vega:** *Risk Factor Currency | Counter Currency*
- **Curvature:** *Risk Factor Currency | Counter Currency*

1.3.3 Normalisation

In the default file format, each row of the sensitivities' files contains the sensitivity as well as a description of the risk factor. The data normalisation splits this information across three stores in the datastore, as described in the data model above.

1.3.4 Vectorisation

For efficiency, Vega sensitivities are stored in vectors. The entries of the vectors represent the maturities of the risk factors.

In the default file format, we allow sensitivities to be provided as either single values or as vectors. During the ETL, sensitivities are grouped together into vectors.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.3.5 Interpolation

For compatibility with risk engines, Vega sensitivities may be loaded for any maturity. During the ETL, these sensitivities are interpolated to match the maturities in the specification.

1.3.6 Query Time (Core)

For the FX risk class, there are three main chains of post-processor calculations: Delta, Vega, and Curvature.

1.4 Delta and Vega

The calculation steps for Delta and Vega are the same:

1. The calculations start by applying currency conversion to the aggregated raw sensitivities from the cube to get the Sensitivities.
2. The risk-weights are applied to get the Weighted Sensitivities (per risk-factor).
3. The (rho) correlations are then used to calculate the Risk Position (per bucket).
4. The Risk Positions are combined across all buckets to calculate the Risk Charge.

In the bookmarks' folder "ActiveViam FRTB" -> "Basel Framework" -> "SBM", there are bookmarks "FX Delta" and "FX Vega", which contain tabs that walk through these calculation steps and include the measures mentioned here.

1.5 Curvature

For Curvature, the calculation steps are:

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1. Start with vectors of shocked prices indexed by risk-weight (per risk-factor).
2. The risk-weight then determines which Shock Up/Down Prices we want, subtracting the trade **PV** if necessary.
3. The delta sensitivities are filtered sensitivities from the Delta calculations, and aggregated per Curvature risk-factor.
4. These are then combined to calculate the CVR Up/Down (per risk-factor).
5. The Risk Position Up/Down are calculated per bucket.
6. The greater of the up and down risk-positions is identified by the Risk Position Scenario and used for the Risk Position (per bucket).
7. The Risk Positions are combined across all buckets to calculate the Risk Charge.

The bookmark "ActiveViam FRTB" -> "Basel Framework" -> "SBM" -> "FX Curvature" contains tabs that walk through these calculation steps and includes the measures mentioned here.

Delta/Vega Sensitivities

The **Delta/Vega Sensitivities** measures are the s_k in [MAR21.4](1) and (2).

For each **Sensitivity Currency**, the **Interpolated Sensitivities** are converted to the reference currency using the IFxRates API (supplied by the reference implementation). After this currency conversion, the values are aggregated for each **Risk Factor** (Vega) or **Bucket** (Delta).

For Delta, if the **Counter Currency** for a **Risk Factor** does not equal the reporting currency, then filtering and translations may be used. See Base Currency and Jurisdiction.

Delta Sensitivities Long/Short

The **Delta Sensitivities Long/Short** measures are the Positive or Negative **Delta Sensitivities**.

The Positive or Negative determination is made at the **Risk Factor Currency** and **Counter Currency** levels.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Curvature Scenario Up/Down PV.CCY

The **Scenario Up/Down PV.CCY** measures are vectors of shocked prices indexed by risk weight.

For each **Sensitivity Currency**, the **Shock Up/Down** prices are converted to the reference currency using the IFxRates API. After this currency conversion, the values are aggregated for each **Bucket**.

If the **Counter Currency** for a **Risk Factor** does not equal the reporting currency, then filtering may be used. See Base Currency and Jurisdiction.

Delta/Vega/Curvature Risk Weight

The **Delta/Vega/Curvature Risk Weight** measures are RW_k in [MAR21.4](3) and $RW_k^{(Curvature)}$ in [MAR21.5](2)(e).

For Delta and Curvature, following [MAR21.87], the risk weights are looked up from the configuration. For specified currency pairs (and first-order crosses), where the right-hand side of the pair is the base or reporting currency, the risk weight may be divided by the square root of 2 (as per [MAR21.88]).

For Vega, following [MAR21.92], the value is looked up based on the configuration for the **Risk Class** (and its liquidity horizon).

Delta/Vega Weighted Sensitivities

The **Delta/Vega Weighted Sensitivities** measures are WS_k in [MAR21.4](3).

For each **Risk Factor** (Vega) or **Bucket** (Delta), the **Delta/Vega Sensitivities** measures are multiplied by the **Delta/Vega Risk Weight**.

Curvature Delta Sensitivities

The **Curvature Delta Sensitivities** measure is s_{ik} in [MAR21.5](2)(f).

For each Curvature **Bucket**, it is all the **Delta Sensitivities** in the same bucket, filtered by **Optionality**.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Curvature Shock Up/Down Prices

The **Curvature shock-up/down prices** measures are $V_i\left(x_k^{RW^{(Curvature)}\pm}\right) - V_i\left(x_k\right)$ in [MAR21.5](2).

Using linear interpolation, the shocked prices corresponding to the **Curvature Risk Weight** are determined from the **Curvature Scenario UP/Down.CCY** vectors. And, if **PV Applied** is not true/yes, the trade **PV** is subtracted.

Curvature CVR Up/Down

The **Curvature CVR Up/Down** measures are $CVR_k^{\pm}$ in **[MAR21.5]**(2).

The **Curvature Delta Sensitivities** are multiplied by the **Curvature Risk Weight** and subtracted from/added to the **Curvature Shock Up/Down Prices** (respectively).

Delta/Vega Risk Position Double Sums

The **Delta/Vega Risk Position Double Sums** measures are the $\sum_k \sum_l WS_k \cdot WS_l$ intermediate values that were requested for the 2017 and 2018 QIS exercises.

For Delta, since there is only a single **Risk Factor** per bucket, the double sums are the square of the aggregated **Delta Weighted Sensitivities**.

For Vega, within each **Bucket**, each pair of **Risk Factors** is categorised according to the combinations of **Option Maturities**. Within each category, the paris of **Vega Weighted Sensitivities** are multiplied together and summed.

Delta/Vega Risk Position Correlations

The **Delta/Vega Risk Position Correlation** measures are ρ_{kl} in [MAR21.4](4).

For Delta, since there is only a single **Risk Factor** per **Bucket**, the ρ_{kl} correlations are always 100%.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

For Vega, within each **Bucket**, and for each combination of **Option Maturities** (see Risk Position Double Sums) the values are looked up from the configuration for [MAR21.94].

Note: The $\rho_{kl}^{(Delta)}$ in [MAR21.94] is always 100%, since there is only a single Delta **Risk Factor** per **Bucket**.

Delta Vega Risk Position

The **Delta/Vega Risk Position** measures are K_b in [MAR21.4](4).

For each **Bucket**, the **Delta/Vega Risk Position** is calculated from the **Delta/Vega Weighted Sensitivities** and **Delta/Vega Risk Position Correlations** using the formula in [MAR21.4](4).

Implementation Note: This calculation has been optimised so that it is performed with $O(N)$ (linear) time complexity, where N is the number of **Risk Factors**.

Curvature Risk Position Up/Down

The **Curvature Risk Position Up/Down** measures are $K_b^{\pm}$ in [MAR21.5](3).

Within each **Bucket**, the **Curvature CVR Up/Down** values are combined using the formula in [MAR21.5](3).

Implementation Note: This calculation has been optimised so that it is performed with $O(N)$ (linear) time complexity, where N is the number of **Risk Factors**.

Curvature Risk Position Scenario

Within each **Bucket**, the **Curvature Risk Position Scenario** measure identifies which of the **Curvature Risk Position Up** and **Curvature Risk Position Down** values is the greater.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Curvature Risk Position

The **Curvature Risk Position** measure is K_b in [MAR21.5](3).

Within each **Bucket**, it is the greater of the **Curvature Risk Position Up** and **Curvature Risk Position Down** values.

Delta/Vega Risk Charge

The **Delta/Vega Risk Charge** measures are Delta and Vega in [MAR21.4](5).

They are calculated by combining the **Delta/Vega Risk Positions** (and aggregated **Delta/Vega Weighted Sensitivities**) over all **Buckets** according to [MAR21.4](5).

Curvature Risk Charge

The **Curvature Risk Charge** measure is Curvature risk in [MAR21.5](4).

It is calculated by combining the **Curvature Risk Positions** (and aggregated **CVR Up** or **CVR Down** values) over all **Buckets** according to [MAR21.5](4).

1.6 Input Files (Reference Implementation)

This section describes how the input files containing the sensitivities and mappings are used for the FX risk class

The sensitivities are loaded from the Delta, Vega, Curvature, or CRIF sensitivity files.

1.6.1 SBM_Delta_Sensitivities*.csv

The Delta Sensitivity Data is loaded from the **Delta** files.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

The following table lists the fields in the file format that is used for the FX risk-class. See the Delta file format documentation for details on the file format. See Data Model (Core) for a description of the data model.

Data Model Field	File Column	Notes
As-Of Date	AsOfDate	
Trade ID	TradeID	
Sensitivity Currency	DeltaCcy	
Sensitivities	DeltaSensitivities	
Risk Class	RiskClass	"FX"
Risk Factor Name	RiskFactor	(Optional) If not present, generated during ETL.
Risk Factor Currency	Underlying	
Couinter Currency	FXCounterCurrency	
Optionality	Optionality	Should this sensitivity be included in the Curvature calculations ('Y') or not ('N')?
	FxComplexDelta	'Y' to use filtering; 'N' to use automatic translations.
	FxOtherCcy	If the trade involves an FX pair, this is the other currency in the pair.
	FXDividerEligibility	'Y' if the trade does not reference the base/reporting currency; 'N' if it does.

1.6.2 SBM_Vega_Sensitivities*.csv

The Vega Sensitivity Data is loaded from the **Vega** files.

The following table lists the fields in the file format that is used for the FX risk-class. See the Vega file format documentation for details on the file format. See Data

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Model (Core) for a description of the data model.

Data Model Field	File Column	Notes
As-Of Date	AsOfDate	
Trade ID	TradeID	
Risk Class	RiskClass	“FX
Option Maturity	OptionMaturity	May be single value, vector, or empty. If empty, treated as the prescribed maturities: 0.5;1;3;5;10.
Sensitivities	VegaSensitivities	May be single value or vector, with the same number of entries as maturities.
Sensitivity Currency	VegaCcy	
Risk Factor Name	RiskFactor	(Optional) If not present, generated during ETL.
Risk Factor Currency	Underlying	
Counter Currency	FXCounterCurrency	

1.6.3 SBM_Curvature_Sensitivities*.csv

The Curvature Sensitivity Data is loaded from the **Curvature** files.

The following table lists the fields in the file format that are used for the FX risk-class. See the Curvature file format documentation for details on the file format. See Data Model (Core) for a description of the data model.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Data Model Field	File Column	Notes
As-Of Date	AsOfDate	
Trade ID	TradeID	
Risk Class	RiskClass	“FX”
Risk Factor Name	RiskFactor	(Optional) If not present, generated during ETL.
Shock Up	Shift_Up_PV	
Shock Down	Shift_Down_PV	
Sensitivity Currency	CurvatureCcy	
Risk Weight	RiskWeight	(Optional)
PV Applied	PV Applied	Has the Trade PV already been subtracted from the shocked PVs (‘Y’) or not (‘N’)?
Risk Factor Currency	Underlying	
Counter Currency	FXCounterCurrency	
	FXDividerEligibility	‘Y’ if the trade does not reference the base/reporting currency; ‘N’ if it does.

1.7 Config Files

This section describes the reference implementation configuration used for the FX risk class

1.7.1 frtb-config.properties

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Data Model Field	Property	Reference
As-Of Date	as-of-date.level	AsOfDate@Date@Dates
Trade ID	trade.level	TradeId@Trades@Booking
Risk Class	risk-class.level	RiskClass@Risk Classes@Risk
Risk Measure	risk-measure.level	Risk Measure@Risk Measures@Risk
Bucket	fx.buckets.level	FX Bucket@FX Buckets@Buckets
	fx.buckets.original.level	FX Original Bucket@FX Original Buckets@Buckets
Risk Factor Name	risk-factors.level	Risk Factor@Risk Factors@Risk
Option Maturity	fx.vega.option.maturity	Vertex@Vertices@Risk
Risk Factor Curency	risk-factors.level	Underlying@Underlying@Market Data
Counter Currency	fx.counter.ccy.level	FX Counter Currency@FX Counter Currency@Risk
	fx.curvature.divider.level	FX Curvature Divider Eligibility@FX Curvature Divider Eligibility@Risk
	fx.delta.divider.level	FX Delta Divider Eligibility@FX Delta Divider Eligibility@Risk
	fx.delta.other.ccy.level	FX Delta Other Currency@FX Delta Other Currency@Risk
	fx.delta.complex.trade.level	FX Delta Complex Trade@FX Delta Complex Trade@Risk

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Data Model Field	Property	Reference
PV Applied	fx.pv.applied.level	PVApplied@PVApplied@Currencies
	fx.delta.double-sums.levels	Ccy@FX Delta Double Sums@Double Sums
	fx.vega.double-sums.levels	Ccy@FX Vega Double Sums@Double Sums, Maturity1@FX Vega Double Sums@Double Sums, Maturity2@FX Vega Double Sums@Double Sums

1.8 Datastore (Reference Implementation)

This section describes how the SA datastore schema is used for the FX risk class.

The schema starts with the TradeBase store, which is an index of all the facts in the SA Cube. The **TradeBase** store has references to the risk-factor descriptions and sensitivities.

1.8.1 Risk Factor Descriptions

The risk-factor description starts with the RiskFactorDescription store, which contains the description of risk-factor independent of the currency (Delta and Curvature) or currency pair (Vega), and a reference to the UnderlyingDescription store for a description of the currency (Delta and Curvature) or currency pair (Vega).

1.8.2 Sensitivities

The sensitivities stores contain the sensitivity values. They are referenced from the **TradeBase** store.

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Risk Measure	Sensitivity Store
Delta	Delta
Vega	Vega
Curvature	Curvature

1.8.3 TradeBase

The **TradeBase** store is the base store in the SA Cube Schema. Each row in this table represents a fact in the SA Cube.

The following table lists the fields in the store that are used for the FX risk-class. See the TradeBase store documentation for details on the store. See Data Model (Core) for a description of the data model.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Trade ID	TradeId	
Risk Factor Name	Risk Factor	
Risk Class	RiskClass	"FX"
Risk Measure	Risk Measure	"Delta", "Vega", or "Curvature"

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.8.4 RiskFactorDescription

The RiskFactorDescription store contains the description of risk-factor.

The following table lists the fields in the store that are used for the FX risk-class. See the RiskFactorDescription store documentation for details on the store.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Risk Factor Name	Risk Factor	
Risk Class	RiskClass	"FX"
Risk Measure	Risk Measure	"Delta", "Vega", or "Curvature"
Risk Factor Currency	Underlying	
Counter Currency	FXCounterCurrency	

1.8.5 UnderlyingDescription

The **UnderlyingDescription** store is a placeholder for the description of the Risk Factor Currency or Currency Pair.

The following table lists the fields in the store that are used for the FX risk-class. See the UnderlyingDescription store documentation for details on the store.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Risk Factor Currency	Underlying	

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Data Model Field	Store Field	Notes
Risk Class	RiskClass	“FX”
	UnderlyingFXOriginalCcy	Same as Underlying

1.8.6 Delta

The **Delta** store contains the Delta sensitivities.

The following table lists the fields in the store that are used for the FX risk-class. See the Delta store documentation for details on the store.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Trade ID	TradeId	
Risk Factor Name	Risk Factor	
Risk Class	RiskClass	“FX”
Risk Measure	Risk Measure	“Delta”
Sensitivities	DeltaSensitivities	
Sensitivity Currency	Ccy	
Interpolated Sensitivities	DeltaSensitivities - Interpolated	
Optionality	Optionality	‘Y’ or ‘N’
	OriginalOptionality	Same as Optionality

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Data Model Field	Store Field	Notes
	FXComplexTrade	'Y' or 'N'
	FXOtherCcy	
	FXDividerEligibility	'Y' or 'N'

1.8.7 Vega

The **Vega** store contains the Vega sensitivities.

The following table lists the fields in the store that are used for the FX risk-class. See the Vega store documentation for details on the store.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Trade ID	TradeId	
Risk Factor Name	Risk Factor	
Risk Class	RiskClass	"FX"
Risk Measure	Risk Measure	"Vega"
Sensitivities	VegaSensitivities	Vector-valued. Same size as Sensitivity Tenors
Sensitivity Tenors	OptionMaturity	Vector-valued
Sensitivity Currency	Ccy	
Interpolated Sensitivities	VegaSensitivities - Interpolated	Vector-valued. Indexed by prescribed Tenors

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.8.8 Curvature

The **Curvature** store contains the Curvature shocked prices.

The following table lists the fields in the store that are used for the FX risk-class. See the Curvature store documentation for details on the store.

Data Model Field	Store Field	Notes
As-Of Date	AsOfDate	
Trade ID	TradeId	
Risk Factor Name	Risk Factor	
Risk Class	RiskClass	"FX"
Risk Measure	Risk Measure	"Curvature"
Shock Up	Shift_Up_PV	Vector-valued. Same size as Risk Weight
Shock Down	Shift_Down_PV	Vector-valued. Same size as Risk Weight
Risk Weight	RiskWeight	(optional) Vector-valued
PV Applied	PVApplied	'Y' or 'N'
Sensitivity Currency	Ccy	
	FXDividerEligibility	'Y' or 'N'

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.9 Cube Schema (Reference Implementation)

The following table lists the levels and hierarchies in the Cube schema that are used in the FX data model.

Data Model Field	Cube Level	Notes
As-Of Date	AsOfDate	Slicing Hierarchy
Trade ID	TradeId	
Risk Class	Risk Class	“FX”
Risk Measure	Risk Measure	“Delta”, “Vega”, “Curvature”
Bucket	FX Bucket	
Risk Factor Name	Risk Factor	
Option Maturity	Vertex	Analysis Hierarchy
Risk Factory Currency	Underlying	
Counter Currency	FX Counter Currency	
		Levels for the Delta Double Sums and Correlations
		Levels for the Vega Double Sums and Correlations

1.10 Configuration (Core)

This section describes how the calculations are configured for the FX risk class

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.10.1 Delta Special Crosses

The list of currency pairs in [MAR21.88].

The file **FX_Special_Crosses*.csv** is loaded into the **FXDeltaSpecialCrosses** store.

Data Model Field	File Column	Datastore Column	Notes
Left-hand side of currency pair	Num	Num	
Right-hand side of currency pair	Den	Den	

1.10.2 Vertices

The list of FX Vega Option Maturities.

The file **Vertices*.csv** is loaded into the **Vertices** store.

Data Model Field	File Column	Datastore Column	Notes
	Index	Index	0-4
Option Maturity	Vertex	Vertex	0.5;1;3;5;10 Option Maturities in [MAR21.14](2)
Risk Class	Risk Class	RiskClass	“FX”
Risk Measure	Risk Measure	Risk Measure	“Vega”

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

1.10.3 Vega Liquidity Horizons

The file **Vega_Liquidity_Horizons*.csv** is loaded into the **VegaRiskWeights** store.

Data Model Field	File Column	Datastore Column	Notes
Risk Class	Risk Class	RiskClass	"FX"
$LH_{\text{risk class}}$ in [MAR21.92]	Vega LH	Liquidity Horizon	"40"

1.10.4 Miscellaneous Parameters

The file **FRTBParameters*.csv** is loaded into the **FRTBParameters** store.

Parameter	Parameter Name	Default Value
RW_k in [MAR21.87]	sa.fx.delta.rw	0.15
RW_k divider in [MAR21.87]	sa.fx.delta.rw.selected.pair.adjustment	1.4142135623731
γ_{bc} in [MAR21.89]	sa.fx.correlation	0.6
CVR_k divider in [MAR21.98]	sa.fx.curvature.divider	1.5
Reporting Currency	sa.fx.reporting-currency	EUR
Base Currency	sa.fx.base-currency	EUR
Is the Base Currency used?	sa.fx.use.base-currency	false
Divide CVR_k by divider in [MAR21.98]	sa.fx.use.fx-divider	false

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited

Parameter	Parameter Name	Default Value
RW_σ in [MAR21.92]	sa.vega.rw	0.55
α in [MAR21.93](1)(a)	sa.vega.rho-option-maturity.alpha	0.01

}

2022 ActiveViam ALL RIGHTS RESERVED. This material is the CONFIDENTIAL and PROPRIETARY property of ActiveViam. Any unauthorized use, reproduction or transfer of this material is strictly prohibited