

DBIQ Volatility Surface Creation Process

Summary

This document describes the primary price sources for market data used by the Deutsche Bank Index Quant group (“DBIQ”), a research function within the Deutsche Bank AG Research team which, in turn, is within the Chairman’s office, to construct interest rate volatility surfaces (each a “**Volatility Surface**”) that are used for the purposes of certain calculations in relation to derivative contracts, securities and DBIQ proprietary benchmarks.

A Volatility Surface for a specific currency and fixing time is created using **market data** and **specific interpolation and extrapolation methods**. Each Volatility Surface is used in conjunction with an interest rate yield curve (created using the DBIQ Interest Rate Curve Creation Process document dated March 2016 (as amended and/or supplemented from time to time and published on the DBIQ Website)), and hence the relevant market conventions of the instruments and rates comprising the yield curve are also specified in the creation of the relevant Volatility Surface. Please refer to the DBIQ Interest Rate Curve Creation Process document for details of the underlying instruments.

Market Data

The market data used for the purposes of determining a Volatility Surface consists of swaption pricing, quoted in terms of volatility. Each swaption is an option (the “**Option**”) from the perspective of either a fixed rate receiver or a fixed rate payer on a fixed-for-floating interest rate swap contract. The pricing of the Option follows a Black-Scholes model. Each Option is represented by three variables: Expiry, Tenor and Strike. Where:

- Expiry means the forward starting time of the Option;
- Tenor means the tenor of the Option or the fixed-for-floating interest rate swap contract; and
- Strike means the strike of the Option or the fixed rate of the fixed-for-floating interest rate swap contract.

Option pricing is grouped into **ATM Option Pricing** and **Skew**, in each case, following the option market convention.

ATM Option Pricing refers to the pricing of options whose Strike is equal to the At-the-money Rate* of fixed-for-floating interest rate swaps settling around the same Expiry and of the same Tenor.

Skew comprises the pricing of Swaptions whose Strike is less than or greater than the At-the-money Rate*, the difference measured at standard intervals of 0.5%, of fixed-for-floating interest rate swaps settling on around the same Expiry and of the same Tenor.

*The At-the-money Rate represents the fixed leg of a fixed-for-floating interest rate swap contract quoted in the relevant currency based on the relevant market convention.

Specific interpolation and extrapolation methods

The interpolation method used (which is called a trilinear method) is to create a continuous surface of market data from the discrete set of market data comprising the ATM Option Pricing and Skew.

The method used obtains this continuous surface by performing successive linear interpolations in the Expiry, Tenor and Strike planes.

Set out below are the market data tables for the Euro and United States dollar surfaces:

Strike	Expiry	Tenor	RIC
ATM	1M	10Y	USD1MX10YATM=R
ATM	2M	10Y	USD2MX10YATM=R
ATM	3M	10Y	USD3MX10YATM=R
ATM-1.5%	1M	10Y	USD1MX10YN4=R
ATM-1.5%	2M	10Y	USD2MX10YN4=R
ATM-1.5%	3M	10Y	USD3MX10YN4=R
ATM-1%	1M	10Y	USD1MX10YN3=R
ATM-1%	2M	10Y	USD2MX10YN3=R
ATM-1%	3M	10Y	USD3MX10YN3=R
ATM-0.5%	1M	10Y	USD1MX10YN2=R
ATM-0.5%	2M	10Y	USD2MX10YN2=R



db Index Development

10 October 2016

ATM-0.5%	3M	10Y	USD3MX10YN2=R
ATM-0.25%	1M	10Y	USD1MX10YN1=R
ATM-0.25%	2M	10Y	USD2MX10YN1=R
ATM-0.25%	3M	10Y	USD3MX10YN1=R
ATM+1.5%	1M	10Y	USD1MX10YP4=R
ATM+1.5%	2M	10Y	USD2MX10YP4=R
ATM+1.5%	3M	10Y	USD3MX10YP4=R
ATM+1%	1M	10Y	USD1MX10YP3=R
ATM+1%	2M	10Y	USD2MX10YP3=R
ATM+1%	3M	10Y	USD3MX10YP3=R
ATM+0.5%	1M	10Y	USD1MX10YP2=R
ATM+0.5%	2M	10Y	USD2MX10YP2=R
ATM+0.5%	3M	10Y	USD3MX10YP2=R
ATM+0.25%	1M	10Y	USD1MX10YP1=R
ATM+0.25%	2M	10Y	USD2MX10YP1=R
ATM+0.25%	3M	10Y	USD3MX10YP1=R

Strike	Expiry	Tenor	RIC
ATM	1M	10Y	EUR1MX10YATM=R
ATM	2M	10Y	EUR2MX10YATM=R
ATM	3M	10Y	EUR3MX10YATM=R
ATM-1.5%	1M	10Y	EUR1MX10YN4=R
ATM-1.5%	2M	10Y	EUR2MX10YN4=R
ATM-1.5%	3M	10Y	EUR3MX10YN4=R
ATM-1%	1M	10Y	EUR1MX10YN3=R
ATM-1%	2M	10Y	EUR2MX10YN3=R
ATM-1%	3M	10Y	EUR3MX10YN3=R
ATM-0.5%	1M	10Y	EUR1MX10YN2=R
ATM-0.5%	2M	10Y	EUR2MX10YN2=R
ATM-0.5%	3M	10Y	EUR3MX10YN2=R
ATM-0.25%	1M	10Y	EUR1MX10YN1=R
ATM-0.25%	2M	10Y	EUR2MX10YN1=R
ATM-0.25%	3M	10Y	EUR3MX10YN1=R
ATM+1.5%	1M	10Y	EUR1MX10YP4=R
ATM+1.5%	2M	10Y	EUR2MX10YP4=R
ATM+1.5%	3M	10Y	EUR3MX10YP4=R
ATM+1%	1M	10Y	EUR1MX10YP3=R
ATM+1%	2M	10Y	EUR2MX10YP3=R
ATM+1%	3M	10Y	EUR3MX10YP3=R
ATM+0.5%	1M	10Y	EUR1MX10YP2=R
ATM+0.5%	2M	10Y	EUR2MX10YP2=R
ATM+0.5%	3M	10Y	EUR3MX10YP2=R
ATM+0.25%	1M	10Y	EUR1MX10YP1=R
ATM+0.25%	2M	10Y	EUR2MX10YP1=R

ATM+0.25%

3M

10Y

EUR3MX10YP1=R

Data Vetting and Verification

The DBIQ Data Vetting and Verification Policy (as set out in Section 8 (*Input Data Management*) of the DBIQ User Guidance and Administrator Handbook Overview dated 31 July 2014 (or any successor publication and/or section of such publication that addresses the input data management policy of DBIQ) (the “**Handbook**”)) sets out standards which promote the use of accurate high quality data in DBIQ proprietary benchmarks produced by DBIQ. This creates a framework which DBIQ will follow to ensure minimum quality, accuracy and reliability of input data used to produce DBIQ proprietary benchmarks.

Input data is subject to quality controls and the source or provider must be responsive to challenges and queries associated with the data. Data sources should have backup processes to ensure the relevant benchmark can be calculated if data provision from a specific source or provider is to cease.

Further information on the DBIQ Data Vetting and Verification Policy can be found in the Handbook.

In accordance with the Handbook, in the event that market data from regulated venues (such as exchanges) is unavailable or does not comply with the DBIQ Data Vetting and Verification Policy specified in the Handbook, alternative price sources are sought, or changes to the DBIQ proprietary benchmark which references such Volatility Surfaces are made.