

## 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 September 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.

**Delta** is the measurement of an option’s price sensitivity to changes in the price of the underlying asset. Delta of a call option has a range between zero and one, while the delta of a put option has a range between zero and negative one. Under current market standard such methodology normally refers to the technique of applying an absolute, parallel shift to the interest rate curve by (i) positive 0.5 basis point and (ii) negative 0.5 basis point, the relevant reference instrument is then re-priced under each curve shift scenario, the average of the change in mark to market (MTM) of the instrument is then recorded as the **Delta** sensitivity.

**Vega** is the measurement of an option’s price sensitivity to changes in the volatility of the underlying asset. Under current market standard such methodology normally refers to the technique of shifting the volatility surface up by 5% relatively and then re-price the relevant reference instrument (for example, interest rate straddle), the change in mark to market (MTM) of the instrument is then recorded as the **Vega** sensitivity.

### 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.

## Market-Data Sources

### Bloomberg London Close Swaption Data

Bloomberg is the primary market data source for indices adopting a London close and valuing swaptions.

The Option pricing is sourced by a subscription to the Bloomberg Valuation Service - (BVAL), offered by Bloomberg, the data-provider. The valuations are available on subscription.

DBIQ subscribes to Interest Rate Swaption Pricing for EUR, USD, JPY and AUD, quoted as NORMAL Implied Volatility, and covering both ATM Pricing and non-ATM Pricing. The Pricing is the snapshot at 1600 London.

## 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.