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# FTSE Implied Volatility Index Series

v2.2

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The FTSE Implied Volatility Index Series is not, and is not intended to be, used by supervised entities in the European Union or the United Kingdom and accordingly, the European Benchmark Regulation\* and the UK Benchmark Regulation# do not apply to the index series. Consequently, supervised entities within the European Union and the United Kingdom are not permitted to use any of the indices within the index series as a benchmark as set out in article 3(1)(7) of the European Benchmark Regulation.

For the avoidance of doubt, neither FTSE International Limited nor any other member of the London Stock Exchange Group plc group of companies, is the benchmark administrator (as defined in article 3(1)(6) of the European Benchmark Regulation) of the index series.

\* [Regulation \(EU\) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds](#)

# [The Benchmarks \(Amendment and Transitional Provision\) \(EU Exit\) Regulations 2019 \(which amends the European benchmark regulation in the United Kingdom\)](#)



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## Section 1

# Introduction

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### 1.0 Introduction

- 1.1 This document sets out the Ground Rules for the construction and management of the FTSE Implied Volatility Index (FTSE IVI) Series. Copies of the Ground Rules are available from FTSE Russell on [www.ftserussell.com](http://www.ftserussell.com).
- 1.2 The FTSE IVI is a volatility index, which measures the interpolated 30, 60, 90, 180 and 360 day implied volatility of an underlying equity index using the index option prices.
- 1.3 The index is comprised of out-of-the-money put and call options from two expirations which span the period of interest. The price of each option reflects the market's expectation of future volatility.
- 1.4 The FTSE Implied Volatility Index Series does not take account of ESG factors in its index design.
- 1.5 The FTSE Implied Volatility Index Series are calculated on an end-of-day basis.
- 1.6 **FTSE Russell**  
FTSE Russell is a trading name of FTSE International Limited, Frank Russell Company, FTSE Global Debt Capital Markets Limited (and its subsidiaries FTSE Global Debt Capital Markets Inc. and FTSE Fixed Income Europe Limited), FTSE Fixed Income LLC, The Yield Book Inc and Beyond Ratings.
- 1.7 FTSE Russell hereby notifies users of the index series that it is possible that circumstances, including external events beyond the control of FTSE Russell, may necessitate changes to, or the cessation, of the index series and therefore, any financial contracts or other financial instruments that reference the index series or investment funds which use the index series to measure their performance should be able to withstand, or otherwise address the possibility of changes to, or cessation of, the index series.
- 1.8 Index users who choose to follow this index series or to buy products that claim to follow this index series should assess the merits of the index's rules-based methodology and take independent investment advice before investing their own or client funds. No liability whether as a result of negligence or otherwise is accepted by FTSE Russell for any losses, damages, claims and expenses suffered by any person as a result of:
  - any reliance on these Ground Rules, and/or
  - any inaccuracies in these Ground Rules, and/or
  - any non-application or misapplication of the policies or procedures described in these Ground Rules, and/or
  - any inaccuracies in the compilation of the Index or any constituent data.



## Section 2

# Management Responsibilities

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### **2.0 Management Responsibilities**

#### **2.1 FTSE International Limited (FTSE)**

2.1.1 FTSE is responsible for the operation and maintenance of the FTSE Implied Volatility Index Series.

#### **2.2 Status of these Ground Rules**

2.2.1 These Ground Rules set out the methodology and provide information about the publication of the FTSE Implied Volatility Index Series.

#### **2.3 Amendments to these Ground Rules**

2.3.1 These Ground Rules shall be subject to regular review by FTSE Russell to ensure that they continue to best reflect the aims of the index series. The review process will include consultation on any proposed changes with the relevant FTSE Russell external advisory committees and the FTSE Russell Index Governance Board.

2.3.2 As provided for in the Statement of Principles for FTSE Russell Equity Indices, where FTSE Russell determines that the Ground Rules are silent or do not specifically and unambiguously apply to the subject matter of any decision, any decision shall be based as far as practical on the Statement of Principles. After making any such determination, FTSE Russell shall advise the market of its decision at the earliest opportunity. Any such treatment will not be considered as an exception or change to the Ground Rules, or to set a precedent for future action, but FTSE Russell will consider whether the Ground Rules should subsequently be updated to provide greater clarity.



## Section 3

# FTSE Russell Index Policies

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### 3.0 FTSE Russell Index Policies

These Ground Rules should be read in conjunction with the following policy documents which can be accessed using the links below:

#### 3.1 Statement of Principles for FTSE Russell Equity Indices (the Statement of Principles)

- 3.1.1 Indices need to keep abreast of changing markets and the Ground Rules cannot anticipate every eventuality. Where the Rules do not fully cover a specific event or development, FTSE Russell will determine the appropriate treatment by reference to the Statement of Principles which summarise the ethos underlying FTSE Russell's approach to index construction. The Statement of Principles is reviewed annually and any changes proposed by FTSE Russell are presented to the FTSE Russell Policy Advisory Board for discussion before approval by the FTSE Russell Index Governance Board.

The Statement of Principles can be accessed using the following link:

[Statement\\_of\\_Principles.pdf](#)

#### 3.2 Queries and Complaints

[Benchmark\\_Determination\\_Complaints\\_Handling\\_Policy.pdf](#)

#### 3.3 Policy for Benchmark Methodology Changes

- 3.3.1 Details of FTSE Russell's policy for making benchmark methodology changes can be accessed using the following link:

[Policy\\_for\\_Benchmark\\_Methodology\\_Changes.pdf](#)

### 3.4 **FTSE Russell Governance Framework**

3.4.1 To oversee its indices, FTSE Russell employs a governance framework that encompasses product, service and technology governance. The framework incorporates the London Stock Exchange Group's three lines of defence risk management framework and is designed to meet the requirements of the IOSCO Principles for Financial Benchmarks<sup>1</sup>, the European benchmark regulation<sup>2</sup> and the UK benchmark regulation<sup>3</sup>. The FTSE Russell Governance Framework can be accessed using the following link:

[FTSE\\_Russell\\_Governance\\_Framework.pdf](#)

### 3.5 **Real Time Status Definitions**

3.5.1 For indices which are calculated in real time, please refer to the following guide for details of real time status definitions:

[Real\\_Time\\_Status\\_Definitions.pdf](#)

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<sup>1</sup> IOSCO Principles for Financial Benchmarks Final Report, FR07/13 July 2013

<sup>2</sup> Regulation (EU) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds

<sup>3</sup> The Benchmarks (Amendment and Transitional Provision) (EU Exit) Regulations 2019



## Section 4

# Eligible Securities

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### 4.0 Eligible Securities

4.1 The FTSE Implied Volatility Index Series is a set of volatility Indices that are derived from the out-of-the money put and call index options from the following Indices.

| <b>Underlying Index</b> | <b>FTSE Implied Volatility Index</b> | <b>Type</b> | <b>Currency</b> | <b>Exchange</b> |
|-------------------------|--------------------------------------|-------------|-----------------|-----------------|
| FTSE 100 Index          | FTSE 100 Implied Volatility Index    | Volatility  | GBP             | ICE Europe      |
| FTSE MIB Index          | FTSE MIB Implied Volatility Index    | Volatility  | EUR             | Borsa Italiana  |

4.2 The FTSE Implied Volatility Index uses the daily settlement prices published by the relevant exchange.

## Section 5

# Calculation Methodology

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### 5.0 Calculation Methodology

#### 5.1 Overview

5.1.1 The FTSE IVI is a volatility index, which measures the interpolated N-day implied volatility of an underlying stock index, such as the FTSE 100 or FTSE MIB. The implied volatility index is comprised of the out-of-the-money (OTM) put and call options and the price of each option reflects the market's expectation of future volatility. Like conventional indices, FTSE IVI employs rules for selecting component options and formulae to calculate index values.

5.1.2 The general formula used in the FTSE IVI calculation is:

$$\sigma^2 = \frac{2}{T} \left( 1 + \log \frac{F}{K_*} - \frac{F}{K_*} + e^{rT} \int_0^{K_*} \frac{P(K)}{K^2} dK + e^{rT} \int_{K_*}^{\infty} \frac{C(K)}{K^2} dK \right) \quad (1)$$

5.1.3 Where  $\sigma \times 100$  is the FTSE IVI,  $P(K)$  and  $C(K)$  are the put and call prices at strike  $K$ ,  $F$  is the forward index level,  $K_*$  is the strike immediately below  $F$  and  $r$  is the risk free interest rate to expiration  $T$ . The above equation can be simplified as:

$$\sigma^2 = \frac{2}{T} \left( 1 + \log \frac{F}{K_*} - \frac{F}{K_*} + e^{rT} \int_0^{\infty} \frac{Q(K)}{K^2} dK \right) \quad (2)$$

5.1.4 Where  $Q(K)$  represents the midpoint of the bid-ask spread of an option, which is a call if  $K > K_*$ , a put if  $K < K_*$ , and the average of the put and a call if  $K = K_*$ .

5.1.5 Under the FTSE IVI methodology the integral in Equation (2) used to estimate  $\sigma^2$  is calculated using a generalisation of Simpson's Rule, where the interval between strikes need not be equal.

#### 5.2 Unequal Interval Simpson's Rule

5.2.1 Simpson's Rule is an established method of numerical integration. However, when the interval between estimation points (i.e. strikes) is not equal, a more general version of Simpson's Rule is required.



5.2.2 Suppose there is a function  $f(K)$  whose values are known at  $K_0, K_0+\delta K_1, K_0+\delta K_1+\delta K_2$  and there is no requirement that  $\delta K_1=\delta K_2$ . The integral of  $f(K)$  in the interval  $[K_0, K_0+\delta K_1+\delta K_2]$  can be found with the Unequal-Interval Simpson's Rule:

$$S_I(K_0, \delta K_1, \delta K_2) = \int_{K_0}^{K_0+\delta K_1+\delta K_2} f(K) dK \approx \frac{\delta K_1 + \delta K_2}{6 \delta K_1 \delta K_2} \left( (2\delta K_1 - \delta K_2) \delta K_2 \cdot f(K_0) \right. \\ \left. + (\delta K_1 + \delta K_2)^2 \cdot f(K_0 + \delta K_1) \right. \\ \left. + (2\delta K_2 + \delta K_1) \delta K_1 \cdot f(K_0 + \delta K_1 + \delta K_2) \right) \quad (3)$$

5.2.3 In order to apply this to the integral in Equation (2), the option data is partitioned into contiguous groups of three strikes.

### 5.3 End-Point Linear Fit

5.3.1 If there is an even number of strikes in the integral of (2) then the data for that integral cannot be partitioned into contiguous sets consisting of three points. In this situation the data is partitioned into contiguous sets of three points and a final overlapping set of two points. The set of two points are integrated using linear interpolation in the normal way for trapezoidal integration:

$$L_I(K_1, K_2) = \int_{K_1}^{K_2} f(K) dK \approx (K_2 - K_1) \frac{f(K_2) + f(K_1)}{2} \quad (4)$$

### 5.4 General Integration Scheme

5.4.1 The general integration scheme employed consists of the Unequal-Interval Simpson's Rule or a mixture of the Unequal-Interval Simpson's Rule and the End-Point Linear Fit. Under this scheme integration of a set of data with  $n$  strikes requires:

$$\begin{aligned} & \text{Int} \frac{n-1}{2} \text{ applications of Unequal-Interval Simpson's Rule (Equation (3)) and} \\ & 1 - \text{Mod}(n, 2) \text{ linear interpolations at the end-points (Equation (4)).} \end{aligned}$$

5.4.2 Whilst the linear interpolation can be calculated at either end of the data series, the FTSE IVI methodology calculates any linear interpolation component using the lowest two strikes available.



## Section 6

# Step by Step Calculation Guide

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### 6.0 Step-by-Step Calculation Guide

- 6.1 FTSE IVI is comprised of near-term and next-term put and call options. Typically these correspond to the first and second contract months of the underlying future when estimating the 30-day implied volatility, but may be any consecutive months depending on the N-day volatility to be calculated.
- 6.2 In order to minimize any pricing anomalies that can occur close to expiration a cut-off of one week (7 days) to expiration is used. That is, when there is less than one week to expiration of the near-term options FTSE IVI rolls to the second and third contract months.
- 6.3 For example, suppose FTSE IVI is being calculated for the FTSE MIB index. These index options expire on the third Friday of the month. Consequently, the second Friday in September FTSE IVI would be calculated using options expiring in September and October. However, on the following Monday, the near-term options would move from September to October and the next-term options from October to November.
- 6.4 The following calculation example uses FTSE MIB option prices. Options on the FTSE MIB expire at 09:05 on the third Friday of the month and there are 13 days to expiration on the near-term and 41 on the next-term. The prices used reflect those at the close of trading at 17:40.
- 6.5 **Step 1 – Time to Expiration and Interest Rates Used in the FTSE IVI Calculation**
- 6.5.1 The FTSE IVI calculation requires the time to expiry for each term and interest rate information.
- 6.5.2 The time to expiration is calculated using the number of seconds between the calculation time and the expiration time. For the purposes of the FTSE IVI calculation the precision of the time calculation is in seconds and there are 365 days in a year.
- 6.5.3 For simplicity, it is easiest to separate the time to expiration calculation into the time remaining on the calculation day until midnight, the time from midnight to expiration on the settlement day and the time remaining in the days between:

$$T = \frac{(\text{Secs}_{\text{Calculation day}} + \text{Secs}_{\text{Settlement day}} + \text{Secs}_{\text{Remaining days}})}{\text{Seconds in 365 days}} \quad (5)$$

6.5.4 In the current example there are 6 hours 20 minutes from the calculation time to midnight, 9 hours 5 minutes from midnight to expiration and 13 days between calculation and settlement in the near-term and 41 days in the next-term. Hence, the time to expiration for the near-term and next-term is:

$$T_{\text{near}} = \frac{22800 + 32700 + 1123200}{31536000} = 0.037376$$

$$T_{\text{next}} = \frac{22800 + 32700 + 3542400}{31536000} = 0.114089$$

6.5.5 The interest rates used are the OIS term rates, quoted on the calculation date, which mature closest to the expiration date of the relevant options. The calculation uses 1 week, 2 week, 1 month, 2 month, 3 month, 6 month, 9 month and 12 month OIS terms. If two term rates are equally close to the expiration date then the nearest OIS term rate is used.

6.5.6 In the example, the near-term options expire in 13 days and the OIS term maturing closest to this is the 2 week rate. Similarly, for the next-term, the options expire in 41 days and the OIS term maturing closest to this is the 1 month rate. No OIS settlement day conventions or rate curve interpolation are considered.

6.5.7 The interest rates for this example are:

$$r_{\text{near}} = 0.375\%$$

$$r_{\text{next}} = 0.374\%$$

## 6.6 Step 2 – Select the Options to be Used in the FTSE IVI Calculation

6.6.1 Options used in the FTSE IVI calculation are those which are the out-of-the-money and have non-zero bid and ask prices (or zero mid-quote prices in the case where there is no bid or ask price information).

6.6.2 Note that the number of options used in the calculation is not fixed and will change as the underlying level and hence volatility changes.

6.6.3 For each contract month (i.e. both the near-term and next-term):

### A. Find the forward index level:

- i. This is achieved by finding the strike at which the smallest absolute difference between call and put prices occurs. For example, in Table 1 it can be seen that this occurs for both the near-term and next-term at the 16500 strike.

**Table 1:** Determining the forward index level

| Near-term |                |               |                     | Next-term |                |               |                     |
|-----------|----------------|---------------|---------------------|-----------|----------------|---------------|---------------------|
| Strike    | Call Mid-Price | Put Mid-Price | Absolute Difference | Strike    | Call Mid-Price | Put Mid-Price | Absolute Difference |
| 15750     | 789            | 96            | 693                 | 15000     | 1610           | 173           | 1437                |
| 16000     | 592            | 149           | 443                 | 15500     | 1209           | 271           | 938                 |
| 16250     | 419            | 227           | 192                 | 16000     | 856            | 418           | 438                 |
| 16500     | 277            | 335           | 58                  | 16500     | 564            | 625           | 61                  |
| 16750     | 170            | 478           | 308                 | 17000     | 337            | 899           | 562                 |
| 17000     | 98             | 655           | 557                 | 17500     | 183            | 1244          | 1061                |
| 17250     | 52             | 859           | 807                 | 18000     | 90             | 1650          | 1560                |

- ii. The forward price can be found using the formula:

$$F = \text{Strike} + e^{rT} |\text{Call price} - \text{Put price}| \quad (6)$$

- iii. The forward index prices for the near-term and next-term,  $F_{\text{near}}$  and  $F_{\text{next}}$  are:

$$F_{\text{near}} = 16500 + e^{0.00375 \times 0.037376} |227 - 335| = 16558$$

$$F_{\text{next}} = 16500 + e^{0.00374 \times 0.114089} |564 - 625| = 16561$$

**B. Determine the at-the-money (ATM) strike price:**

- i. This is the first strike  $K_*$ , immediately below (or equal to) the index forward price. Continuing with the example the ATM strikes for the near-term and next-term are  $K_{*,\text{near}} = 16500$  and  $K_{*,\text{next}} = 16500$  respectively.

**C. Select the options that are out-of-the-money (OTM):**

- i. Select the call options with strike prices  $> K_*$ . Starting with the first strike that is greater than  $K_*$  select the options with increasingly higher strike prices, but excluding options with zero bid or ask prices. No more options are considered once two consecutive zero bids or two consecutive zero asks have been found. Table 2 details the near-term calls as an example.

**Table 2:** Near Term call inclusion

| Call Strike | Bid | Ask | Included? |
|-------------|-----|-----|-----------|
| 16750       | 169 | 171 | Yes       |
| 17000       | 97  | 99  | Yes       |
| 17250       | 51  | 53  | Yes       |
| 17500       | 25  | 27  | Yes       |
| 17750       | 10  | 14  | Yes       |
| 18000       | 3   | 7   | Yes       |
| 18250       | 1   | 3   | Yes       |
| 18500       | 1   | 1   | Yes       |
| 18750       | 0   | 1   | No        |
| 19000       | 0   | 0   | No        |
| 19250       | 0   | 0   | No        |
| 19500       | 0   | 0   | No        |
| 19750       | 1   | 1   | No        |

- ii. Now select the put options with strike prices  $< K_*$ . Starting with the first strike that is less than  $K_*$  select the options with increasingly lower strike prices, but exclude options with zero bid or ask prices. No more options are considered once two consecutive zero bids or two consecutive zero asks have been found. Table 3 illustrates this for the near-term puts.

**Table 3:** Next term put inclusion

| Put Strike | Bid | Ask | Included? |
|------------|-----|-----|-----------|
| 10000      | 0   | 0   | No        |
| 10500      | 1   | 1   | Yes       |
| 11000      | 2   | 4   | Yes       |
| 11500      | 5   | 9   | Yes       |
| 12000      | 5   | 9   | Yes       |

- iii. Finally, the put and call options for the ATM strike  $K_*$ , are selected. The price used for  $K_*$  is the average of the put and call mid-quote prices. For example, as shown in Table 4, in the near-term the put and call mid-quote prices are 335 and 277 respectively, hence the price for  $K_*$  option is:

$$\text{Price}_{K_0} = \frac{277+335}{2} = 306$$

**Table 4:** Near term and next term OTM options

| Near-term Options |                    |           | Next-term Options |                    |           |
|-------------------|--------------------|-----------|-------------------|--------------------|-----------|
| Strike            | Option Type        | Mid-quote | Strike            | Option Type        | Mid-quote |
| 10500             | Put                | 1         | 9500              | Put                | 6         |
| 11000             | Put                | 3         | 10000             | Put                | 7         |
| 11500             | Put                | 7         | 10500             | Put                | 8         |
| .                 | .                  | .         | .                 | .                  | .         |
| 16000             | Put                | 149       | 15500             | Put                | 271       |
| 16250             | Put                | 227       | 16000             | Put                | 418       |
| 16500             | Put & Call average | 306       | 16500             | Put & Call average | 594.5     |
| 16750             | Call               | 170       | 17000             | Call               | 337       |
| 17000             | Call               | 98        | 17500             | Call               | 183       |
| .                 | .                  | .         | .                 | .                  | .         |
| 18000             | Call               | 5         | 19000             | Call               | 14        |
| 18250             | Call               | 2         | 19500             | Call               | 4         |
| 18500             | Call               | 1         | 20000             | Call               | 1         |

#### D. Calculate the volatility

- First determine the number of times Equations (3) and (4) need to be applied in each term.
- In the near-term there are 30 options, implying that the Unequal-Interval Simpson's Rule (Equation (3)) is applied:

$$\text{Integer part of } (30-1)/2 = 14 \text{ times}$$

and the linear end-point fit (Equation (4)) is used:

$$1 - \text{Modulus}(30, 2) = 1 \text{ time.}$$

- Therefore, near-term options must be split into one group of two and 14 groups of three contiguous strikes.
- Now calculate the contribution from each group of near-term options. For example, the contribution from the group of two strikes, 10500 and 11000 found using Equation (4) is:

$$\begin{aligned} & \frac{1}{2} \times (11000 - 10500) \times \left( \frac{3}{11000^2} + \frac{1}{10500^2} \right) \\ & = 8.4659 \times 10^{-6} \end{aligned}$$

and the contribution from strikes 11000, 11500 and 12000 found using Equation (3) is:

$$\begin{aligned} & \frac{500+500}{6 \times 500 \times 500} \times \left( (2 \times 500 - 500) \times \frac{500 \times 3}{11000^2} \right. \\ & + (500+500)^2 \times \frac{7}{11500^2} \\ & \left. + (2 \times 500 - 500) \times \frac{500 \times 7}{12000^2} \right) \\ & = 4.7521 \times 10^{-5} \end{aligned}$$

- v. A similar calculation is required for all the other groups of three strikes in the near-term. Table 5 below summarises the results for the near-term options.

**Table 5:** Near term strike grouping

| Strike group  |                |                | Strike Differences |                 | Contribution            |
|---|----------------|----------------|--------------------|-----------------|-------------------------|
| K <sub>0</sub>  | K <sub>1</sub> | K <sub>2</sub> | δK <sub>1</sub>    | δK <sub>2</sub> |                         |
| .   | 10500          | 11000          | .                  | .               | 8.4659x10 <sup>-6</sup> |
| 11000   | 11500          | 12000          | 500                | 500             | 4.7521x10 <sup>-5</sup> |
| 12000   | 12250          | 12500          | 250                | 250             | 2.3333x10 <sup>-5</sup> |
| 12500   | 12750          | 13000          | 250                | 250             | 2.1538x10 <sup>-5</sup> |
| 13000   | 13250          | 13500          | 250                | 250             | 2.0400x10 <sup>-5</sup> |
| 13500   | 13750          | 14000          | 250                | 250             | 2.3877x10 <sup>-5</sup> |
| 14000   | 14250          | 14500          | 250                | 250             | 2.8254x10 <sup>-5</sup> |
| 14500   | 14750          | 15000          | 250                | 250             | 4.6958x10 <sup>-5</sup> |
| 15000   | 15250          | 15500          | 250                | 250             | 8.9208x10 <sup>-5</sup> |
| 15500   | 15750          | 16000          | 250                | 250             | 1.9901x10 <sup>-4</sup> |
| 16000   | 16250          | 16500          | 250                | 250             | 4.2871x10 <sup>-4</sup> |
| 16500   | 16750          | 17000          | 250                | 250             | 3.2390x10 <sup>-4</sup> |
| 17000   | 17250          | 17500          | 250                | 250             | 9.3584x10 <sup>-5</sup> |
| 17500   | 17750          | 18000          | 250                | 250             | 2.1057x10 <sup>-5</sup> |
| 18000   | 18250          | 18500          | 250                | 250             | 3.5311x10 <sup>-6</sup> |
| Near-term total contribution=sum of all contributions |                |                |                    |                 | 1.3792x10 <sup>-3</sup> |

- vi. Next calculate the term preceding the integral in equation (2):

$$1 + \log \frac{F_{\text{near}}}{K_{*,\text{near}}} - \frac{F_{\text{near}}}{K_{*,\text{near}}} = 1 + \log \left( \frac{16558}{16500} \right) - \frac{16558}{16500} = -6.1637 \times 10^{-6}$$

- vii. Finally, the near-term calculation can be completed:

$$\begin{aligned} \sigma_{\text{near}}^2 &= \frac{2}{T_{\text{near}}} \left( 1 + \log \frac{F_{\text{near}}}{K_{*,\text{near}}} - \frac{F_{\text{near}}}{K_{*,\text{near}}} + e^{r_{\text{near}} T_{\text{near}}} \left[ \sum_i S_1(K_0, \delta K_1, \delta K_2) + L_1(K_1, K_2) \right] \right) \\ &= \frac{2}{0.037376} (-6.1637 \times 10^{-6} + e^{0.00375 \times 0.037376} \times 1.3792 \times 10^{-3}) \\ &= 7.3484 \times 10^{-2} \end{aligned}$$

- viii. In the next-term there are 22 options, which means there 10 groups of three options that are used with Equation (3) and one group of two options used with equation (4). The results for the next-term are given in Table 6 below.

**Table 6:** Next term strike grouping

| Strike Group  |       | Strike Differences |              |              | Contribution            |
|---|-------|--------------------|--------------|--------------|-------------------------|
| $K_0$   | $K_1$ | $K_2$              | $\delta K_1$ | $\delta K_2$ |                         |
| .   | 9500  | 10000              | .            | .            | $3.4120 \times 10^{-5}$ |
| 10000   | 10500 | 11000              | 500          | 500          | $7.2438 \times 10^{-5}$ |
| 11000   | 11500 | 12000              | 500          | 500          | $8.5208 \times 10^{-5}$ |
| 12000   | 12500 | 13000              | 500          | 500          | $1.3228 \times 10^{-4}$ |
| 13000   | 13500 | 14000              | 500          | 500          | $2.4470 \times 10^{-4}$ |
| 14000   | 14500 | 15000              | 500          | 500          | $5.3476 \times 10^{-4}$ |
| 15000   | 15500 | 16000              | 500          | 500          | $1.1523 \times 10^{-3}$ |
| 16000   | 16500 | 17000              | 500          | 500          | $1.9223 \times 10^{-3}$ |
| 17000   | 17500 | 18000              | 500          | 500          | $6.3901 \times 10^{-4}$ |
| 18000   | 18500 | 19000              | 500          | 500          | $1.2678 \times 10^{-4}$ |
| 19000   | 19500 | 20000              | 500          | 500          | $1.3893 \times 10^{-5}$ |
| Next-term total contribution=sum of all contributions |       |                    |              |              | $4.9577 \times 10^{-3}$ |

Similarly:

$$1 + \log \frac{F_{\text{next}}}{K_{*,\text{next}}} - \frac{F_{\text{next}}}{K_{*,\text{next}}} = 1 + \log \left( \frac{16561}{16500} \right) - \frac{16561}{16500} = -6.1493 \times 10^{-6}$$

and the completed next-term calculation is:

$$\begin{aligned} \sigma_{\text{next}}^2 &= \frac{2}{T_{\text{next}}} \left( 1 + \log \frac{F_{\text{next}}}{K_{*,\text{next}}} - \frac{F_{\text{next}}}{K_{*,\text{next}}} + e^{r_{\text{next}} T_{\text{next}}} \left[ \sum_i S_i(K_0, \delta K_1, \delta K_2) + L_1(K_1, K_2) \right] \right) \\ &= \frac{2}{0.114089} (-6.1493 \times 10^{-6} + e^{0.00374 \times 0.114089} \times 4.9577 \times 10^{-3}) \\ &= 8.6828 \times 10^{-2} \end{aligned}$$

- ix. The N-day FTSE IVI value can now be calculated. In this example the FTSE IVI value is a 30-day interpolated value and this interpolation requires the number of seconds to the settlement of the near-term and next-term options. The number of seconds in one year and in 30 days:

$$\begin{aligned} S_{\text{near}} &= 1178700 \\ S_{\text{next}} &= 3597900 \\ S_{\text{year}} &= 31536000 \\ S_{30 \text{ days}} &= 2592000 \end{aligned}$$

- x. With these the interpolated 30-day volatility is calculated using the following:

$$\text{FTSE IVI} = 100 \times \sqrt{\frac{S_{\text{year}}}{S_{30 \text{ days}}} \left( \frac{S_{\text{next}} - S_{30 \text{ days}}}{S_{\text{next}} - S_{\text{near}}} \times S_{\text{near}} \times \sigma_{\text{near}}^2 + \frac{S_{30 \text{ days}} - S_{\text{near}}}{S_{\text{next}} - S_{\text{near}}} \times S_{\text{next}} \times \sigma_{\text{next}}^2 \right)} \quad (7)$$

- xi. Hence, the 30 day FTSE IVI is:

$$\begin{aligned} \text{FTSE IVI} &= 100 \times \sqrt{\frac{31536000}{2592000} \times \left( \frac{3597900 - 2592000}{3597900 - 1178700} \times 1178700 \times 7.3484 \times 10^{-2} \right.} \\ &\quad \left. + \frac{2592000 - 1178700}{3597900 - 1178700} \times 3597900 \times 8.6828 \times 10^{-2} \right) \\ &= \mathbf{29.03} \end{aligned}$$



## Appendix A: Further Information

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A Glossary of Terms used in FTSE Russell's Ground Rule documents can be found using the following link:

[Glossary.pdf](#)

Further information on the FTSE Implied Volatility Index Series is available from FTSE Russell.

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