**3. Details**

**Calculation steps for the Volatility Indicator**

The volatility indicator is calculated based on the overnight return and the intraday realized variance using the following steps:

a. Calculate the sum of 5-minute squared log-returns (intraday variance for day d) over all $n$ 5-minute intervals t of a trading day $d$,

$$\text{variance}_{intraday,d} = \sum_{t=1}^{n} log\left(\frac{price_{t,d}}{price_{t-1,d}}\right)^2$$

b. Calculate the squared overnight log-return (in the same instrument) (overnight variance)

$$\text{variance}_{overnight,d} = log\left(\frac{price_{first,d}}{price_{last,d-1}}\right)^2,$$

with

$$price_{first,d} = price_{t-1,d}, with\ t = 1 \text{ and}$$

$$price_{last,d-1} = price_{t,d-1}, with\ t = n$$

c. Take the sum of intraday and overnight volatility and scale it to a 30-day volatility by multiplying with $\sqrt{30} \cdot 100$, in the following this will be called $\text{RV}_{\text{Raw}}$

$$\text{RV}_{raw,d} = \sqrt{(\text{variance}_{overnight,d} + \text{variance}_{intraday,d})}\ \sqrt{30} \cdot 100$$

d. Take the average of the $\text{RV}_{\text{Raw}}$ over the last m days (later on referred to as Averaging Window), this term is called volatility indicator:

$$Volatility\ Indicator_d = \max\left\{\frac{1}{m-1}\sum_{t=1}^{m-1} \text{RV}_{raw,d-t}, \text{RV}_{raw,d}\right\}$$

The volatility indicator will be calculated per product type for one benchmark product.