**IRS Cashflow Linearization**

ZC = ZeroCurve has following sub types - FC = Forward Zero Curve & DC = Discount Zero Curve

R = Floating Rate

We consider here a single floating coupon – all floating coupons are handled similarly. Fixed coupons are simpler. OIS swaps are also handled the same, way.

Here PV is the desired PV – can be set to 0, if desired outcome is zero.

Now the equation can be linearized as shown in section X.

**FRA Cashflow Linearization**

ZC = ZeroCurve has following sub types - FC = Forward Zero Curve & DC = Discount Zero Curve

R = Floating Rate

## FRA except AUD & NZD

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Now the equation can be linearized as described in section X.

## AUD & NZD FRAs

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Equation

Now the equation can be linearized as described in section X.

# Deposit Rate

Therefore:

# IR Future

The future price is quoted as 100-rate, where rate is in percent. The convexity adjustment is also included in the rate, i.e., rate = futureRate+convexAdjustment.

The SwapClear reports show the rate in decimal format, so for our purposes we can omit the step to get the rate from price, and for converting from percent to decimal.

Omitted steps:

rate = (100-(price+convexAdjustment))/100

Assuming above has been done already, we get:

Therefore we have:

The future has an effective date and termination date that does not necessarily match the value date and maturity date. Therefore for bootstrapping purposes a scaling has to be applied as shown below.

# Linearization

We need to formulate the linear expression such that the LHS represents the expected result, which must be a constant, and RHS contains a list of terms. Each RHS term is a combination of a scalar value multiplied by exp() factors. In the example below, F1, F2 and F3 are three terms, and ER is the expected result.

Assume:

Therefore:

Following step approximates exp() to linear expression assuming that the error di is very close to zero.

Substituting the approximation we get:

In above equation, the unknowns are the di variables – these are generated by the matrix solver as the resultant vector. We use these to correct the input rates for the next iteration.

Steps to linearize:

1. For each term:
2. F=Evaluate term using guess curve
3. For each factor in term
   1. Let s=scalar factor
   2. Let location=column in matrix given by curve & pillar in rate
   3. Calculate F\*s and add to matrix at (current row, location).

Evaluate and store ER-(Sum of all F values) in vector for current row