Yield Curve Calibration

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Justification – why do we need curve calibration? (1/2)

Usual morning on FX Derivatives Desk of some Investment Bank:

> 10:05 – hihi pls quote NDF USDRUB Notional 1 bio RUB for 1 2 3 6 and 12m OOO thx!
>
> 10:07 – hihi /1100 /2300 /3450 /6730 /13500 ref 96.00 zero PnL

- The number after "/" is so called Swap Points (SwPs). Basically, they are the amount of Roubles, divided by 10'000, you need to add to the spot to get forward price for a given maturity. For example:

- FwD 12m = spot (96.00) + 13500 / 10000 = 97.35. To this price we need to add PnL and send result to the Client. However, it is incorrect to add PnL directly to FwD, instead, we shift implied rate differential

How to get Implied from SwPs?

- Linear Approximation (good enough):

$$r \to SwPs = S_0 r T \Rightarrow r = \frac{SwPs}{S_0 T}$$

- Annual Compounding:

$$r \to SwPs = S_0((1+r)^T - 1) \Rightarrow r = \sqrt[T]{\frac{FwD}{S_0}} - 1$$

- Exponential Compounding:

$$r \to SwPs = S_0(e^{rT} - 1) \Rightarrow r = \frac{\log(FwD/S_0)}{T}$$

Justification – why do we need curve calibration? (2/2)

To recap, in order to get final prices for the Client we need:

1. Get "fair" prices from Trading

2. Calculate implied rate differentials for all provided maturities

3. Add PnL to those rates (for example, 30 bps)

4. Calculate new SwPs with new implied rates (use the reverse of the formulas from last slide)

5. Send these new SwPs to the Client

Usually, Trading mails reference SwPs on key currencies in the morning every day. Salespeople then need to use this data in order to construct new prices to Clients (given spot shifts during the day)

However, there is an issue: what if customer asks for a price on forward with a specific (non-standard) maturity date? How can sales team calculate the correct number of SwPs to show the Client?
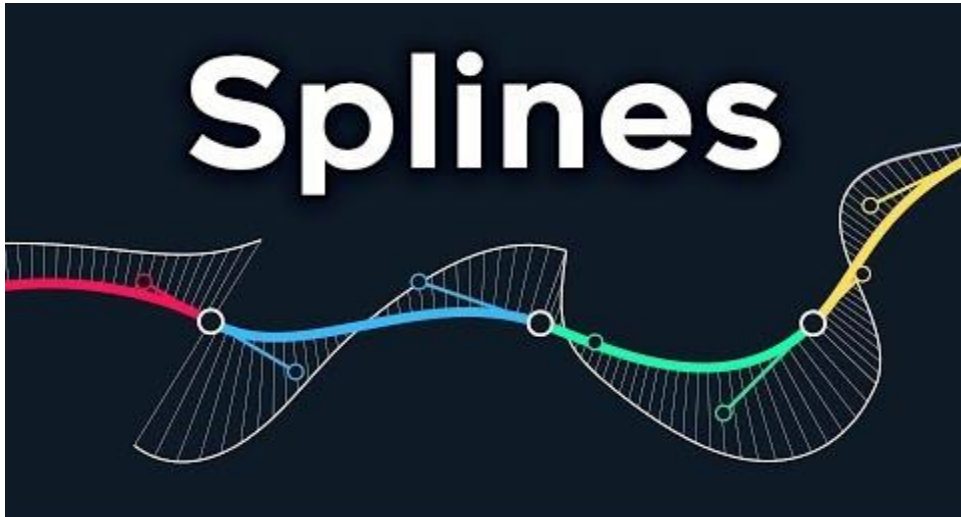

Rate differentials for standard maturities
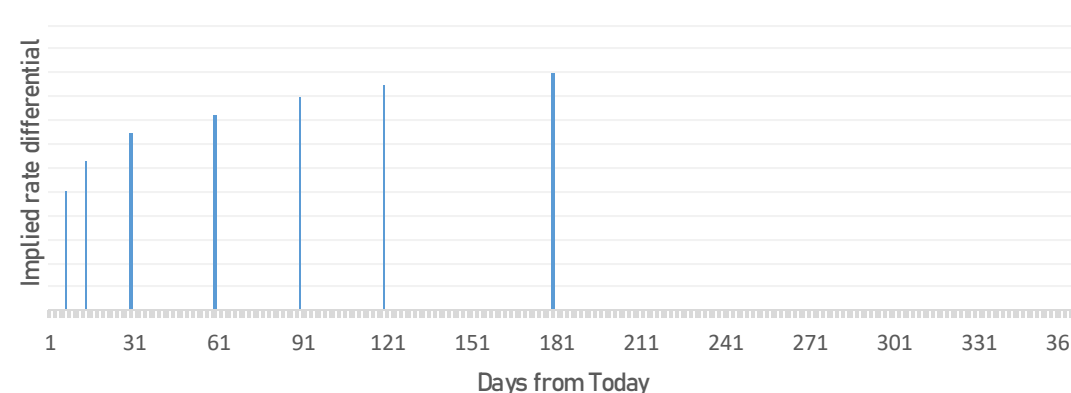
We need to fill in the gaps between known values of differentials. This is why we need interpolation!

If you want a deep-dive look into the mechanics of splines

Cannot recommend this video enough:

"The Continuity of Splines"
By Freya Holmér

An 1:13:50 explanation of everything you need to know about splines, starting from the absolute basics