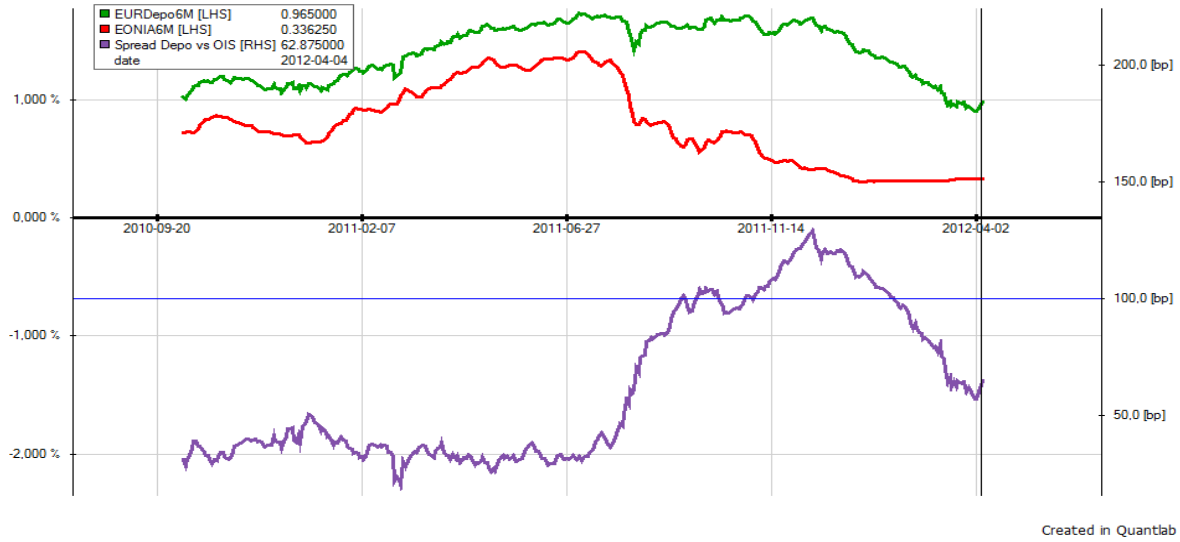
Credit crisis and dual curve construction using OIS

It has hardly escaped anyone that the credit crisis has forced the market to price in counterparty credit risk, and that this has had a profound impact on simple things like standard pricing of a fixed/float interest rate swap. The finance and mathematics behind a "simple" yield curve fit is no longer to find in the old text books, and in the following short presentation we would like to go through the basics of dual curve construction in this brave new world.



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Dual Curve Construction

for single tenor

Input data and options:

1. A blended curve having instruments of equal tenor (ex. 6M for EURSWAP market)
2. A discount curve matching the funding levels appropriate to the particular deal (ex. OIS)
3. Short-end and long-end extrapolation. No deposits in the curve. Use synthetic instruments.
4. Choice of models for the discount function and forward rates including interpolation model.

Instruments and blending

1) Forward curve instruments

- Using 6M FRA blended with EUR 6M SWAPs is one possibilty.
- Here the FRAs are prioritized.

2) Discount (funding) curve

- Overnight index swaps (OIS)
- Specifically if CSA agreements are in use.

EUR6MFRA_1M	2012-04-13	1,5920
EUR6MFRA_2M	2012-05-14	1,4820
EUR6MFRA_3M	2012-06-13	1,3850
EUR6MFRA_4M	2012-07-13	1,3210
EUR6MFRA_5M	2012-08-13	1,2790
EUR6MFRA_6M	2012-09-13	1,2400
EUR6MFRA_12M	2013-03-13	1,2170
EUR6MFRA_18M	2013-09-13	1,3170
EURSwap3Y	2014-09-15	1,4980
EURSwap4Y	2015-09-14	1,7060
EURSwap5Y	2016-09-13	1,9220
EURSwap6Y	2017-09-13	2,1120
EURSwap7Y	2018-09-13	2,2680
EURSwap8Y	2019-09-13	2,3960
EURSwap9Y	2020-09-14	2,5070
EURSwap10Y	2021-09-13	2,6050
EURSwap11Y	2022-09-13	2,6970
EURSwap12Y	2023-09-13	2,7830
EURSwap13Y	2024-09-13	2,8580
EURSwap14Y	2025-09-15	2,9190
EURSwap15Y	2026-09-14	2,9680
EURSwap16Y	2027-09-13	3,0040
EURSwap17Y	2028-09-13	3,0300
EURSwap18Y	2029-09-13	3,0460
EURSwap19Y	2030-09-13	3,0540
EURSwap20Y	2031-09-15	3,0560
EURSwap21Y	2032-09-13	3,0540
EURSwap22Y	2033-09-13	3,0490
EURSwap23Y	2034-09-13	3,0400
EURSwap24Y	2035-09-13	3,0290
EURSwap25Y	2036-09-15	3,0170
EURSwap26Y	2037-09-14	3,0040
EURSwap27Y	2038-09-13	2,9900
EURSwap28Y	2039-09-13	2,9760
EURSwap29Y	2040-09-13	2,9630
EURSwap30Y	2041-09-13	2,9510
EURSwap35Y	2046-09-13	2,9150
EURSwap40Y	2051-09-13	2,9090
EURSwap50Y	2061-09-13	2,9200
EURSwap60Y	2071-09-14	2,9280

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Curve extrapolation

Short-end

- If not using deposits we need alternate short instruments.
- Create synthetic deposits or FRAs.
- Use a constant basis.

Long-end

- Same as with short-end.
- Price synthetic zeros using constant basis.

name	maturity	yield
EUR 6M FRA-synt 1W x 1W+6M	2012-03-20	1,6450
EUR 6M FRA-synt 2W x 2W+6M	2012-03-27	1,6282
EUR6MFRA_1M	2012-04-13	1,5920
EUR6MFRA_2M	2012-05-14	1,4820
EUR6MFRA_3M	2012-06-13	1,3850
EUR6MFRA_4M	2012-07-13	1,3210
EUR6MFRA_5M	2012-08-13	1,2790
EUR6MFRA_6M	2012-09-13	1,2400
EUR6MFRA_12M	2013-03-13	1,2170
EUR6MFRA_18M	2013-09-13	1,3170
EURSwap3Y	2014-09-15	1,4980
EURSwap4Y	2015-09-14	1,7060
EURSwap5Y	2016-09-13	1,9220
EURSwap6Y	2017-09-13	2,1120
EURSwap7Y	2018-09-13	2,2680
EURSwap8Y	2019-09-13	2,3960
EURSwap9Y	2020-09-14	2,5070
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EURSwap15Y	2026-09-14	2,9680
EURSwap16Y	2027-09-13	3,0040
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EURSwap21Y	2032-09-13	3,0540
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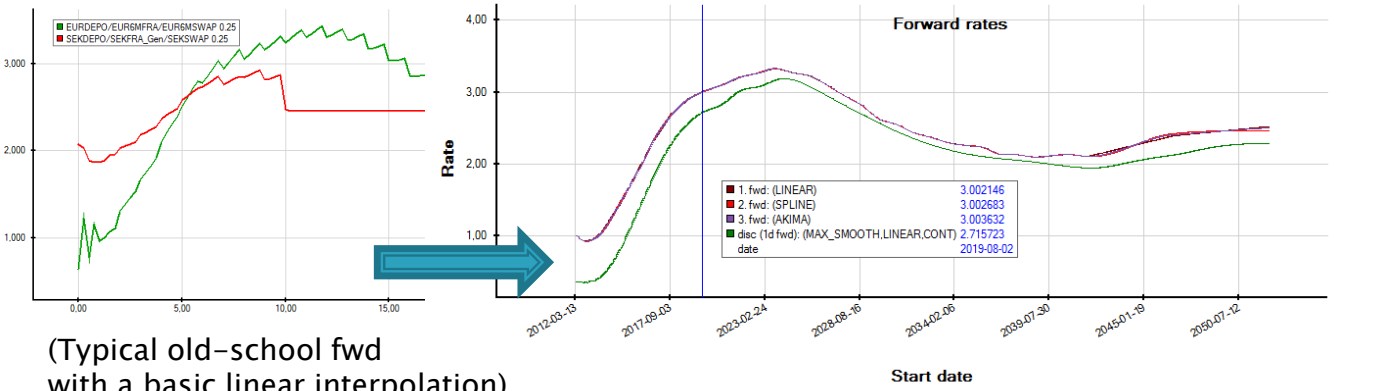
Interpolation

Two types of discount fit-models

1. Exact fit such as Bootstrap which prices all instruments exactly. Here we have a choice of interpolation models on intermediate nodes such as:
   - Linear, Step, Spline, Hagan West, Hermite, Akima, with or without Hyman monotonicity filters.
2. Best-fit models such as Maximum-Smoothness, Tension-Splines, Taanggard, Nelson-Siegel etc.

Interpolate the discrete forward tenor curve

Linear, Step, Spline, Hermite, Akima, with or without Hyman monotonicity filters.

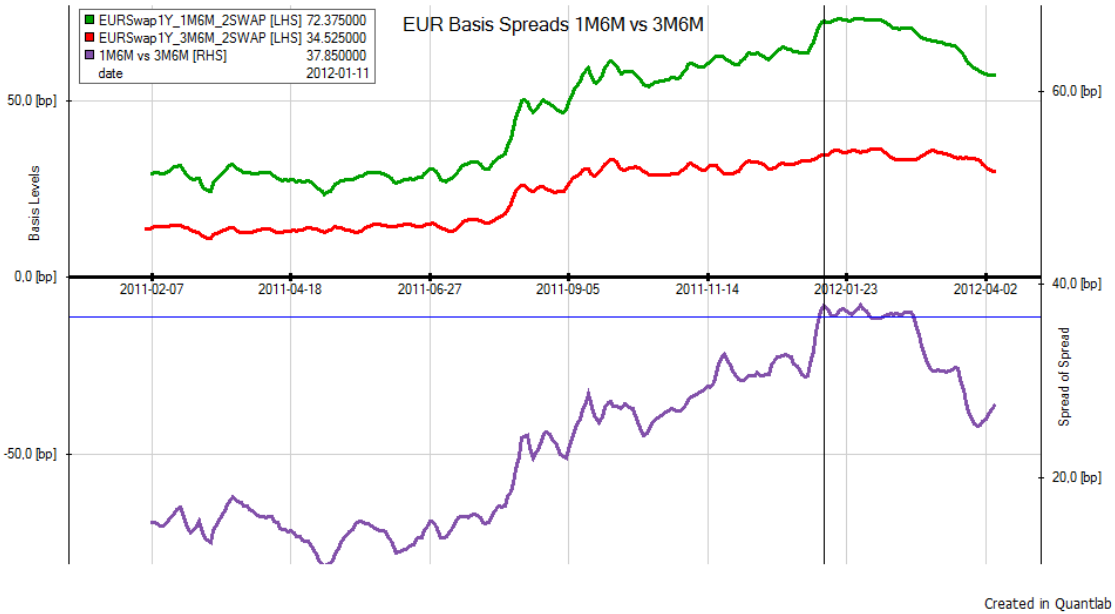


(Typical old-school fwd with a basic linear interpolation)

Dual Curve Construction

for multiple tenors

We now want to repeat the forward curve construction for all non-standard tenors such as the 1M, 3M, and 12M, interpolated on the discrete forward rates. The swap curve is now a ”swap surface”.
In order to do so we also need the relevant basis spread curves.



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Multiple tenors cont.

We can now extend the non-standard curves using 1M MM Swaps on the 1M curve, 3M Futures on the 3M curve, 12M FRAs on the 12M curve etc.

Hopefully we now end up with a set of forward curves all created using the dual curve set-up and joint OIS discounting.