Quantitative Finance

Which models do Bloomberg/Reuters use to derive implied volatility for interest rate derivatives with negative forward rates?

Asked 7 years, 11 months ago Modified 9 months ago Viewed 4k times

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can anybody tell me which models Bloomberg and Reuters ares using to derive implied volatility for interest derivatives with negative forward rates?

I know that Black-76 is the standard model, and that ICAP for example uses the displaced diffusion version of Black's model... but do Bloomberg and Reuters get their data from ICAP? Or do they also have internal models?

I recently started using Bloomberg and find it very confusing sometimes...

It would be very helpful if anybody had some literature about this issue or about the different models used by data providers. I would like to write a paper on this topic but the info is pretty limited... at least for somebody like me.

The only helpful article I found was this: d-fine - New volatility conventions in negative interest environment

Thank you!

Philipp

implied-volatility derivatives bloomberg negative black76

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asked Nov 23, 2016 at 9:46

Philipp
41 1 2

3 On Bloomberg, if you ask HELP HELP, they should be able to direct you to the relevant documentation. – assylias Nov 23, 2016 at 9:58

2 Answers

Sorted by: Highest score (default)

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Short Version

- Market standard (since the low interest rate environment after 2008) is to use Normal Vol (used in the Normal / Bachelier model)
- Market data comes from contributors like Tullett, ICAP and the like and can be premium and vol quoted etc.
- Usually, these quotes are filtered and combined into a generic quote (e.g. BVOL for Bloomberg Volatility)
- Quotes are combined to a vol cube. If premium quoted, the premium is "translated" into the respective vol based on the model (Black or Bachelier / Normal)
- Frequently, the SABR model is used to interpolate (and extrapolate) a vol smile.

Long Version

While I agree that this is best asked at the help desk, I am less confident that you will get a concise answer for a question about the complex task of building a vol surface, that requires knowledge about market data and conventions as well as the models (computations) involved in the process. Bloomberg's white paper alone is 42 pages long but does not even address where the data itself comes from. Below is my attempt to provide a short summary that should outline the basics, some of which will be off topic as they are assumed to be common knowledge. Nonetheless, it may probably help a few beginners in the field.

Reuters and Bloomberg require quotes from market makers. In terms of Bloomberg, `VCUB` is the function that handles all the market data and combines it to a full-fledged vol cube. It is called a cube because the input data is a set of points in a 3-dimensional space (expiry, tenor and strike).

You can retrieve the white paper on VCUB's help page (F1 or HELP VCUB). In essence, VCUB has two tabs:

- `Analyze Cube` : the output (the vol cube)
- `Market Data` : the input data

Market data in interest rate derivatives comes in many ways. You can look at VCUB to see the different types, but in my opinion, `NSV` is even better for this, because you can go to 92) enhanced monitor to have more choices and directly display the associates tickers. In terms of ICAP, `VOLS` brings you directly to the contributor page, where you can find the various types of

quotes:

In general, there exist

- *ATM Swaptions*: can be vol quoted, premium spot, and premium forward quoted
- *OTM Swaptions*: typically, only available for the most liquid markets and frequently provided on a fixed grid of off-the-money strikes specified as an offset relative to the ATM strike
- *Caps*: Interest Rate Caps are a sequential series of interest rate options called caplets sharing the same strike. For a given (quoted price) of the cap, the implied vol (Black or Normal) is defined as the single vol applied to every caplet in the cap that delivers the given price of the cap - in the respective model.
- *Interest Rate Floors*: same logic as caps

Black-76 formula for pricing a call is (in essence Black-Scholes in terms of forward price instead of spot)

$$C_{BS}(K) = F_0 N(d_1) - K N(d_2)$$

where $d_{1,2} = \frac{\log(F_0/K)}{\sigma_{BS}\sqrt{T}} \pm \frac{\sigma_{BS}\sqrt{T}}{2}$.

Bachelier

$$C_N(K) = (F_0 - K)N(d_N) + \sigma_N \sqrt{T} n(d_N)$$

where $d_N = \frac{F_0 - K}{\sigma_N \sqrt{T}}$.

Given identical K, F_0, T you have to use different implied volatilities σ_{BS} and σ_N to match the market price in both models as the volatility has different meanings in each model. Black assumes a lognormal distribution of the underlying and σ_{BS} measures the relative change in F_t, quoted in percent. Bachelier model assumes a normal distribution and σ_N measures the absolute change in F_t, quoted in basis points. Therefore, the probability of the forward rate going from 1% to 2% is the same as the probability of it going from 2% to 4% in Black, and from 2% to 3% in Bachelier. Some details about the connection (conversion) between Black-Scholes and

Bachelier volatilities can for example be found in A Black-Scholes user's guide to the Bachelier model.

For ATM strikes, you can approximate one versus the other as

$$Black\ vol * ATM\ strike \approx Normal\ vol$$

In the screenshot from SWPM below, Black and Bachelier are used to price the same option. NPV is practically identical, but Vol is different. However,

$$23.61 * 2.489792 = 58.78 \approx 58.63$$

Moving back to Bloomberg, for example, `EUSP0101 Curncy DES` is a premium quoted straddle. Usually, at least since a few years, quotes would be more liquid and reliable as normal vol (direct Bachelier vol quotes) like EUR SWPT NVOL OISv3 1Y1Y, which has the ticker `EUNE11 Curncy DES`. `USSN015 Curncy` is the ticker for the 1y5y USD Swaption ATM Normal Vol quote for 3m LIBOR with OIS discounting:

You can look at `ALLQ` to see what market makers you have access to for any given ticker.

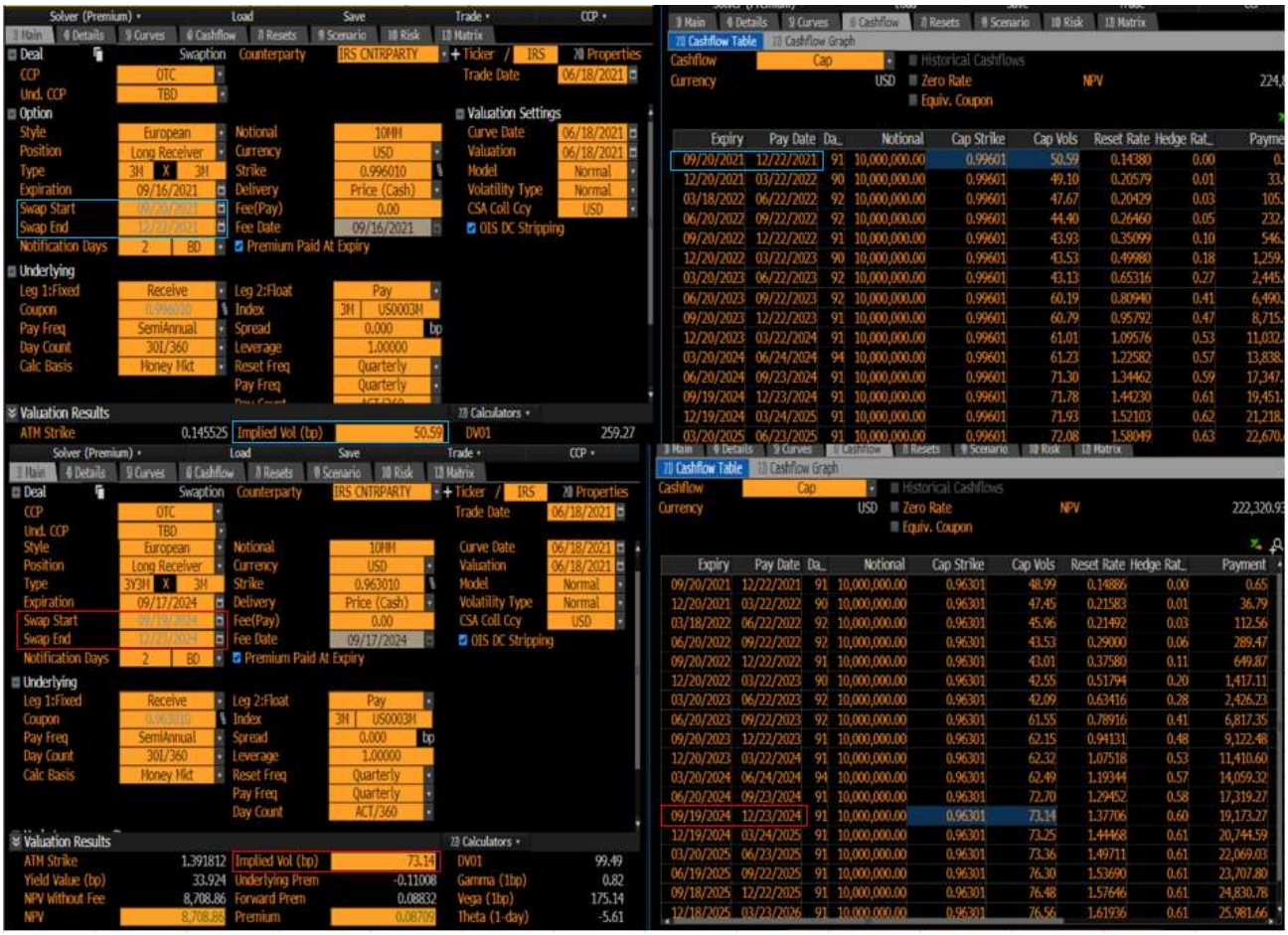
The purpose of a VOL cube is to combine liquid quotes of interest rate caps / floors and swaptions to a volatility cube that can be used to price interest rate derivatives. What quotes to choose is a bit of art. Essentially, liquidity is the main concern, and in terms of negative rates, also feasibility. For example, Black (lognormal) quotes are naturally undefined for negative rates as can be seen in the screenshot from VCUB below.

The ICAP page (VOLS) shows that there are also shifted Black quotes, but the market generally uses Normal Vols nowadays. Once the set of market data to use is defined, you need to combine the market data to a cube. in VCUB, you have quite a lot of flexibility here, where BVOL stands for Bloomberg Volatility, which is a combination of various market quotes on ALLQ, filtered for update frequency, spikes etc. If you want, you can directly choose a contributor of your choice as well (Tullett, ICAP etc.)

SABR is used to fit the vol surface to quotes. This will usually NOT fit quoted vols as it is a general best fit around all points. If matching quoted vols is a desired feature, you can for example combine piecewise linear within the quoted spectrum and SABR for extrapolation as a choice in VCUB.

The shift in the SABR model is to handle negative strikes and should not be confused with the shifted Black vol quotation. The Normal model is valid on (-Inf, +Inf) in strike dimension. However, the SABR model have a boundary at strike 0. That's why when you use SABR, you must set up a shift when you are dealing with negative forwards or strikes.

Since, as mentioned above, a Cap Vol is the single vol applied to every caplet, Bloomberg uses the so called cap stripping to extract the volatilities of individual caplets implied by the quotes of the caps that consist of them. The additional benefit of this is that you get one surface since Caplet pricing can directly use swaption vol because each optlet can be seen as a one period swaption. So caplet vol is swaption vol (for given expiry and swap end as well as strike).



That is also why Bloomberg does not have scenarios for cap / floor vol shifts but only swaption vol shift in their scenarios.

Some potentially useful questions and answers here (in no particular order):

- Where can I find caplet implied volatility data
- Does it matter that Bachelier IV differs from BS IV for a given option price?
- From implied vol to shifted Black volatility
- OIS discounting - Is SOFR to replace LIBOR or Fed Fund Rate or both
- What is the importance of alpha, beta, rho in the SABR volatility model?
- SABR Question: Why does the market take the beta parameter as a constant?
- Bartlett's modified Delta for the SABR model

Share Improve this answer Follow edited Feb 11 at 0:16 answered Dec 25, 2022 at 16:06

AKdemy
9,574 3 26 146

-1

as per the paper , shifted logN , and Normal are both used by bloomberg

i am not sure where bbg / reuters get their data from

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edited Dec 15, 2016 at 20:56

answered Dec 15, 2016 at 19:29
Randor
796 1 7 25