

## Multi-curve and collateral framework

The interest rate market has changed dramatically since the financial crisis start in 2007. Most of the models used in academic literature and by practitioners had to be reviewed with those changes in mind. Another market reality has gained more importance and became the de facto market standard with the new regulation that came into effect in March 2017: the collateralization of derivatives trades. The course describes in details those two related major changes that are the adoption of the multi-curve framework and the collateral framework.

The multi-curve framework is a way to describe coherently a market where basis swaps, exchanging payments linked to different indices, require a spread. Not all the indices are equal, and each index requires its own curve. Nevertheless, the curves cannot be created indiscriminately if one wants to maintain a coherent approach.

The workshop details the foundations of this approach which has been adopted as the new standard. We analyse the impact on the interaction between the curves, how market instrument liquidity and conventions force curves that are a lot more than simply a collection of single curves. A very generic curve calibration process, adapted to the multi-curve framework, is described. Even if the frameworks for multi-curve is nowadays relatively standard, their details and the far-reaching impacts of seemingly small changes are not always fully understood. Constructing multiple curves is only a small part of the game in practice. The real challenge is to use them to hedge portfolios and describe risks coherently.

The other side of changes in the market is the emphasis on collateralization and its impact on derivative pricing. Part of the course is devoted to the extension of the multi-curve framework in presence of collateral. In particular the so-called "OIS discounting" pricing is analysed in detail, including its often hidden hypothesis. The collateral pricing is at the same time a very robust framework when all the ingredients are there but very fragile when you try to create it or want to change some ingredients. This is a very important aspect that need to be kept in mind in th current situation where benchmarks (LIBOR and overnight) are reformed.

**Prerequisites for the attendees:** Understanding of the main interest rate derivatives (swaps, OIS, FRAs). Familiarity with the pricing of derivatives. Basic stochastic calculus.

The lecture notes of the workshop are provided in the form of the book Interest Rate Modelling in the Multi-Curve Framework: Foundations, Evolution and Implementation, Palgrave (2014).

### Workshop Agenda

#### Pricing with collateral (VM) - cash

- Margin: terminology and fundamentals
- Regulatory framework for Variation Margin, time table.
- Cash collateral and generalization. The cash-collateral discounting approach has been around for a couple of years now. The standard results and their exact application. Extension to generalized definitions of collateral. What is hidden behind OIS discounting (and when it cannot be used).

#### Pricing with collateral (VM) - asset and foreign currency

- Assets (bonds) collateral. Not all CSA/collateral agreements are based on cash. Generalization of collateral results for collateral with assets (collateral square).
- Foreign currency collateral.

#### Multi-curve framework

- Definitions and fundamental hypothesis of the framework. Relation to collateral. The basic instruments. The multi-curve framework is based on relatively simple hypothesis, but those hypotheses are far reaching with subtle impacts.

- Market fragmentation

### **Curve calibration**

- Standalone curves or simultaneous calibration. The multi-curve framework is more than a juxtaposition of single curves. Two-swaps basis swaps in EUR, SOFR in USD (LIBOR/SOFR basis swaps).
- Curve description: Defining flexible curves. Spread curves. What to interpolate? Impact of interpolation on risk.
- Risk computation: the growing number of (delta) risk figures. With multiple curves, the number of risk factors is also multiplied. How to look at risks for (linear) products? Jacobian/transition matrices.
- Curves are never simple. Incorporating turn-of-year, central bank meeting dates, dealing with sparse data,
- Risk management in a multi-curve/multi-currency framework. How appearance of risk is changing with the selection of calibration instruments.
- The market quotes are quite heterogeneous in term of instrument used and tenors. Standardisation of nodes and remapping of risk make it easier to read reports. It can also be used to store/use historical data for VaR, scenarios, statistical analysis. The synthetic curves.
- Workshop: Standalone tool: example of curve calibration, price and bucketed PV01

### **Pricing with collateral (VM) - asset and foreign currency - 2**

- CSA delivery option: cheapest-to-deliver
- Absence of collateral and funding
- Term repos and OIS
- Hidden convexity adjustments