

Learning Curve®

Interest-Rate Models: OIS & CSA Discounting

Prior to the credit crisis, interest rate modelling was generally well understood. The underlying fundamental principles had existed for over 30 years with steady evolutions in areas that were most relevant to options and complex products. Credit and liquidity were ignored as their effects were minimal. Pricing a single currency interest rate swap was straightforward. A single interest rate curve was calibrated to liquid market products and future cash flows were estimated and discounted using this single curve. There was little variation between implementations and results across the market were consistent.

Following the credit crisis, interest rate modelling has undergone nothing short of a revolution. During the credit crisis, credit and liquidity issues drove apart previously closely related rates. For example, Euribor basis swap spreads dramatically increased and the spreads between Euribor and Eonia overnight indexed swaps diverged. In addition, the effect of counterparty credit on valuation and risk management dramatically increased. Existing modelling and infrastructure no longer worked and a rethink from first principles has taken place.

Today a new interest rate modelling framework is evolving based on OIS discounting and integrated credit valuation adjustment. Pricing a single currency interest rate swap now takes into account the difference between projected rates such as Euribor that include credit risk and the rates appropriate for discounting cash flows that are risk free or based on a funding cost. This approach is referred to as dual curve, OIS discounting, or CSA (Credit Support Annex) discounting and forces a re-derivation of derivatives valuation from first principles. In addition, the counterparty credit risk of uncollateralised over-the-counter transactions are measured as a CVA which takes into account the likelihood that the counterparty will default, along with expected exposures, volatility of these expected exposures, and wrong way risk.

Interest Rate Modelling Prior To The Credit Crisis

Prior to the credit crisis, interest rate derivatives were valued with models that focused on the dynamics and term structure of interest rates but generally ignored other elements including:

- Credit risk
- Liquidity risk
- Collateral agreements
- Funding costs

Since the introduction of **Black-Scholes** in 1973, interest rate modelling has evolved steadily. There have been several key milestones with the most recent evolutions prior to the credit crisis relating to volatility skew modelling.

Valuing a single currency vanilla interest rate swap involved calculating forward rates and discounting expected cash flows from a single interest rate curve based on no-arbitrage assumptions. These curves were calibrated from liquid interest rate products including money market securities, Eurodollar futures, FRAs and interest rate swaps. A common reference rate for euro denominated swaps is Euribor. Euribor rates are published 11am Central European Time each day and are calculated as the average (excluding the top and bottom 15%) offer rates from over 40 contributing banks for Euro Interbank deposits. Fifteen different maturities are published. These deposits are unsecured but prior to the credit crisis were considered a proxy for a risk-free rate. Similar interbank deposit rates are calculated for other currencies.

Impact Of The Credit Crisis On The Rates Market

As the credit crisis unfolded, there were significant impacts on the structure and dynamics of the rates market. Credit and liquidity drove segmentation and rates that were previously closely related diverged, causing a rethink of how these rates should be modelled.

Basis swap spreads increased dramatically

Reflecting the different credit risk and market segmentation between different Euribor rate tenors, basis swap spreads blew out during the crisis from being fractions of a basis point (where they had been quoted for decades) to double digits in a matter of months. The three-month vs. six-month Euribor basis swap spread went from under a basis point to peak at over 44 basis points around October 2008, after the **Lehman Brothers** default.

OIS and LIBOR swap rates diverged

The basis widened dramatically from under 10 basis points to peak at 222.5 basis points around Lehman's default in October 2008. The Euribor/Eonia spread has persisted even after the credit crisis and reflects the revised view of the different credit and liquidity characteristics between these two rates. The Eonia rate has now become the market standard proxy for a EUR market risk-free rate.

The relationship between forward rates of different tenors diverged

Prior to the credit crisis there were small but generally negligible differences between forward rates implied from interest rate products of different tenors. No-arbitrage arguments held and a six-month rate implied from a three-month rate and a three times six-month forward would match. As the credit crisis continued, the market segmented and this previously arbitrage-free relationship broke down.

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Increased use of collateral agreements

Another effect of the credit crisis has been a dramatic increase in the use of collateral agreements as a method of managing counterparty risk. The 2010 **International Swaps and Derivatives Association** Margin Survey reports that 70% of OTC derivatives net credit exposure worldwide is covered by collateral, compared with 29% in 2003.

The New Interest Rate Modelling Paradigm

Clearly the credit crisis had a significant impact on the interest rates market. A large part of this related to the increased importance of credit and liquidity risk along with structural changes such as an increased use of collateral agreements. These changes have driven a profound shift in the way all OTC products are valued and risk managed. The result has been an abandonment of the classic derivatives pricing framework based on single interest rate curves and the introduction of a new approach that takes into account current interest rate dynamics and market segmentation using multiple curves.

Dual curve/OIS discounting

The old style no-arbitrage, single-curve derivatives valuation framework where Euribor was a reasonable proxy for a risk neutral discount rate has been permanently changed by the credit crisis. An understanding of the credit risk embedded in Euribor and similar rates and an increased importance in the modelling of funding have driven a separation between the index rates used for the floating legs of the swap (the projection rates) and the appropriate rates used for present value (the discount rates). The market-standard rate to discount future cash flows is now OIS rates.

The method of projecting rates using Euribor and discounting rates using Eonia changes the fundamental framework for existing derivative modelling. It has required a rethink from first principles that continues to be discussed and refined. Pricing and risk managing even a vanilla single currency swap has become significantly more complex. Curve construction, pricing and hedging now involve multiple instruments and additional basis risks. These complexities, compound for interest rate products such as cross currency swaps, caps/floors and swaptions.

Funding cost

The debate about what are appropriate discount rates is still in progress. The role of funding and funding costs is a complex one. The impact of different market participants funding costs, the uncertainty in some institutions about measuring funding costs, and the impact of liquidity value adjustment are the subject of current academic and market debate.

Counterparty risk & CVA

A broader and evolving understanding of valuing and managing counterparty credit risk was well underway before the credit crisis. Many of the larger global banks had been actively measuring and managing counterparty credit risk many years prior to the crisis. The crisis, however, dramatically increased the focus for market

participants as well as regulators and accelerated the impact on the broader OTC markets. The measurement and management of counterparty risk is now something that impacts all market participants. Accurate valuation of OTC products now requires accurate valuation of the credit component of each transaction. In addition, regulatory initiatives such as Basel III and Solvency II, along with accounting rules such as ASC 820 (FAS 157) and IAS 39 have mandated more accurate counterparty risk valuation and risk management.

The larger banks have led the evolution of valuing and managing counterparty credit risk. Over time they have converged to generally consistent methods and processes. The concept of a CVA is now widely accepted and consistently calculated across the markets. OTC transactions that carry counterparty exposure executed by all the larger institutions now have a CVA component as part of the valuation. An accurate CVA calculation takes into account all transactions in the portfolio with that counterparty as well as any netting agreements, credit support annexes and collateral.

“As the credit crisis continued, the market segmented and this previously arbitrage-free relationship broke down.”

Dual Curve OIS Discounting Curve Construction

Following the credit crisis, interest rate derivatives are now valued with models that reflect the observed market segmentation, counterparty risk and interest rate dynamics. Valuing a single currency vanilla interest rate swap involves calculating forward rates based on Euribor rate curves and discounting expected cash flows using Eonia rates. As in the single curve case, these curves are calibrated from liquid interest rate products. For the euro curves this includes money market securities, futures, FRAs, Eonia swaps, basis swaps and interest rate swaps. The process is complicated, however, by changes to the modelling principles around calculating the expected forward rates. These forward rates must be conditional on the Eonia rates used for discounting.

Conclusion

A new generation of interest rate modelling is evolving. An approach based on dual curve pricing and integrated CVA has become the market consensus. There is compelling evidence that the market for interest rate products has moved to pricing on this basis, but not all market participants are at the stage where existing legacy valuation and risk management systems are up to date. The changes required for existing systems are significant and present many challenges in an environment where efficient use of capital at the business line level is becoming increasingly important.

This week's Learning Curve was written by **Rohan Douglas**, ceo, and **Peter Decrem**, director of rates products at **Quantifi**.