Derivatives Pricing in the New World: Features and Challenges

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Derivatives in the old world

Pricing

- The price was unique
- The price was clean (risk-neutral expectation of discounted payoff)
- Banks were generally regarded to be default free
- Top banks could fund themselves at a risk-free rate (LIBOR)
- Lines of credit for risky counterparties
- Interest rate derivatives priced off a single curve (per currency)
- Individual deal valuations

Derivatives in the old world (con'd)

Structuring:

- From vanillas to exotics
- From single to multiple assets for a given asset class
- From single to multiple asset classes (hybrids)

Challenges:

- Path-dependent and callable deals (pricing and Greeks)
- Competition on complex modeling and challenging numerical calculations
- Issues with lack of calibration data (volatilities, correlations, ...)

Derivatives in the new world

Pricing:

- Non-linear pricing (the price is not unique)
- Difference between price and value
- Collateral agreements
- Clearing
- XVA valuation adjustments
- Multi-curve modeling for (single currency) interest rate derivatives
- Valuations at portfolio (or even at firm) level

Derivatives in the new world (con'd)

Structuring:

- Vanillas are the new exotics
- Options on strategies
- Hybrids such as CLNs for yield enhancement
- Extinguishable swaps designed so that CVA is a gain and not a loss

Challenges:

- Pricing and hedging of XVA
- Accounting issues and new XVA debate
- Valuations at portfolio (or even at firm) level

New features and challenges

Collateral agreements

- Collateral agreements mitigate counterparty risk.
- They are defined by a Credit Support Annex (CSA).
- A CSA specifies:
    - Type and eligibility of collateral(s)
    - Collateral rate(s)
    - Frequency of collateral posting
    - Thresholds, MTAs, asymmetries, ...
- In general, however, a CSA:
    - Does not eliminate credit risk because of thresholds, asymmetries, time lags, reconciliation issues, gap risk, ...
    - May even increase credit risk (for instance when you are short a call)

New features and challenges

Clearing

- Central clearing reduces the aggregate level of exposures among banks, thus reducing systemic risk.
- However, only very few OTC deals can currently be cleared:
  - IR: single-currency fixed/float swaps, zero-coupon swaps, OIS swaps, basis swaps, FRAs, variable notional swaps, swap futures (not all currencies)
  - Credit: single name CDSs, index CDSs (not all names/indices)
  - FX: EM-currencies NDFs, cash-settled forwards (not all currencies)
  - Commodities: futures, swaps, options, indices (not all commodities)

New features and challenges

XVA

- XVA is an abbreviation for a generic (X) Valuation (V) Adjustment (A).
- XVAs are meant to be added to the clean price of the corresponding derivative.
- The X can stand for:
  - C (Credit)
  - D (Debit)
  - F (Funding)
  - L (Liquidity)
  - K (Capital)
  - IM (Initial Margin)
  - T (Tax)
  - R (Rating-based ATE or Replacement cost)
- Adjustments are not fully additive.

XVA implementation issues

- To calculate XVA at portfolio (or firm) level we must introduce a hybrid model covering all asset classes.
- Ideally, we want this hybrid model to be consistent with the FO models used on individual asset classes.
- In practice, there is a trade-off between model complexity and ease of implementation.
- Modeling challenges:
  - Efficient Monte Carlo simulation
  - Possibly different models for scenario generation and exposure calculation
  - American Monte Carlo for path-dependent and/or callable deals
  - Calculation of firm-wide VAs

XVA implementation issues (con'd)

- Data issues:
  - What market data should we calibrate the model to?
  - Lack of curve and volatility data for illiquid currencies
  - No CDS quotes for most counterparties
- Performance issues:
  - American Monte Carlo can be challenging
  - Large portfolios require distributed computing on clusters
  - AAD needed for GReeks
- Further modeling challenges:
  - Modeling more than one discount curve per currency
  - Modeling non-zero correlation between default and exposure (wrong-way or right-way risk)
  - Modeling different close-out conventions
  - Stochastic recovery and/or intensities of default

Conclusions

- The derivatives world changed considerably in the last few years.
- Vanillas are the new exotics.
- Focus shifted to CSA, clearing, margin calculations, XVA and accounting practices.
- Derivatives have now to be priced at portfolio level.
- Valuations require the implementation of complex and efficient hybrid models.
- Additional challenges are lack of data and performance issues.
- Ongoing debate on the definition of some XVAs and their inclusion in balance sheets.

Appendix: modern pricing of derivatives

When the collateral rate is equal to the risk free rate r and the close-out value is the risk-free one, the derivative's price (to the bank) is $V(t) = V_r(t) - CVA - FVA$, where:

$$CVA = (1-R)\int_t^T E_t\left[\lambda(u)D(t,u)\left(V_r(u) - C(u)\right)^+\right] \mathrm{d}u$$

$$FVA = \int_t^T E_t\left[(r_F(u) - r(u))D(t,u)\left(V_r(u) - C(u)\right)\right] \mathrm{d}u$$

and $V_r(t)$ is risk-free derivative's price at time t, $D(t,u) := \exp\{-\int_t^u [r_F(u) + \lambda(u)]\,\mathrm{d}u\}$, r_F is the bank's funding rate, λ is the counterparty's intensity of default, R is the counterparty's recovery rate, $C(t)$ is the value of collateral at time t.