Counterparty credit risk in portfolio risk management

Prominent financial institution failures reminded market participants that over-the-counter derivatives bring counterparty credit risk. Even as these markets move towards settlement through clearing houses, significant volumes of existing and new transactions remain bilaterally settled, especially as non-standard derivatives may not qualify for central clearing. UBS Delta is providing tools for clients to measure counterparty exposure alongside other investment risk

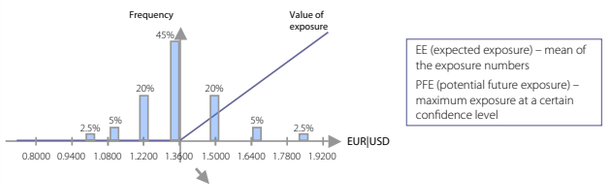
Prudent risk management of credit portfolios includes measurement and limitation of exposure to individual issuers to manage concentration risk. Investment portfolios will have limits, for example, on percentage of current value invested in securities issued by "Bank XYZ". Where over-the-counter (OTC) derivative counterparties are also issuers of securities held, counterparty risk may be incremental to issuer exposure. If a portfolio includes a swap with Bank XYZ as the counterparty, then exposure to them failing on that swap should be considered alongside exposure to them failing on their debt issues.

Counterparty credit risk measurement

Counterparty exposure is properly measured not just by the current value of trades with a counterparty, but also by how this value can move as markets move. Where sets of trades with counterparties feature multiple risk drivers/asset classes, modelling the potential exposure becomes a complex problem. Many investment banks have had to tackle this challenge. At UBS we have recently built a new counterparty risk trading system (see box, *Modelling CVA and counterparty exposure*), which we are rolling out internally and now making available to clients through UBS Delta, our portfolio risk management and performance system for clients.

Table A shows exposure measures calculated for an example large portfolio of uncollateralised in-the-money (ITM) long-dated swaps – four sets of nettable trades (netting sets) with three counterparties.

1 An illustrative model – EE and PFE



Buy EUR10m for USD13.6m, one-year forward (only trade with c/p)

Probability	2.5%	5%	20%	45%	20%	5%	2.5%
Rate (in one year)	0.9945	1.1015	1.2200	1.3512	1.4965	1.6574	1.8356
Trade value	-4.2m	-2.8m	-1.4m	0	+1.365m	+2.974m	+4.756m
Exposure	0	0	0	0	+$1.37m	**+$2.97m**	+$4.6m
Prob x exp	**0**	**0**	**0**	**0**	**$0.27m**	**$0.15m**	**$0.12m**

EE = $0.54m **97.5% PFE = $2.97m**

Source: UBS Delta

Exposure modelling

Here we use a simple example to explain exposure measures: The only trade with counterparty "MadeUpBankLtd" is a foreign exchange forward, buying EUR10m for USD, one-year forward at 1.3600. We allow (for educational purposes only) currency returns to take seven equally spaced values, with defined probabilities, as in figure 1. We calibrate the distribution ensuring that the mean price equals the forward and standard deviation of returns equals one-year volatility.

For each rate we calculate the value of the trade (and thus the netting set) and from that the counterparty exposure: positive netting set value equals exposure; negative and the exposure is zero, as money is owed to the counterparty. (Note: In either case, we will lose the transaction at default. If we wish to keep the same position in EUR|USD, the trade will need replacing.)

The average of these exposure numbers – expected exposure (EE) – is just over USD0.5m. EE is driven by EUR|USD and by the volatility of EUR|USD, due to asymmetry of the exposure profile. Potential future exposure (PFE), a measure of the extreme of the exposure, is just under USD3m, at the 97.5% confidence level. PFE is commonly used to limit exposure to individual counterparties.

EE numbers have the advantage that, when being aggregated across netting sets (that cannot be netted together), the EEs are additive, unlike PFEs. EEs are therefore often used for portfolio level measures and limits.

Sensitivities

We can use this simple model to derive useful measures of sensitivity of exposure to market drivers and volatility changes. Shifting EUR|USD up by 0.01 pushes the EE up on this trade by ~USD32,000 and the exposure rises by ~USD49,000 per one point rise in volatility. Where netting sets have large numbers of market drivers, sensitivity measures are very useful, especially when volatile markets cause large exposure moves just as counterparty credit may need extra attention.

Exposure profiles

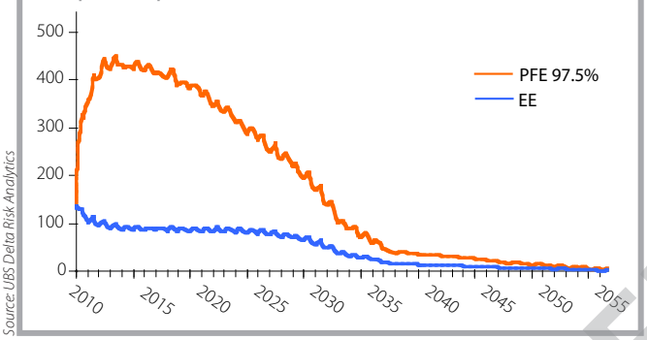
Performing the same exercise for different time horizons will give EE and PFE exposure profiles. Taking the second row of table A as an example, we can show the exposure profile (EE and PFE) across the maturity spectrum for this set of receive-fixed ITM swaps (see figure 2). Many risk limit frameworks use peak PFE/peak EE measures, as shown in table A.

A. Exposure and sensitivities – summary

Counterparty/netting set	Value (millions)	Peak 97.5% PFE (millions)	Peak EE (millions)	CVA (millions)	Spread delta	EUR IR delta
A Bank Ltd	380.7	893.9	380.7	27.8	247,323	-276,062
DEF Ltd (Set 1)	136.2	450.6	136.2	13.2	98,041	-130,416
DEF Ltd (Set 2)	364.8	930.6	364.8	40.8	208,958	-481,542
GHI, Inc.	299.8	762.8	299.8	29.0	162,441	-298,540
Total	1,181.5	–	1,181.5	110.8	716,763	-1,186,560

Source: UBS Delta Risk Analytics

2 Exposure profile – DEF Ltd



Source: UBS Delta Risk Analytics

Credit valuation adjustment

Credit valuation adjustment (CVA) can be a useful measure for investment managers understanding and hedging counterparty risk. It is an accounting adjustment to positive replacement values of derivative instruments for financial institutions. It is the estimated cost of hedging counterparty exposure, based on the EE profile and the credit default swap (CDS) market, accounting for correlation between exposure and probability of counterparty default ('wrong-way risk'). Using UBS Delta, clients can calculate CVA for a netting pool and show sensitivities of CVA to movements in credit spread and underlying market drivers – table A – in order to hedge CVA.

Exposure measurement for portfolio managers

If a pension scheme chooses to bridge an asset/liability gap by receiving fixed on long-dated interest rate swaps, that hedge will only be effective as long as the counterparties to the trades survive.

Even where netting sets are collateralised, counterparty risk should be managed. For example, taking the first netting set ("ABank Ltd") above and modelling as a fully collateralised relationship gives a 15-day 99% close-out value-at-risk of USD131m.

For the buy side in general, exposure to counterparties needs to be monitored, and understanding the sensitivity of exposure to movements in underlying drivers is very important for management of counterparty risk.

Modelling CVA and counterparty exposure

The CVA quant team explains our approach to modelling exposure, now being integrated into UBS Delta:

The computational kernel of UBS's counterparty exposure system is based on models for valuing and hedging CVA. This emphasises accuracy as CVA is used to compute initial credit charges and exposure hedges. To evaluate CVA, we must evaluate portfolio price distributions. From these distributions, risk measures including EE, PFE and sensitivities are derived.

UBS's CVA system addresses the main technical challenges of computing credit exposure as follows:

- **Scenario generation.** Counterparty exposure needs a portfolio view to account for netting effects – all constituent trades are analysed using the same set of scenarios. So that the simulation and pricing methodologies deal with all types of products in a consistent way, models follow a risk-neutral dynamic, calibrated every day using the same market parameters used for mark-to-market valuation. Scenario consistency is ensured by using the same numeraire dynamics across all products.
- **Accuracy.** To deal with exotic types of transactions UBS's CVA system uses American Monte Carlo (AMC) techniques and a generic mathematical framework, which can be applied to all types of transactions in a consistent way.
- **Product representation.** UBS has developed a Portfolio Payoff Language, agnostic to the product type, which allows abstract trade representation. There is then a direct mapping between this representation and the AMC pricing algorithm.
- **C-CDS approach.** CVA is computed as the price of a contingent credit default swap. This allows determining the potential future evolution of CVA and taking into account correlation between the default of the counterparty and the underlying risk factors.
- **Sensitivities.** To enable proper CVA hedging, UBS's CVA system computes both credit and market deltas, as well as cross gammas.
- **Collateral and close-out.** To correctly price counterparty exposure, we take account of collateralisation and all credit support annex characteristics to calculate close-out risk, which can be considerable.

Reference: Cesari, G et al (2009), Modelling, Pricing, and Hedging Counterparty Credit Exposure: A Technical Guide (Springer Finance)